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Abstracts

001

INTERMITTENT HYPOXIA AS A MODEL FOR STUDYING SLEEP APNOEA AND CARDIOVASCULAR AND METABOLIC CONSEQUENCES (HELEN BEARPARK MEMORIAL LECTURE)

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Obstructive Sleep Apnoea (OSA) is a disorder combining intermittent hypoxia (IH), sleep fragmentation and respiratory efforts. OSA is frequently associated with Excessive Daytime Sleepiness and excess in traffic accidents. It also leads to frequent cardiovascular and metabolic consequences. However, obesity and visceral adiposity represent major confounding factors in OSA. Thus both the complexity of the disease and the limited access to the evaluation of intermittent hypoxia consequences at the tissue level in patients, have limited our understanding of sleep apnoea pathophysiology and the development of specific treatments. The intermittent hypoxia model was developed both in normal volunteers and in rodents, in order to study the cardiovascular and metabolic consequences of OSA, without the confounding factors met in humans. IH has been demonstrated as being associated with increased blood pressure, impaired vasoreactivity and structural arterial remodeling leading to atherosclerosis, cardiac remodeling, and myocardial infarction. There is now substantial evidence that intermittent hypoxia in rodents, as a partial model of sleep apnea, triggers atherogenesis. Blood pressure alterations and hemodynamic strains on the vascular wall, impairment in vascular reactivity, lipid metabolism dysregulation, oxidative stress and activation of pro-inflammatory transcription factors at the vascular wall level are among the key-factors promoting vascular remodeling. Also, several biological markers potentially linked with early atherosclerosis development have been evidenced as involved both in IH and in OSA patients. More recently, the role of adipose tissue has been evidenced. We found that dyslipidemic and pro-atherogenic effects of IH were in part mediated through the inflammatory remodelling of visceral white adipose tissue, when studying the effects of epididymal lipectomy in apolipoprotein E-deficient mice.

002

SNORE-LIKE VIBRATION AS A CAUSE OF CAROTID ENDOTHELIAL DYSFUNCTION AND DAMAGE

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Heavy snoring may be an independent risk factor for carotid atherosclerosis. Our previous studies using an animal model to examine direct effects of peri-carotid tissue vibration demonstrated that an external 60 Hz vibration insult stimulated carotid endothelial dysfunction manifested as decreased response to endothelium-dependent vaso-dilators and diminished accumulation of cyclic guanosine monophosphate (*cGMP*) the biological effector molecule that stimulates vascular smooth muscle relaxation (Cho JG et al. Tissue vibration induces carotid artery endothelial dysfunction: a mechanism linking snoring and carotid atherosclerosis? *Sleep*. 2011;34:751–757). Taken together these data indicated that periodic vibration of vascular tissues affected the production and/or the biological activity of endothelial nitric oxide (NO) which ultimately stimulates cGMP production in vascular smooth muscle. To explore the impact of vibration insult on the vascular endothelium further we constructed a device that transforms a recorded human snore to vibration energy, which can then be employed as an insult to cultured endothelial cells as a model of vascular tissue vibration. Human carotid artery endothelial cells (HCAEC) were exposed to 6 h of snore-vibration or not (control) and subsequently harvested for molecular and biochemical assessment. Consistent with the data obtained from the vascular tissue vibration studies *in vivo*, snore-vibrations inhibited cGMP formation in HCAEC stimulated by the vaso-relaxant acetylcholine; however cell viability remained unchanged. These outcomes indicate that NO biology is affected by vibration insult and this is not simply related to cell death. Vibration also increased gene expression of pro-inflammatory mediators including tumour necrosis factor (TNF) and monocyte chemo-attractant protein-1 MCP-1; pro-thrombotic tissue factor (Tf) and the antioxidant response element haem-oxygenase-1 (HO-1). This vibration-stimulated gene response led to the accumulation of MCP-1 (assessed by Elisa) and both Tf and HO-1 proteins (assessed by cytometry and/or immuno-fluorescence microscopy), whereas, these proteins were either not detected or expressed at low levels in the control cells. Our data suggest that pro-inflammatory/pro-thrombotic mediators are up-regulated in response to vibration challenge and that oxidative stress may be central to endothelial dysfunction induced by snore-vibration injury.

004

RELATIONSHIPS BETWEEN HORMONAL AND COGNITIVE CONSEQUENCES OF SLEEP DEPRIVATION

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It has been long established that sleep deprivation is associated with impaired memory, reduced vigilant attention, increased subjective ratings of sleepiness and impaired mood. More recently it has been found that hormonal changes, particularly changes in sex hormones such as testosterone, can also impact cognitive performance. As part of a larger program of research examining the effects of sleep restriction on glucose metabolism and sex hormones, we investigated if testosterone might act as an effect modifier between sleep restriction and impaired cognitive performance. We recruited healthy men (age range 23–39 y) with normal weight and blood biochemistry to undertake a controlled, in-residence, laboratory-based sleep restriction

protocol. The protocol included 2 nights of baseline sleep (10 h TIB; 1000 h–0800 h) followed by 5 nights where sleep was restricted to 4 h TIB (0400 h–0800 h) and 1 night for recovery (10 h TIB; 1000 h–0800 h). Meals were timed (0910 h, 1300 h, 1830 h), food intake was calorie controlled (no snacking between meals), and physical activity was minimized. At baseline and after the 5 nights of sleep restriction, blood was sampled via an indwelling catheter at 0900 h (fasting) and at 2 hourly intervals thereafter from 1000 h until 2000 h. A battery of cognitive tasks including the Psychomotor Vigilance Task (PVT), Karolinska Sleepiness Scale (KSS) and Mood, which was assessed using a visual analogue scale (VAS) ranging from 1 (Elated) to 9 (Depressed), were completed 4 times on B1 and SR5. Both days were used in the analysis. Linear Mixed Model Analyses using random intercept and nested repeated terms were conducted to determine whether testosterone was an effect modifier between sleep restriction and cognitive performance. Participants with higher testosterone levels reported greater sleepiness on the KSS following sleep restriction ($p < 0.001$) and they also recorded significantly higher lapses in vigilant attention ($p = 0.001$), more PVT errors ($p < 0.001$), and longer total lapse time ($p = 0.009$) and worse VAS mood ($p = 0.008$). The results of this study suggest that testosterone may modify the effect of sleep restriction on cognitive performance. Further investigation will be needed to provide insight into how testosterone may play a role in modifying vulnerability to sleep loss.

005

SLEEP DISORDERED BREATHING DOES NOT AFFECT NOCTURNAL DIPPING OF BLOOD PRESSURE IN PRESCHOOL CHILDREN

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Introduction: Blood pressure (BP) typically falls from wake to sleep, however this nocturnal dipping is lacking in adults with sleep disordered breathing (SDB), and the absence of dipping is associated with increased cardiovascular risk. SDB prevalence peaks in the preschool years, however, nocturnal dipping patterns have not been studied.
Methods: 163 3–5 yo children (59% M) were recruited: 128 for assessment of SDB and 35 non-snoring control children. All children underwent overnight polysomnography, with additional pulse transit time (PTT) measurement, which is non-invasive and inversely related to BP. PTT was calculated as the time delay between the ECG R-wave and the 50% point of the rise in the corresponding finger pulse wave. PTT was averaged for each 30 s epoch of sleep and mean values for wake (before sleep onset), and the first periods of NREM1&2, NREM3&4 and REM sleep were calculated for each child. Children were grouped according to their history and obstructive apnoea hypopnoea index (OAHI); control OAHI ≤ 1 event/h (n = 35); primary snoring (PS) OAHI ≤ 1 event/h (n = 66); Mild SDB 1–5 events/h (n = 34); Moderate/Severe SDB (M/S) > 5 events/h (n = 28). One-way RM ANOVA with Student-Newman-Keuls post-hoc testing was used to determine whether significant dipping occurred from wake to each sleep stage. A general linear model RM analysis assessed differences between SDB severity groups using percentage change from wake.
Results: Groups were similar for age and sex. PTT significantly increased from wake to NREM1&2, to NREM3&4 and to REM in all children ($p < 0.001$). The magnitude of the change from wake was significantly higher in NREM3&4 and REM than NREM1&2 ($p < 0.05$ for both), but the magnitude was not significantly different between the controls and the different SDB severity groups.
Conclusions: Preschool children experience a significant rise in PTT from wake to sleep, indicative of a fall in BP, which occurs irrespective of SDB severity. These results indicate that nocturnal dipping is preserved in young children with SDB. Preschool children may not have been exposed to the effects of SDB long enough to affect nocturnal dipping profiles, however further research is needed to establish the long-term effects of SDB on the cardiovascular system in these children.

006

INACTIVITY IS A RISK FACTOR FOR MODERATE-SEVERE OBSTRUCTIVE SLEEP APNOEA (OSA)

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Introduction: Inactivity is postulated to adversely affect health independently of the protective effects of exercise based physical activity. We hypothesise that 1) physical inactivity increases risk of, and exacerbates the severity of OSA; 2) the OSA symptom profile (daytime tiredness, fatigue, depression or driving risk) is more severe in physically inactive patients.
Methods: This retrospective case control study used sleep clinic patients (polysomnography defined apnea-hypopnea index AHI > 5) as cases and community controls from the Busselton Health Study. Five physical activity categories for occupation were derived from job title (sedentary; light; medium; heavy; very heavy). Four recreational physical activity categories (sedentary; low; moderate; high) were derived from self-reported questionnaire. Medium occupation and moderate recreational activity were used as minimal thresholds for optimal activity. Thus, 3 categories of relative inactivity: 1 active occupation/inactive recreation; 2 inactive occupation/active recreation; 3 inactive occupation/inactive recreation; were compared to an active occupation/active recreation category using multivariate logistic and linear regression models.
Results: Of cases, 76% (n = 1769) had moderate or severe OSA (AHI > 15). Odds ratios for moderate-severe OSA were increased with inactivity after adjustment for age, BMI, smoking and alcohol (Table).

		Males			Females		
Occupation	Recreation	OR	95% CI	P-value	OR	95% CI	P-value
Active	Active	1.0	Referent		1.0	Referent	
Active	Inactive	3.5	2.1, 5.9	<0.0001	2.0	0.9, 4.3	N.S.
Inactive	Active	1.6	1.0, 2.5	<0.0001	4.1	2.2, 7.9	<0.0001
Inactive	Inactive	4.5	2.6, 7.7	<0.0001	8.3	4.6, 15.9	<0.0001

However, within case (AHI ≥ 5) linear regression suggested inactivity was not associated with AHI. Inactive men had 2 fold risk of depression after adjustment for confounders (95% CI 1.3, 3.2).

Discussion: National guidelines recommend 30 minutes of moderate recreational exercise daily to maintain health. However, these results suggest that inactivity, during leisure time and at work, independently confer a risk of developing moderate-severe OSA.

007

POOR SLEEP HYGIENE HABITS IN EARLY CHILDHOOD: LINKS WITH PROBLEMATIC SLEEP

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Introduction: Problematic sleep is seen to affect 20–40% of the paediatric population and to have long term consequences: therefore it is crucial that these problems are identified early and are treated with the optimal method to ensure that children are developing to their full potential. We aimed to determine the effect that sleep hygiene practices have on sleep quality in a community sample of 3-year old New Zealand children, and to identify which aspects of sleep hygiene have the strongest influence.
Methods: Parents of 911 children completed a questionnaire about their child's sleep hygiene practices and sleep, and provided demographic information in 2011. The questionnaire was designed to seek information about the child's daytime practices, routines that surround bedtime, and sleep patterns. Children were classified into two groups (poor and good sleep hygiene) based on their total sleep hygiene percentile score (poor scored $\geq 75^{th}$ percentile, good scored $<75^{th}$ percentile) using a scoring system developed by the researchers.
Results: A total of 26.5% of mothers and 24.5% of fathers stated their child's sleep was a problem. After multivariate adjustment, children with poor sleep hygiene were more likely to suffer problematic sleep (odds ratio = 1.84; 95% CI, 1.18 to 2.86). A bedroom temperature not conducive to sleep was most influential on problematic sleep followed by watching TV or DVDs to fall asleep, consuming caffeine before bed, and not engaging in relaxing activities before bed. A child's failure to fall asleep in their own bed was the aspect of poor sleep hygiene most associated with problematic sleep.
Conclusions: The results emphasize the importance of establishing good sleep hygiene to avoid problematic sleep in 3-year-olds, and intervention strategies to improve sleep hygiene are recommended for future studies. The developed questionnaire and scoring system have the potential to become valuable tools in the research of problematic sleep and sleep hygiene.

008

INTERACTIVE EFFECTS OF MANDIBULAR ADVANCEMENT AND CAUDAL TRACHEAL DISPLACEMENT: A COMPUTATIONAL FINITE ELEMENT MODEL (FEM) OF THE RABBIT UPPER AIRWAY

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Introduction: Both mandibular advancement (MA) and tracheal displacement (TD) influence upper airway (UA) function in obstructive sleep apnoea (OSA) patients. We previously developed and validated a two-dimensional (mid-sagittal) FEM of the passive rabbit UA and surrounding peri-pharyngeal tissues. In the present study, we utilise this model to examine MA and TD interactive effects on peri-pharyngeal tissue stress levels, UA lumen dimensions and collapsibility.
Methods: Simulations were performed with graded MA (0 to 2.2 mm; 0.55 mm increments) combined with graded TD (0 to 8 mm; 1.1 mm increments). Model outputs (expressed as change from baseline) included: total tissue stress (sum of individual finite element stress values; TS), UA luminal cross-sectional area (ΔCSA, %), UA length (ΔL, %), and UA closing pressure (Pclose). Linear regression analysis quantified relationships (between TD and ΔCSA, ΔL or Pclose for each MA level) as an intercept (i.e. values at TD = 0 mm for each MA) and slope (i.e. % or cmH_2O per mm of TD for each MA).
Results: With TD = 0 mm, TS increased with MA from a defined zero stress state at MA = 0 mm to 1.2 MPa at MA = 2.2 mm. When TD was added, TS increased substantially across all MA reaching, with TD = 8 mm, 3.9 MPa for MA = 0 mm and 5.4 MPa for MA = 2.2 mm. ΔCSA intercept (i.e. MA without TD) increased with increasing MA, reaching 12.6% for MA = 2.2 mm, while ΔL intercept decreased with increasing MA, reaching −0.4% for MA = 2.2 mm. At MA = 0 mm, ΔCSA and ΔL increased with TD by 4.6%/mm and 1.6%/mm, respectively (both $R^2 > 0.95$), values that were not significantly different across all applied MA levels ($P > 0.1$). Pclose at baseline was −3.8 cmH_2O and initially fell by −0.8 cmH_2O to reach an intercept value of −4.6 cmH_2O at MA = 0.55 mm, and then by −0.4 cmH_2O for each additional MA increment to reach an intercept of −5.7 cmH_2O at MA = 2.2 mm. At MA = 0 mm, Pclose decreased with TD by −0.3 cmH_2O/mm ($R^2 = 0.98$), a value that was not significantly different across all applied MA levels ($P > 0.5$).
Conclusion: Our model predicts that graded MA increases peri-pharyngeal tissue stress and UA lumen size and decreases in UA collapsibility. For any MA, adding TD results in further increases in tissue stress and UA lumen size and additional decreases in collapsibility. MA and TD applied together additively raise peri-pharyngeal tissue stress levels resulting in a substantially less deformable structure than when either is applied alone.

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009

ACUTE EFFECTS OF HIGH-DOSE ALCOHOL ON SLEEP ARCHITECTURE OF 18–21 YEAR OLD COLLEGE STUDENTS

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Introduction: Binge drinking is prevalent in college student populations, however little is known about its effect on sleep in this age-group. In older adults the most consistent findings are that in the first half of the night alcohol increases slow wave sleep (SWS) and decreases REM sleep, with the opposite occurring in the second half. Alcohol also decreases sleep onset latency (SOL) and sleep efficiency, and increases wake after sleep onset (WASO). The effect of alcohol on sleep in late adolescence is of particular interest given the increase in alcohol consumption, the dramatic changes in normal sleep architecture that occur in this group, and because the acute effects of alcohol during waking are known to vary with age.
Methods: We evaluated the effect of acute alcohol consumption on sleep in 24 light drinking late adolescents (19.1 ± 1.0 yrs, 12 female) under two conditions; one with pre-sleep alcohol administration

(Dosed to 0.1% peak BAC) and the other with a placebo beverage consumed over a 30 minute period, one hour prior to bed after a standardised meal. All abstained from alcohol for 48 hrs prior to testing.
Results: Mean BAC at lights out was 0.084% in the alcohol Vs. 0.00% in the placebo condition. There were no gender effects or differences in time in bed, total sleep time or sleep onset latency (all $p > 0.05$) between conditions. However, there was less REM ($p = 0.011$) and more stage 2 sleep ($p = 0.035$) following alcohol over the night. Further, alcohol increased SWS ($p = 0.02$) and decreased REM sleep ($p < 0.001$) in the first half of the night. In the second half of the night, alcohol disrupted sleep with increased WASO (interaction: $p = 0.034$) and decreased SE ($p = 0.04$). Further, alcohol increased SWS ($p = 0.01$) in the 2nd half of the night, with no subsequent REM sleep rebound ($p = 0.262$).
Conclusion: While consistent with previous findings in adults, we did not observe the decrease in SOL or increased second half of the night REM sleep. This indicates that while alcohol is still changing sleep architecture it may be doing so differently in this age group, a group known engage in risky drinking behaviour.

010

PRETERM BIRTH IS ASSOCIATED WITH REDUCED CEREBRAL OXYGENATION DURING SLEEP

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Introduction: Preterm infants are at risk of cardiovascular complications including significantly increased risk of the Sudden Infant Death Syndrome (SIDS). SIDS is believed to result from immature cardiovascular control leading to an uncompensated hypotension in conjunction with failure of arousal from sleep. We have previously suggested that reduced arousability may be due to impaired cerebral oxygenation(1). Thus we aimed to determine the effect of preterm birth on cerebral oxygenation during sleep across the first 6 months of life.
Methods: 17 healthy term and 16 healthy preterm infants (mean gestational age 31.1 weeks; range 27–36 weeks) were recruited and underwent daytime polysomnography at three matched post-term ages: 2–4 weeks, 2–3 months and 5–6 months. In addition to the standard polysomnography measures, we measured blood pressure (Finometer™, Finometer Medical Systems, Amsterdam, The Netherlands) and cerebral tissue oxygenation index (TOI) (NIRO-200 spectrophotometer, Hamamatsu Photonics KK, Tokyo, Japan). Infants were slept in both the prone and supine sleep positions and in both sleep states, active sleep (AS) and quiet sleep (QS). Data were compared between term and preterm infants using two-way analysis of variance.
Results: Cerebral TOI was consistently lower in the preterm compared to the term cohort. At 2–4 weeks, this difference reached significance in both AS and QS and in both the prone and supine positions ($P < 0.001$ for all). At 2–3 months cerebral TOI was significantly lower in the preterm infants in AS in the supine position ($P < 0.05$) and in both sleep states in the prone position ($P < 0.001$). At 5–6 months cerebral TOI was significantly lower in the preterm cohort in both sleep states in the prone position ($P < 0.05$).
Discussion: Cerebral oxygenation is significantly lower in preterm compared to term born infants at matched post-term ages until at least 5–6 months post-term age. This difference was most marked in the prone position, which is the major SIDS risk factor. We suggest that impaired cerebral oxygenation may contribute to the increased risk of SIDS amongst the preterm population.
Reference
1. Wong FY et al. Cerebral Oxygenation Is Depressed During Sleep in Healthy Term Infants When They Sleep Prone. Pediatrics. 2011 March 1, 2011;127(3):e558–e65.

011

SLEEP TRENDS AMONG CHILDREN: IS THERE SCIENTIFIC EVIDENCE FOR DECLINING SLEEP LENGTH AND SLEEP DEPRIVATION IN CHILDHOOD AND ADOLESCENCE?

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The notion that children are sleeping less than they used to is widespread both in the scientific literature and the popular media. Secular declines in sleep, variously ascribed to electrification, increased use of technology, and 'modern lifestyle' is believed to have resulted in many children not getting enough sleep. This has raised concerns amongst parents, teachers, health care professionals and policy makers since short sleep has been associated with a wide range of detrimental physical and mental health outcomes.

Up until recently, sparse and conflicting evidence existed for secular trends in children's sleep duration. Available studies were restricted to children of specific age groups, from specific countries and over short periods of time. Interestingly, most of these studies show sleep had increased or that mixed trends exist, despite popular beliefs of a decline. Given widespread concern of a decline, amidst sparse and conflicting evidence, a systematic review and meta-analysis of 690,747 children across 20 different countries was conducted. The results of this review confirmed popular beliefs that children are sleeping less than used to, with the rate of decline being greatest for older children, boys and on schooldays.

Secular declines in sleep are concerning since short sleep has been associated with a wide range of detrimental health outcomes. However, declines in sleep may not necessarily suggest that children today are sleeping less than they need. Indeed, declines in sleep could suggest that children used to sleep more than they needed or that sleep is discretionary and that children do not need a specific amount of sleep. Interestingly, when recommendations for children's sleep are examined, we find that sleep recommendations have also declined over the years at a rate almost identical to the declines in the actual sleep duration, with recommended sleep duration consistently exceeding actual sleep time by <37 minutes, suggesting that children have always needed more sleep, regardless of how much sleep they are actually getting. In light of current trends in children's sleep, efforts are needed to better understand children's sleep need.

012

TIME TRENDS IN ADULT SLEEP DURATION: ARE WE REALLY SLEEPING LESS?

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Accumulating evidence points to chronically curtailed sleep as a risk factor for mortality and morbidity. This is alarming because adults

are thought to be sleeping less now than in the past. This decline is believed to be inevitable consequence of our modern 24-hour societies. However, there is little evidence to support the claim of an epidemic of sleep loss.

We investigated time trends in adult sleep over recent decades. Systematic review found no consistent decline in sleep duration over the past 40 years across a number of countries. As many nations experienced an increase in sleep as experienced a decrease and there were conflicting results for others. Analysis of activity diaries from Australia indicated no significant change in average sleep duration over the period 1992 to 2006. Thus the time allocated to sleep does not appear to have succumbed to the tremendous technological incursion during this period.

The public health impact of changes in average sleep duration is unclear because short (<6 hour) and long (>9 hour) durations have been the focus of epidemiological research linking sleep to long-term health outcomes. Changes in the prevalence of these risk markers may predict growing health burdens. Analysis of Time Use data from 10 OECD countries found long sleep has become more common while the prevalence of short sleep is mostly unchanged over the previous 3 decades.

The sleep quality of adults may have deteriorated over time but supporting data are limited. Data from Australian general practice indicate insomnia complaints are no more frequent than in the past although management of insomnia has changed in recent years, mainly as a result of prescribing trends. Thus current evidence does not support the notion that we are increasingly sleep-deprived. Increased public awareness and other psychological factors may be responsible for this perception.

013

TRENDS IN INSOMNIA SYMPTOMS AND USE OF SLEEP MEDICATION

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Insomnia-related symptoms have been claimed to be increasing among the adult general population. However, long-term time series of the prevalence data are scarce. The National FINRISK Study carried out since 1972 every five years using independent, random and representative population samples from different parts of Finland indicates that occasional insomnia-related symptoms have increased between 1972 and 2007 in adult general population in Finland. Increase in insomnia-related symptoms among adults may be related with economics.

School children's sleep quality may have deteriorated during the last decades. However, time series data for even shorter periods are lacking. Time series of annual National School Health Study for the period of 1996 to 2011 indicate that insomnia-related symptoms among Finnish school children aged 14–17 years have generally increased from 1996 to 2006. After that the increase has stopped and in some symptoms a slight decrease is observed. The possible underlying mechanisms are unknown.

According to the annual wholesale statistical database compiled by the Finnish Medicine Agency indicates that the consumption of traditional hypnotics (N05C) increased almost every year between 1975 and 2003. After 2003, the consumption of these drugs began to decline. The reasons for this change are not fully known. The seeming decrease in the annual use of traditional hypnotics does not mean that the consumption of sleep medication in general has started to decrease. There seems to be a change in the practices of physicians. Insomnia is increasingly treated by small subclinical doses of antidepressants and some other new drugs. These drugs are currently increasingly used for purposes other than those which they were originally developed. Long-term consequences of this practice are unknown. In regards to sleep medication, the observed change in clinical practice is in contradiction with the official care guidelines for insomnia in Finland.

014

SOCIAL, FAMILY AND WORK-RELATED DETERMINANTS OF POOR SLEEP AND SLEEP MEDICATION USE IN CONTEMPORARY SOCIETY

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Insomnia symptoms are patterned by socioeconomic status, but follow-up studies and studies focusing on broader material circumstances alongside conventional indicators of socioeconomic position are few. Moreover, a lifecourse approach provides a more comprehensive understanding about the social determinants of sleep. In addition, working conditions as well as difficulties in combining paid work and family have emerged as antecedents of insomnia. In addition to self-reported measures, determinants of more severe, objectively measured insomnia such as reimbursed hypnotics and other psychotropic medication use should be examined.

Insomnia symptoms are more prevalent among women, unmarried, those with low income, unemployed, and among disability retirees. Economic difficulties in childhood and adulthood are also important predictors of insomnia symptoms among adults independent of occupational class or income, or other conventional indicators of socioeconomic position. Economic difficulties are also associated with psychotropic medication.

Various physical and psychosocial working conditions have had strong associations with insomnia symptoms, which have remained among women and men after mutual adjustment socioeconomic position and health-related factors. Workplace bullying is also associated with subsequent self-reported insomnia symptoms and psychotropic medication. The associations between work-family conflicts and insomnia symptoms are particularly strong and equally found among women and men. Work-family conflicts also have strong associations with sleep medication among women.

Social, family and work-related determinants of insomnia and sleep medication are important among the working-aged populations. This evidence can be used to identify potential risk groups and to prevent insomnia, redundant use of medication, and subsequent ill-health and work disability.

015

DIAGNOSING OSA IN CHILDREN AND PAEDIATRIC CPAP TREATMENT

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An approach to the comprehensive assessment of a snoring child with sleep difficulties will be presented.

I will attempt to cover the common and important differential diagnoses and co-morbidities of snoring including allergy, dento-facial aspects, developmental delay/disability and gastrointestinal issues. There will be a focus on the role of CPAP and orthodontic approaches

to treatment including practical considerations when trying to establish and monitor CPAP therapy. A framework for paediatric sleep medicine/dental cooperation in the diagnosis and management of paediatric OSA will be suggested.

016

OBSTRUCTIVE SLEEP APNOEA IN CHILDREN, ASSESSMENT AND SURGICAL MANAGEMENT

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The topic explores the presentation, investigations and surgical management of paediatric sleep disordered breathing.

017

ORAL APPLIANCES AND RAPID MAXILLARY EXPANSION; AN ORTHODONTIC APPROACH TO OSA IN CHILDREN

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Children with sleep disordered breathing (SDB) manifest a spectrum of abnormal breathing ranging from simple snoring, upper airway resistance syndrome to obstructive sleep apnea syndrome (OSAS). SDB can affect a child's growth and craniofacial development leading to neurocognitive deficits and cardiovascular sequelae. In infants, symptoms may include noisy and obstructed breathing whereas in pre-school aged children, snoring and mouth breathing may be common. In school-aged children with SDB, behavioural problems, orthodontic and craniofacial abnormalities can occur. A narrow upper airway with maxillary constriction and mandibular retrusion is often phenotypical of paediatric OSAS. Specific craniofacial morphological features may include a hyperdivergent growth pattern with increased craniomandibular, intermaxillary, mandibular plane angles and increased lower anterior facial heights.

Recently, the field of orthodontics is playing a key role in the diagnosis and treatment of SDB syndromes. Oral appliances (OAs) and functional orthopaedic appliances have been used routinely in children to shift the mandible forwards thereby enlarging the upper airway and improving respiratory function. Although well researched in adults, the few studies evaluating the use of OAs as an alternative means of treating OSA in children show significant reductions in the apnea hypopnea index. Rapid maxillary expansion (RME) is a dentofacial orthopaedic procedure routinely used to open the midpalatal suture. Although mainly used is to correct dental and skeletal discrepancies, concomitant benefits include increases in nasopharyngeal airway dimensions and improvement in nasal respiration.

OA therapy and RME are emerging as valid alternative treatment options for paediatric OSA and a review of the current literature will be presented. Orthodontic therapy and assessment should be encouraged in paediatric OSAS as an early interceptive approach may modify nasal respiration and prevent obstruction of the upper airway. Early use of OAs and RME may improve the symptoms of snoring and OSAS and their potential to change the natural history of paediatric OSAS warrant further investigation.

018

DISSOCIATING COMPONENTS OF COGNITION AND AFFECT DURING SLEEP DEPRIVATION

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It is well established that sleep deprivation leads to degraded performance, including lapses in attention, slower reaction times and impairments in cognition. Sleep deprivation also impacts on an individual's mood and affective state. Early studies of sleep-related effects on cognition, such as memory and executive functioning, often found discrepant results. Thus, despite over 100 years of research on sleep loss and performance, it is unclear as to which cognitive mechanisms are differentially affected by sleep deprivation. One reason for the discrepancy in the literature regarding the cognitive effects of sleep loss is the heterogeneity of tasks that have been used for performance testing. Most available neurocognitive tests involved multiple intertwined cognitive processes that do not unambiguously reveal the underlying neural impairments. More recently, studies in the field of sleep research have begun to move away from assessing global task performance to examining isolated components of cognition and mood impaired by sleep loss, with the aim of dissociating which aspects of cognition are most affected. Recent studies have also used both subjective and objective assessments of affect to examine the impact of sleep loss on different aspects of mood.

This symposium will outline and discuss recent laboratory-based studies that have examined the effects of sleep loss on dissociable components of cognition. This presentation will also discuss changes in affect that occur during sleep deprivation, measured subjectively and physiologically, and present some new data on sleep-related changes in affective processes. Understanding the specific cognitive processes underlying poor performance during sleep deprivation has important implications for determining the contribution of sleep loss to errors, incidents, and accidents, and for devising appropriate countermeasures for sleep deprivation.

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019

WHAT CAUSES AN ATTENTION LAPSE? – DISSOCIATION OF ATTENTION LAPSES WHILE SLEEPY

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Drowsiness, defined as a heightened drive for sleep, is a leading contributing factor to both motor vehicle crash risk and occupational accident risk. In both field- and laboratory-based studies this dynamic altered state of alertness is well characterised by an increase in attentional lapses, which is captured by the most widely used measure of sleep-related impairment: the Psychomotor Vigilance Task (PVT).

The hallmark of sleep-related impairment on the PVT is the 'lapse' – an individual delayed response to a stimulus (≥500 ms). Using this task, extensive evidence has now accumulated which demonstrates that the absolute number of attentional lapses increases in frequency with drowsiness due to acute and chronic partial sleep loss, and/or circadian timing. In addition, the cause of a drowsiness-induced attention lapse is often thought to reflect the sleep-wake system rapidly and unconsciously transitioning between these two states resulting in a

'microsleep'. Here, the eyes become heavy, slowly rolling up and down, with long periods of full closure, and brief periods of alpha activity.

However, despite common assumption in the literature all sleep-related attentional lapses are not caused by the same phenomenon (i.e. a microsleep). A review of empirical evidence suggests lapses may be caused by several different factors, including simultaneous eyes blinks, microsleep, being distracted or looking but not seeing. Using a novel approach which combines and synchronizes PVT lapses with corresponding eye and head coordinates via corneal reflection eye tracking (ISCAN), we will describe the ability to dissociate different types of attention lapses, and evaluate how these may be modulated by time awake and time of day.

020

DRIVING AFTER NIGHT SHIFT – SIMULATION, INSTRUMENTED VEHICLES AND THE DITCH

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Introduction: Night shift workers are at increased risk of crashes driving home after work. The combination of acute and chronic sleep deprivation and circadian misalignment results in a range of cognitive impairments and difficulty remaining awake. In 2009 1.4 million Australians (16% of employees) worked shifts, often involved in employment that requires a high level of alertness such as transportation or emergency services. Improving alertness and reducing risk in this population can result in major public health and financial benefits.
Methods: We studied driving performance immediately following night shifts, when employees would be driving home, using laboratory based driving simulation (AusEd) and in a subsequent study using an instrumented vehicle on a driving track. Simultaneous measurement of ocular movements was recorded.
Results: Driving performance (variation in lateral lane position and speed on driving simulation) and reaction time is impaired following the first night shift. Although a nap during the shift improved morning driving performance it did not restore performance to baseline levels. The proportion of time with eyes closed and mean blink duration are increased during driving simulation following restricted sleep, with blink duration most closely related to frequent lapses in attention. Driving performance was also impaired during instrumented vehicle driving following night shift, with increased episodes of lane crossing and overt episodes of falling asleep requiring the instructor to stop the vehicle. The proportion of time with eyes closed and blink duration were similar in the post sleep and post nightshift conditions for the first 15 minutes of driving, with a progressive increase in these metrics after 15 minutes in the post nightshift drive.
Discussion: Both simulated and instrumented vehicle driving performance is impaired following night shift. Blink duration and proportion of time with eyes closed are increased while driving following restricted sleep and may be useful indicators of drowsiness.

021

SUBJECTIVE AND OBJECTIVE MEASURES OF FATIGUE IN THE FIELD – WHAT DOES THE PVT TELL US?

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The relationship between sleep and circadian disruption, and performance impairment has been widely studied. Measuring performance in the laboratory provides critical information about the changes that occur in waking function in response to sleep restriction and circadian misalignment. Such work has been applied outside of the laboratory to understand situations in which performance variability exists in relation to work patterns – in particular, the implications for health, safety and productivity.

While findings from laboratory research are vital in informing policy and practice in workplaces and on the roads, the application of such findings comes with challenges. The artificial environment of the laboratory provides for control over experimental conditions but does not always endear confidence in those tasked with applying or using the findings in practice. The participation of 'young, normal healthies' in laboratory research also contributes to a degree of distrust around the generalizability of findings. On the other hand, assessing workplace performance can be extremely difficult, particularly for complex occupations or tasks. A compromise position is to have workers complete a laboratory-style test in their workplaces, under the conditions in which they operate each day or night. The PVT (psychomotor vigilance task) has been used to assess 'performance' in specific workplaces during particular rosters or shifts. This paper examines the benefits and drawbacks associated with using a reaction time test in field settings to assess 'performance' drawing on studies in healthcare, aviation, mining, manufacturing, rail and maritime operations. In combination with subjective measures, and information about sleep, wake and work patterns, a task such as the PVT can provide organisations with useful, reliable and practical information to inform their policy and practice and manage health, safety and productivity.

022

HEALTHCARE DELIVERY TO ABORIGINAL AUSTRALIAN AND TORRES STRAIT ISLANDER PEOPLES – CHALLENGES, SUCCESSES AND SOLUTIONS

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Australia's indigenous peoples, Aboriginal Australians and Torres Strait Islanders, face a plethora of challenges of which health is but one. Nonetheless the environmental, social and economical disadvantage faced by many Indigenous Australians can be further compounded and influenced by well-documented health disparities. Whilst cardiovascular disease, trauma and mental health issues are major drivers of premature mortality, disability and impaired quality of life, lung disease and associated conditions contribute a burden of disease that is comparable to diabetes. Into this mix of elevated disease burden and poorer health outcomes are added issues associated with the delivery of appropriate, effective, acceptable and sustainable health care services.

While the response to the challenge of Aboriginal and Torres Strait Islander health must be informed by an understanding of disease burden and disparities it is also important that individuals, communities, advocates, managers and health care providers see beyond the problem and concentrate on solutions. This can be difficult when we all are so often assailed with 'bad news stories' either in the general media, biomedical literature or our own clinical practice.

Although this presentation will outline the broader issues of Indigenous Australian health disadvantage, with a particular focus on lung disease and related disorders, it will also aim to outline where earlier work has demonstrated success. Although the problem is far from solved projects covering tobacco cessation, pneumonia management and pulmonary rehabilitation have all demonstrated how carefully

planned programs that are delivered in partnership with local organisations and residents can make a difference. Finally how such programs can inform a clearer and broader strategy for long-term solutions to health disadvantage in this setting more generally and in relation to lung and associated conditions more specifically will be discussed.

023

BOTH WAYS HEALTH LITERACY – WORKING WITH ABORIGINAL UNDERSTANDINGS OF HEALTH ILLNESS AND TREATMENT

MICHAEL CHRISTIE
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Years of collaborative research into health services in remote Aboriginal communities have led us to examine some key assumptions about communication in clinical contexts, and to develop the idea of 'both ways' health literacy. We work with a definition of health literacy as: *'the capacity to build and generate shared understandings about health, treatment and health services'*. This definition focuses upon both knowledge and the structures and processes through which agreed understandings and agreed ways forward are negotiated, produced and reproduced.

The term *'both ways health literacy'* could be used to emphasise the importance of valuing both biomedical and Aboriginal knowledge, structures and processes in relation to developing shared understanding about human being, the body, pathology, sickness and health. The need to develop both ways health literacy of course applies to both Aboriginal and non-Aboriginal health care workers (specialists, doctors, nurses, community workers and volunteers), as well as to clients and their families.

As an example, we introduce a new idea: the Touch Pad Body, an iPad or generic custom-designed touch screen application that displays an interactive 3D zoomable semi-transparent body that might in conversation become an Aboriginal body. The device embeds an Aboriginal definition of communication as *building shared understandings* (subverting the received notion of communication as *transfer of information*). As a somewhat ambiguous object the Touch Pad Body allows for the top-down and bottom-up practices to work together in new ways. Enabling ongoing situated 'both-ways' (re)negotiation of the categories and moral judgements through which health professionals and service users work together, the Touch Pad Body could unsettle and interrupt received notions of health, disease and treatment on both sides of the health delivery practice to create new understandings, engagements and moralities.

024

PRACTICAL EXPERIENCE OF OSA TREATMENT OVER 20 YEARS IN THE NORTHERN TERRITORY

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This is an anecdotal reflection of the challenges associated with establishing and maintaining positive CPAP compliance with indigenous clients with sleep disordered breathing. In late 2000, I assumed (sole at that time) responsibility for supplying CPAP to the Darwin market, inheriting a list of names associated with 280 CPAP sales. Only 40 of those were compliant users and only one of those persons was indigenous. While CPAP might be the gold standard treatment for SDB, not every client has a bed, power point or even an address which provides an interesting challenge in establishing acceptance of CPAP let alone compliance. Funding of the therapy is an issue overshadowing all aspects of service delivery. Some brief case studies will illustrated how my understanding developed of what promoted but not necessarily guaranteed successful outcomes for indigenous clients. Understanding, social support and regular initial reviews and positive reinforcement helped overcome significant obstacles for many clients. Given the prevalence of obesity, diabetes and renal disease in our indigenous community, the potential population of clients with SDB warrants significant strategic planning for not only identification of the disease but the systems and strategies that might be employed to develop acceptable standards of compliance.

025

SLEEP SERVICES AT NORTHERN TERRITORY TOP END

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The burden of chronic disease in Aboriginal people is very high and indigenous people have the highest rates of Cardiovascular, Respiratory, Diabetes and Renal morbidity/mortality. Published data shows that indigenous people are more Obese compared to non-indigenous population and more so in women. There is no widely published data on the prevalence of Sleep disorders, in particular obstructive sleep apnoea contributing to co-existing cardiovascular disease and obesity in indigenous or non-indigenous population from the Northern Territory (NT). Indigenous people make up to 30% of the Northern Territory (NT) population and 12.5% of the national Indigenous population, of them 81% live in remote communities. There has been no dedicated Respiratory & Sleep service at the NT for several years other than visiting Respiratory and Sleep specialists from Interstate. However in the recent past through the support of Australian Lung foundation and NT department of health have recruited Physicians to provide Respiratory and Sleep service for the Top End of Australia. Due to wider geographical and cultural diversity it has been a challenge to provide/develop Sleep service at the Top End. We intend to present the prevalence and other relevant data on Sleep disorders in both Indigenous and Non-indigenous patients at the Top End and share our experience setting up a new Sleep service in relation to the challenges faced in adapting to culturally/socially acceptable circumstances.

026

WHAT'S CULTURE GOT TO DO WITH IT? ONTOLOGIES, SLEEP AND DREAMING IN ABORIGINAL AUSTRALIA

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While sleep is a something that all humans do, like eating, it is something that is done differently in various societies and cultures around the world. Apart from when, where, how and with whom we sleep, how we understand and conceptualise what occurs while we are sleeping, and while we are dreaming, also varies cross-culturally. In many Indigenous Australian cultures, the nature of being is understood with reference to cosmologies that link aspects of personhood with important dimensions of country, and place. While sleeping, and in dreams, especially, individuals may have experiences that are understood in relation to that cosmology, which includes a cultural conception of the person in which a person is understood to extend beyond their physical

body. Thus a person's dreamt experiences may be understood as events that have actually occurred, events that have significance in waking life. Sleeping does not necessarily then represent a realm of disassociation from the events of waking life, and a person may feel particularly vulnerable to various human and other spiritual entities while in the sleeping state.

027

THE SLEEP HEALTH OF AUSTRALIAN INDIGENOUS AND NON INDIGENOUS CHILDREN IN BOTH URBAN AND RURAL CENTRES

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Introduction: The little data available suggests that sleep health is poorer in Australian indigenous children (IC) than non indigenous (NIC) children and that this is likely to impact health and wellbeing. This difference may be further impacted if Indigenous children live in rural rather than urban centres. This paper presents and compares data from three studies to address these issues.
Methods: Self report data (Sleep Disturbance Scale for Children[1] and Sleep Timing Questionnaire[2]) was collected from (1) 25 IC and 25 NIC (mean (SD) age = 8.8 (1.4 y) in Northern Territory urban primary schools; (2) 19 IC and 49 NIC from a rural area school in South Australia (mean (SD) age = 11.6 (2.1 y) and (3) 10 IC and 20 NIC from an urban primary school in South Australia between 2009–2012. Sleep parameters measured included prevalence of behavioural sleep disorders, sleep disordered breathing and parasomnias and self reported bedtimes, waketimes, total sleep time and sleepiness. Impact on school performance and behaviour were measured with the Child Behaviour Checklist.
Results: Significant relationships between sleep quality and behaviours were found for indigenous children in the Northern Territory but none with academic performance. In rural South Australian indigenous children, later bed and wake times were a feature rather than differences in total sleep time, which were similar to NIC. Data analyses are ongoing.
Conclusions: Compared to NIC, sleep health in IC appears to be more related to sleep quality rather than sleep quantity. How much this may impact on wellbeing and academic performance and longer term health requires further study in larger more objectively measured samples.
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028

SLEEP AND ACADEMIC PERFORMANCE IN INDIGENOUS AUSTRALIAN CHILDREN FROM A REMOTE COMMUNITY: AN EXPLORATORY STUDY

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Aim: Disruptions to sleep in childhood are associated with poor behaviour and deficits in academic performance and executive function. Although academic performance of indigenous children from remote communities in Australia is documented as well below that of nonindigenous children, the extent of sleep disruption and its contribution to academic performance among this population has not been assessed.

This pilot study aimed to objectively assess the sleep of remote indigenous children and the association between sleep disruption and both academic performance and executive function.
Method: Twenty-one children from a remote Australian indigenous community aged 6–13 years wore actigraphy for two consecutive nights, reported subjective sleepiness, and were objectively assessed for academic performance (Wechsler Individual Achievement Test, 2nd Edition) and executive function (NEuroloPSYcological Assessment-II).
Results: Results show marked reduction in sleep time, sleep fragmentation, academic performance and auditory attention compared with nonindigenous norms. Sleep duration was not associated with performance, possibly because of reduced sleep and performance observed across the entire group. Sleep fragmentation was associated with reduced reading and numerical skills ($P < 0.05$).
Conclusions: The sleep of indigenous children in remote communities is an important area of future inquiry, and our initial findings of poor sleep and an association between sleep disruption and academic performance may have important implications for intervention strategies aimed at 'closing the gap'. Further studies should assess a broader range of demographic, social and economic factors to better understand the associations reported here and guide future intervention.

029

BARRIERS AND CHALLENGES FOR INDIGENOUS HEALTH WORKERS

KELVIN KONG
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The set up of the Awabakal AMS ENT service has brought new challenges facing Aboriginal and Torres Strait Islander. The topic explores the set up of the clinic, challenges facing patients and health workers and the stigma with Sleep disordered breathing.

030

THE EFFECTS OF DIETARY SUGAR INTAKE ON PREPUBESCENT GIRLS SLEEP STAGES: A PRELIMINARY STUDY

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Introduction: This study aimed to determine whether a high sugar diet effects sleep quality and sleep architecture across the night in prepubescent girls.
Methods: Nine healthy female participants aged 10–12 years (M = 11 years 8.4 months, SD = ±8.6 months) were recruited from four schools in Adelaide. Participants were prepubescent with a Tanner stage of one or two, with the exception of one who had a Tanner stage of four. All participants attended the sleep centre for two separate nights. On one night they consumed the standard diet (mean amount of sugar: 42.4 g ± 3.18 g) and on the other night they had a high sugar diet (mean amount of sugar: 74.7 g ± 10.0 g); all food intake was controlled and recorded. Participants were entertained with age appropriate games and movies before going to bed at 9 pm. Sleep quality and sleep architecture was determined by polysomnography. To compare sleep architecture changes across the night, each participant's sleep was divided into three sections (first third, second third, and final third). Paired samples t-tests were used to examine the difference in sleep between the two diets and due to the differences in sugar consumed a Pearson Correlation was completed between sugar and the significant findings.
Results: During the first third of the night slow wave sleep was significantly greater in the sugar diet (72% vs. 51%, $t(7) = -3.53$, $p = 0.01$), with a trend towards better sleep efficiency ($t(7) = -1.8$, $p = 0.06$). During the second third of the night there was significantly less slow wave sleep (18% vs. 28%, $t(7) = 2.60$, $p = 0.02$) and significantly greater REM sleep (19% vs. 16%, $t(7) = -2.52$, $p = 0.02$) in the sugar diet, while in the final third, stage one and two sleep, and sleep efficiency were significantly less in the high sugar diet (3% vs. 3.5%, $t(7) = 1.97$, $p = 0.05$; 43% vs. 49%, $t(7) = 2.04$, $p = 0.04$; $t(7) = 1.93$, $p = 0.05$, respectively). When looking at sleep across the entire night, sleep efficiency showed no significant differences between the diets. Pearson correlations showed no significant relationships with sugar.
Discussion: Sugar intake appears to significantly alter sleep macrostructure in prepubescent girls however, the improvement in sleep may be related to glucose metabolism. Further studies are required to determine the precise relationship given the lack of an overall correlation between sleep stage changes and sugar intake in this sample.

031

PRESCHOOL DRAMA: ACUTE CARDIOVASCULAR SURGES WITH APNOEAS AND HYPOPNOEAS

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Introduction: Surges in heart rate (HR) and blood pressure (BP) at obstructive apnea termination have been associated with the adverse cardiovascular consequences of sleep disordered breathing (SDB) in adults and school aged children. The prevalence of SDB peaks in the preschool years, but to date, acute cardiovascular changes have not been studied at this age.
Methods: Children aged 3–5 yo (59%M; n = 124) referred for assessment of SDB underwent overnight polysomnography with the additional measurement of pulse transit time (PTT) – a non-invasive, continuous measure of BP changes. Children were grouped according to their history and obstructive apnoea hypopnoea index (OAHI); primary snoring (PS) OAHI ≤ 1 event/h (n = 68); Mild SDB 1–5 events/h (n = 36); Moderate/Severe SDB (MS) > 5 events/h (n = 20). AASM criteria for respiratory event classification were used. PTT was calculated as the time between the ECG R-wave and the 50% point of the rise in the corresponding finger pulse wave. Beat-by-beat analysis of HR and PTT was performed; pre-event (mean of 10 s preceding event); early-event (mean of first half of event); late-event (mean of second half of event); and post-event (mean 3 consecutive beats at HR peak/PTT trough within 15 s). Means for each child for each sleep state were used in one-way RM ANOVA with Student-Newman-Keuls post-hoc testing to assess changes across event phases in each state. Two-way ANOVA assessed group and sleep state effects in each event phase.
Results: 340 obstructive events were analysed. Percentage change in PTT from pre- to post-event was lower, and HR higher, than pre- to early- and late-event during both NREM and REM sleep ($p < 0.05$ for all). PTT and HR in early- and late-event were similar to pre-event. Post-event changes in PTT were similar in all severity groups. Post-event changes in HR were also similar between groups, but higher in NREM than REM sleep ($p < 0.01$).
Conclusions: Obstructive events in preschool children elicit acute increases in HR and falls in PTT, indicating surging BP. Such circulatory perturbations can be involved in the development of hypertension. These findings highlight the need for further research into preschool children with SDB, to monitor for development of cardiovascular complications.

032

IS THE DAMAGE DONE? LONG-TERM EFFECTS OF IMPROVEMENTS IN SLEEP DISORDERED BREATHING ON NEUROCOGNITION AND BEHAVIOUR IN SCHOOL-AGED CHILDREN

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Introduction: The detrimental neurocognitive and behavioural consequences of sleep disordered breathing (SDB) in children are well documented. Whether these deficits improve, remain or continue to decline over the long term is still unknown. The aim of this study was to examine the long-term effect of improvement in SDB on neurocognition and behaviour in a cohort of school-aged children.
Methods*:* Children with SDB and healthy non-snoring controls (mean age: 12.8 ± 1.5 years; 53% male) underwent repeat polysomnography, and age standardised neurocognitive and behavioural assessment 3.8 (±0.5) years following initial testing. Initial diagnosis classified subjects into four groups: control (OAHI < 1 event/h and no history of snoring; N = 18); PS (OAHI ≤ 1 event/h with history of snoring; N = 22); mild OSA (OAHI 1–5 events/h; N = 11); and, moderate to severe OSA (MS OSA: OAHI > 5 events/h; N = 7). Mixed model analysis, controlling for socioeconomic status and maternal IQ, determined

whether a change in OAHI predicted changes in neurocognitive and behavioural domains.
Results: 65% PS, 75% Mild OSA and 100% MS OSA showed improvement in OAHI from time 1. A decrease in OAHI was predictive of an increase in performance IQ and reading ability ($p \leq 0.05$), however no group differences were observed. Initial group differences in behavioural assessment did not change over time with all severities of SDB continuing to exhibit significantly poorer internalising ($p < 0.001$), externalising ($p < 0.05$) and total problem behaviour ($p < 0.01$) than controls, irrespective of changes in OAHI.
Conclusion: The majority of children with SDB showed improvement in OAHI over a 4-year period, either with treatment or spontaneously. At an individual level, improvements in OAHI were predictive of improvements in two neurocognitive domains: non-verbal reasoning and reading ability. Improvements in OAHI were not predictive of behaviour over time. Regardless of resolution, children with an initial diagnosis of SDB continued to exhibit significantly poorer behaviour than controls. Overall, these results suggest that a number of deficits associated with SDB in school-aged children, in particular behaviour, do not improve in the long term, irrespective of the improvement in OAHI. This has substantial implications for the timing of treatment.

033

THE IMPACT OF OBSTRUCTIVE SLEEP APNOEA ON QUALITY OF LIFE IN OBESE CHILDREN

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Background: Obesity and obstructive sleep apnoea (OSA) have been shown, independently, to impair quality of life (QoL) in children. Studies demonstrating that obesity affect physical and psychosocial function have not adjusted for OSA, a known co-morbidity. But OSA itself affects physical and emotional function, and school performance. The aim of this study was to determine if the QoL of obese children is further compromised by the presence of OSA.
Methods: Sixty four healthy weight (n = 28) and obese children (n = 36) aged between 7–13 years were recruited. Polysomnography was used to diagnose OSA (OAHI ≥ 1 hr^{-1}). All children and caregivers completed the PedsQL™ 4.0 generic QoL survey and analysis was performed in accordance with PedsQL™ guidelines. One-way ANOVA was performed between groups.
Results: Twelve children (19%) were obese *without* OSA (mean BMI 29.4 ± 4.6; mean OAHI 0.5 ± 0.2 hr^{-1}), and 24 children (38%) were obese *with* OSA (mean BMI 30.6 ± 6.5; mean OAHI 10.3 ± 10.9 hr^{-1}, $p < 0.001$). Compared to healthy weight children without OSA (mean BMI 16.5 ± 2.1), obese children *without* OSA self-reported reduced social function ($p < 0.05$) and overall QoL ($p = 0.05$), and obese children *with* OSA reported poorer physical function ($p < 0.001$), emotional function ($p = 0.05$), social function ($p < 0.005$), school performance ($p < 0.05$) and overall QoL ($p = 0.001$). These self-report outcomes were supported by the caregivers' reports.
Conclusion: Social function and overall QoL is poor in obese children, but those with co-morbid OSA have impaired QoL in all domains, namely: physical, emotional and social function, school performance and overall QoL.

034

INDICATIONS, RESULTS AND OUTCOME FOR CLINICAL POLYSOMNOGRAPHY IN CHILDREN UNDER 2 YEARS OF AGE

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Introduction: Polysomnography (PSG) is a routine investigation for breathing concerns during sleep in all age groups. There are, however, no accepted criteria to define an abnormal result in infancy. The aim of this study is to describe the indications and results of PSG for children under 2 years of age and to evaluate the relationship between PSG results and clinical recommendations. The results will define parameters on PSG that relate to clinical decision making related to PSG in early life.
Methods: Retrospective overnight PSG data from children under 2 years of age were retrieved for a 3 year period (2008–2010). PSG data and clinical notes were reviewed to collect study indication, results of PSG, and the physician's recommendations.
Results: A total of 435 PSG records from 325 children were retrieved. Of the 250 studies that have been reviewed to date, the average age was 9 months 4 days ± 14 days, with 42% of the children being under six months of age at the time of the study. The most common indication was obstructive sleep apnoea (OSA; 48%) followed by physical anomalies/syndrome (22%), cleft lip and/or palate (19%), apnoea (6%) and family history of sudden infant death syndrome (SIDS; 6%). Applying the current paediatric criteria for abnormal PSG (apnoea hypopnea index; AHI > 1.0 events/h), 243 (97%) of the children studied had an abnormal result and 61% of these children had an AHI > 10 events/h. Compared to children ≥6 months, children <6 months had lower sleep efficiency (67% vs 82%, $p = 0.03$), and higher AHI (31.9 vs 12.9 events/h, $p < 0.001$). Age shows a significant negative correlation with oxygen desaturation index (Pearson −0.39, $p \leq 0.01$).
Discussion: The current paediatric criteria defining abnormal PSG results are inappropriate for children <2 years. In this young age group, separate criteria are likely required for children under and over 6 months of age. Linking this data to the clinical recommendations will support developing and testing of new criteria appropriate to identify abnormal PSG results in children <2 years of age.

035

ADENOIDECTOMY IMPROVES OSA RELATED QOL IN CHILDREN

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Background: OSA in children is an absolute indication for adenoidectomy, which is a simpler procedure than tonsillectomy or adenotonsillectomy, with faster recovery times and less postoperative morbidity.
Aim: The first prospective evaluation of OSA-related symptoms and QOL questionnaires before and after adenoidectomy.
Hypothesis: OSA related QOL, and symptoms of OSA would improve after adenoidectomy.

Methods: Parents completed questionnaires about their children's current (preoperative) symptoms and QOL, and then provided repeat questionnaire evaluations one and three months postoperatively.
Instruments: We used the OSA18 and an Adenoid Symptom Questionnaire. The OSA18 is a standardised and validated questionnaire that assesses the impact of OSA on QOL and results in a total score that distinguishes three groups: a score of <60, 60–80 or >80: <60 means OSA has little impact on QOL, 60–80 indicates moderate impact, and >80 indicates a large impact. The Adenoid Symptom Questionnaire is a list of 20 questions related to symptoms of adenoid hypertrophy and sleep disordered breathing, answers are reported on a Likert scale or as yes/no.
Results: Responses were obtained for 39 participants; 38% female, aged 1.78 to 13.43 years at the time of surgery (average 5.42 years). The mean pre-operative OSA18 total score was 84 (range 34–143), compared to 32 (range 18–80), 3 months after adenoidectomy. One child still had a score >80 group, one 60–80 and 37 children were <60. The main symptoms that changed were snoring and witnessed apnoea. Preoperatively 30 children snored always/often, 5 sometimes, and 4 never/rarely. By contrast at the three month follow up 3 children snored often/always, 8 sometimes and 28 rarely/never. Witnessed apnoeas were present preoperatively in 13 children often/always, 4 sometimes and 22 rarely/never compared to the three month follow up when 1 child had apnoeas often/always, 2 sometimes and 36 rarely/never. Chi-Square analysis of pre to post op improvement was $p < 0.001$ for snore and witnessed apnoeas.
Discussion: This prospective evaluation of symptoms and quality of life showed dramatic improvement in OSA related QOL post adenoidectomy (without tonsillectomy), indicating that adenoidectomy effectively resolves presenting problems for the majority of these children.

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IMPROVEMENT OF SLEEP DISORDERED BREATHING IN CHILDREN IS ASSOCIATED WITH A REDUCTION IN OVERNIGHT BLOOD PRESSURE

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Introduction: Sleep disordered breathing (SDB) is associated with elevated blood pressure (BP) in adults. Several studies have now shown that childhood SDB is also associated with elevated BP, however, there is little research investigating the long-term BP outcomes in this population. This study aimed to assess overnight BP and heart rate (HR) in children with both resolved and unresolved SDB four years after initial diagnosis.
Method: 60 children (mean age: 12.9 ± 0.2 y, 55% male) underwent repeat overnight polysomnography (PSG) with continuous BP measurement (Finometer™ FMS, The Netherlands) 4.0 ± 0.3 y after initial diagnosis. 40 children were originally diagnosed with SDB (n = 21 Primary Snoring (PS), n = 11 Mild Obstructive Sleep Apnoea (OSA), n = 8 Moderate/Severe OSA) and 20 were non-snoring controls. Children were deemed 'resolved' (absence of snoring and obstructive apnoea hypopnoea index (OAHI) ≤ 1) or 'unresolved' (continued to snore and/or had an OAHI > 1) on their repeat PSG.
Results: At follow-up, 18 children had a complete resolution of SDB, and 22 still had SDB which was mostly PS (n = 16). There was no significant difference in age, sex or BMI z-score between the resolved, unresolved and control groups. There was a significant decrease ($p < 0.05$) in OAHI in both the resolved and unresolved SDB groups, while OAHI for controls remained unchanged. At the initial PSG study BP was elevated in Wake and all sleep stages in both SDB groups compared to controls ($p < 0.01$ for all). Wake BP remained unchanged between the studies in both SDB groups, however, there was a significant reduction in BP at follow up in all sleep stages ($p < 0.05$ for all). In the control group there was a significant increase in Wake BP at follow up ($p < 0.05$), but no change during sleep. At follow up there was no significant difference in BP between the unresolved, resolved and control groups in Wake or any sleep stage.
Conclusion: Children with either unresolved or resolved SDB at follow-up exhibited a significant reduction in BP during sleep, with levels similar to controls. The reduction in BP in the unresolved group may be attributed to the fact that these children all had a significant reduction in OAHI and were now mostly primary snorers. This study highlights that even minor improvements in SDB can improve cardiovascular outcome.

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SLEEP DISTURBANCE IN CHILDREN WITH CYSTIC FIBROSIS

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Introduction: Sleep affects every aspect of a child's health, daily functioning, and well being. Sleep disruption is a common symptom described in patients with chronic disease and is thought to contribute to impaired daytime functioning and overall quality of life. Cystic fibrosis (CF) is the most common inherited chronic disease affecting Australian children. In adults with CF, sleep problems are common and are associated with depressed mood, fatigue and impaired daytime function. There is a paucity of international data regarding sleep quality in children and adolescents with CF. We aimed to compare sleep duration and questionnaire measures of sleep disturbance in children with CF and age matched control children.
Methods: 20 children with CF and 20 age matched healthy control children (range 8–16 y) were recruited and studied with 2 weeks of sleep recorded by sleep diary together with questionnaires [OSA-18, Paediatric Daytime Sleepiness Scale (PDSS), Sleep Disturbance Scale for Children (SDSC)]. Data were compared with one way ANOVA if normally distributed or Kruskal-Wallis one way ANOVA on Ranks if not.
Results: 20 CF and 20 control subjects completed the study, and were well-matched for age. The mean (±SD) FEV_1 for the CF group was 79 ± 19% predicted. CF and control subjects had similar sleep duration (9 h during the week and 9.5 h at weekends) and no differences in night wakenings. However, children with CF had higher total scores on the OSA-18: median 36 compared to controls median 21.5 ($p < 0.001$), with all subscales being significantly higher in the CF group. They also had higher mean scores on the PDSS: 14.8 compared to 10.9 ($p < 0.01$); and SDSC: 47.4 compared to 35.8 ($p < 0.001$), with higher values for the subscales of initiating sleep and excessive daytime sleepiness.
Conclusions: Clinically stable children with CF have significantly more sleep problems than healthy children despite having similar sleep duration. Further studies are needed to identify if these disruptions in sleep

are associated with poorer quality of life and mood. *Because CF is a complex and difficult to treat chronic illnesses, identification and treatment of sleep disorders could make an important difference in patients' daily functioning and disease management.*

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TRENDS IN HOME MECHANICAL VENTILATION IN A TERTIARY PAEDIATRIC CENTRE IN SINGAPORE: 1998–2011

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Introduction: This study aims to describe trends and outcomes of home mechanical ventilation (HMV) in Singapore which is increasingly used in children over the past 2 decades but their use have not been documented before.
Methods: Review of all patients who had started HMV in a tertiary paediatric centre in Singapore.
Results: Between 1998 and 2011, HMV was started in 69 patients, 5 (7.2%) with invasive and 64 (92.8%) with non-invasive ventilation. Median age of initiation was 12 years (range 3 months to 31 years). 50 (72.5%) were males. 42 (60.9%) were Chinese, 22 (31.9%) Malays and 5 (7.2%) other ethnic groups. The most common indication was neuromuscular disorders (44.9%), followed by obesity (17.4%), chronic lung diseases (10.1%) and chest wall disorders (8.7%). Bilevel positive airway pressure was used in 48 patients (70.0%) and continuous positive airway pressure in 21 (30.0%). The majority of patients required only nocturnal use but 6 (8.7%) required continuous ventilation (3 via tracheostomy). 6 (8.7%) had required supplemental oxygen initially (2 eventually weaned off). The number of patients started on HMV increased from 5 in 1998–2002, to 12 in 2003–2006 and 52 in 2007–2011. After initiation of HMV there were a total of 1627 unscheduled admission days (6.5 per patient-year) due to respiratory conditions, with 511 intensive care unit (ICU) days (2.0 per patient-year). Neuromuscular patients accounted for 1112 unscheduled admission days (7.2 per patient-year) and 363 ICU days (2.4 per patient-year). At the end of the study, 58 patients (84.1%) were still ventilated, 3 patients (4.3%) had died (1 from severe pneumonia, 1 from a post-operative complication and 1 from out of hospital collapse), 7 (10.1%) were weaned off HMV, and 1 (1.4%) did not tolerate it. Only 1 patient required admission for equipment failure, and 1 patient had a small pneumothorax.
Discussion: There has been a rapid increase in the use of HMV from the end of the last decade. There is a significant burden of respiratory and ICU admissions especially among neuromuscular patients on HMV. The number of Malay patients (13.6% Malays in general population) on HMV is disproportionately high and seems to be contributed by obese patients. Caregivers have managed HMV well without a formal home nursing program.

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TITRATION OF PAEDIATRIC NON-INVASIVE VENTILATION – IS IT WORTH IT?

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Introduction: Polysomnography (PSG) is considered essential in order to appropriately individualise the settings (titrate) of non-invasive ventilation (NIV) in both adults and children. There is little or no evidence of whether changes in ventilatory support recommended following titration PSG are actually made by the treating physician or whether changes are associated with a positive impact on the patient's symptoms or quality of life (QOL).
Aims: 1) To assess whether recommendations for changes in settings made after a titration sleep study are carried out. 2) To assess whether there is an improvement in daytime symptoms and QOL following a titration PSG.
Methods: A retrospective chart review was carried out of all NIV (CPAP and bi-level ventilation, BPAP) titration studies that have been carried out at our tertiary paediatric sleep laboratory in the past 5 years. All patients with at least 2 studies in the past 5 years were included in the analysis. Parents completed the OSA-18 questionnaire on the night of the PSG. Results are presented as mean (SD).
Results: A total of 42 patients (17 bi-level and 25 CPAP, age 11 (6) years) had 71 pairs of titration studies (30 BPAP and 41 CPAP). Time between studies was 1.1 (0.5) years. Changes in pressure were recommended in 16 of 41 (39%) CPAP studies, of which 50% had been made by the time of the next PSG. For BPAP studies, there were changes recommended in 13 (43%) studies. Changes to inspiratory pressure were recommended in 9/30 (30%) studies, to expiratory pressure in 4/30 (13%) studies and respiratory rate in 6/30 (20%). Recommended changes were adopted in 55%, 75% and 50% of studies respectively. There was an improvement in total OSA-18 scores in 48% of the paired CPAP studies and 65% of BPAP studies. OSA-18 scores improved in 66% of the studies where changes had been implemented versus 22% of those where they had not ($p = 0.08$).
Conclusions: Titration studies frequently led to recommendations for a change in respiratory support settings, however only about half of these recommendations were carried out in full. QOL scores improved more if recommendations for change were implemented.

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CHILDREN WITH OBSTRUCTIVE SLEEP APNOEA HAVE SIGNIFICANTLY INCREASED BLOOD PRESSURE VARIABILITY

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Introduction: Obstructive sleep apnoea (OSA) has been associated with hypertension in both adults and children. The mechanism/s that underlie this hypertension are unknown, however impaired autonomic function via increased sympathetic activity is thought to play a role. To date few studies have assessed autonomic control of blood pressure in children with OSA. Thus, this study aimed to assess the affect of OSA severity and sleep state on autonomic blood pressure control in children.
Methods: 105 children (7–12 y, 59% male) referred for assessment of OSA and 36 (50% male) non-snoring controls were studied. Routine overnight polysomnography was performed with continuous BP monitoring. Subjects were assigned to diagnostic groups according to their obstructive apnoea hypopnoea index (OAHI); primary snoring (PS,

OAHI ≤ 1 event/h), mild obstructive sleep apnoea (OSA, OAHI > 1–5) and moderate/severe OSA (MS, OAHI > 5). 3 min epochs of BP (mean 39 ± 2) were analysed per subject. Autonomic control was assessed using power spectral analysis of blood pressure variability (BPV) in the low frequency range (reflecting sympathetic activity, 0.04–0.15 Hz). BPV was compared between OSA severity groups and sleep states (NREM1/2, SWS, REM) using 2-way ANOVA.
Results: There was a significant effect of OSA severity and sleep state on BPV ($p < 0.001$ for both), and a significant interaction between the variables ($p = 0.02$). During REM sleep children with Mild and MS OSA had significantly higher BPV compared with both the Control and PS groups ($p < 0.05$). BPV was higher during REM compared with SWS in the Control, PS and Mild OSA groups. BPV was lower during SWS compared to NREM1/2 in the PS and Mild OSA groups. There was no difference in BPV between the sleep states in the MS OSA group.
Conclusion: Children with OSA have significantly increased BPV compared to non-snoring controls and children with PS, suggesting that these children with OSA have increased sympathetic activity. This may be the underlying mechanism for the increased BP previously reported in these children, however further studies are required to identify if the increased sympathetic activity persists after treatment.

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SLEEP AND RESPIRATORY OUTCOMES IN CHILDREN WITH SLEEP DISORDERED BREATHING: A FOUR YEAR FOLLOW-UP

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Introduction: Treatment of paediatric sleep disordered breathing (SDB) is usually reserved for those with significant obstructive sleep apnoea (OSA). Studies now suggest that treatment success is more variable than previously thought, and little is known about the natural history of children with primary snoring (PS) who are often not treated. This study aimed to investigate the long-term sleep and respiratory outcomes of children with a range of SDB severities.
Method: 61 children (mean age: 12.9 ± 0.2, 56% male) underwent full repeat overnight polysomnography (PSG) 4.0 ± 0.3 y after initial diagnosis. 41 children had SDB at the original PSG (n = 22 PS, n = 11 Mild OSA, n = 8 Moderate/Severe (MS) OSA) and 20 were non-snoring controls. At follow-up, SDB severity, presence of snoring, sleep and respiratory measures were re-assessed. Children were deemed 'resolved' if there was an absence of snoring and obstructive apnoea hypopnoea index (OAHI) ≤ 1 on their repeat PSG, and deemed 'unresolved' if they continued to snore and/or had an OAHI > 1. Sleep disturbance questionnaires (paediatric daytime sleepiness score (PDSS); sleep disturbance score (SDSC); OSA-18) were compared between the three groups.
Results: At follow-up, 54% (n = 22) of children were 'unresolved' (PS n = 16, Mild OSA n = 1, MS OSA n = 3) and 46% were 'resolved'. Respiratory measures including OAHI and respiratory disturbance index (RDI) were significantly reduced for both the resolved and unresolved groups ($p < 0.05$). In the resolved group there was also a significant decrease in snoring frequency and %NREM1 ($p < 0.01$). In the unresolved group Wake after sleep onset (%WASO) was significantly increased ($p < 0.05$). There were no significant differences for any measures in controls. Both the SDB groups had significantly higher sleep disturbance scores compared to controls on the PDSS, SDSC and OSA-18 ($p < 0.01$ for all) at follow-up.
Conclusions: Four years after diagnosis there was a significant improvement in respiratory measures and SDB was resolved in 46% of children. However, over half of the children still had SDB, mostly primary snoring (n = 16). Furthermore, children with both resolved and unresolved SDB continued to have higher sleep disturbance scores as assessed by questionnaire, a finding which needs to be explored further.

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CHILDREN WITH OBSTRUCTIVE SLEEP APNOEA HAVE AN IMPAIRED EXERCISE CAPACITY

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Background: Although the effects of obesity on cardiopulmonary exercise responses have been studied in children, effects of obstructive sleep apnoea (OSA) have not. Since OSA is a co-morbidity of obesity and OSA is known to affect ventricular dimensions and heart rate at rest and in sleep, we aimed to examine the effects of OSA versus obesity on cardiopulmonary responses to exercise.
Methods: Healthy weight and obese children aged between 7–13 years were recruited. Polysomnography was used to diagnose OSA (OAHI ≥ 1 hr^{-1}) and exercise testing was performed on a cycle ergometer. Independent t-test analysis was performed between 'No OSA' and 'OSA' groups. Analysis of covariance was performed to evaluate cardiopulmonary responses attributed to obesity versus OSA.
Results: Forty of 71 children (56%, mean age 10 yr) had OSA (mean BMI 27.0 ± 8.4; mean OAHI 8.9 ± 10.0 hr^{-1}). At peak exercise capacity, children with OSA had a lower cardiac output (8.9 ± 1.5 L/min v 10.5 ± 1.3 L/min, $p < 0.001$) and oxygen consumption (20.82 ± 8.28 mL/kg/min v 29.65 ± 9.21 mL/kg/min, $p < 0.001$) compared to those without OSA. Peak exercise was achieved at 69 ± 31 Watts for children with OSA and 83 ± 22 Watts ($p = 0.06$) for those without. There was no difference in ventilatory responses to exercise between the two groups. At peak exercise capacity cardiac output and oxygen consumption were independently associated with the respiratory-related arousal index, nadir SpO_2 and mean heart rate during total sleep time. Obese children fatigued earlier than healthy weight children but cardiopulmonary function was not affected by obesity.
Discussion: Independent of weight status, children with OSA have impaired cardiac responses to aerobic exercise. Obese children are exercise limited due to physical deconditioning but those with OSA are further compromised due to an impaired cardiac response.

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NEUROPSYCHOLOGICAL FUNCTION IN VERY YOUNG CHILDREN FOLLOWING TREATMENT FOR SLEEP DISORDERED BREATHING

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Background: Childhood cognitive, emotional and motor skill acquisition development is driven by dynamic changes in brain plasticity. The time between birth and 4 years in particular is a sensitive period for the development of brain functions relating to attention, inhibition,

self-regulation and language[1,2]. Disruption of normal brain activity during sleep at this time of rapid change, such as due to sleep disordered breathing (SDB) induced hypoxia and sleep fragmentation, have been proposed to affect developmental brain and behavioural trajectories[3]. In view of this potential impact, establishing whether the age at which a child is treated for SDB is fundamental in determining the success of treatment in reducing long-term neurobehavioural impairments and is of great importance and implication for clinical practice.

Aim of Study: To establish whether neurocognitive and behavioural deficits are associated with SDB severity and/or associated sleep fragmentation and hypoxia in children aged 1–4 years, and, whether such deficits improve with early intervention, as re-assessed 12 months later.

Methods: Data will be collected on polysomnographic measures such as respiratory and movement related arousals, levels of hypoxia and sleep fragmentation. Neurocognitive assessment will include child temperament and behaviour, cerebral blood flow velocity and sleep routine in the home. Relationships between polysomnographic and neurocognitive measures will be examined using multivariate tests. Paired sample testing will be utilised to evaluate the effect of changes in polysomnographic and neurocognitive parameters following the 12-month follow-up period, compared to baseline data.

Outcomes and Implications: The outcomes of this study will provide valuable information on the effectiveness of removing the tonsils and adenoids, which is the first line of treatment, for paediatric sleep disordered breathing, in improving neurocognitive and behavioural deficits. The findings of this study will thus determine whether residual neurocognitive and behavioural deficits in children treated for SDB are prevented by earlier detection and intervention, and therefore likely to benefit long-term academic progress and eventual occupational success and job opportunity.

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044

CENTRAL HYPOVENTILATION IN ARNOLD-CHIARI SYNDROME – ROLE OF ADAPTIVE SERVO VENTILATION IN A PAEDIATRIC PATIENT

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Background: The Arnold Chiari malformation (ACM) is an anomaly of the brain, that mainly involves the lower brainstem and lowermost portion of the cerebellum, but the anatomy of the whole brain is affected. Central Breathing control problems are reported with ACM and could be mild with occasional dysrhythmic breathing to profound disturbances in hypoxic and hypercapniec responses and associated respiratory failure.

Case History: We report on a 14 year old boy with ACM type I who has had variable degrees of central dysrhytmic problems. His central dysrhythmic breathing was initially managed with supplemental oxygen. He had a very low baseline respiratory rate of <10/min on occasions falling down to 4–6/min. There was no hypercapnoea associated at that time and supplemental oxygen normalized gas exchange. Oxygen was weaned at 11 years of age. There were no daytime symptoms associated at that time. On regular follow-up he was noted to have increasing daytime lethargy and decreasing school performance with parents reporting poor quality sleep. Repeat polysomnography revealed marked increase in his dysrhytmic breathing pattern in both REM & NREM sleep. There was associated hypercapnoea. Repeat MRI was arranged which showed cerebellar herniation to C2 without pressure effect and neurosurgical consult sought for consideration of surgery.

Treatment of type II respiratory failure was planned with bilevel non-invasive ventilation. In view of the very low background respiratory rate any effect on increasing the respiratory rate to overcome respiratory failure resulted in poor synchronization and inadequate treatment of the respiratory failure. Sleep was also fragmented due to poor tolerance by the patient. Based on previous literature on the role of adaptive servo ventilation in central sleep apnoea a trial of ventilatory support with VPAP Adapt was initiated. This was well tolerated and synchronization was achieved with normalization of gas exchange and sleep architecture. His daytime symptoms and school performance have improved significantly.

Our experience suggests that there is a role for adaptive servo ventilation in treating central hypoventilation in the paediatric age group. Careful patient selection and monitoring is needed. More studies are needed to understand the physiological basis.

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CPAP COMPLIANCE LEVELS FOR RURAL PATIENTS DIAGNOSED WITH SEVERE OSA (AHI > 30) 4 YEARS AFTER COMMENCEMENT OF TREATMENT

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Aim: To determine 2011 compliance levels among patients diagnosed with severe OSA (AHI > 30) in 2007.

Methods: A retrospective audit was conducted in 2011 at Manse Medical, a regional Victorian sleep medicine practice. Case-notes of patients identified as having a new diagnosis of severe OSA in 2007 were reviewed. Current patient-reported, compliance levels were evaluated by means of a posted questionnaire, with follow-up phone call.

Results: During 2007, diagnostic sleep studies were performed on 267 individuals in the Hamilton Sleep Disorders Centre. Of these, 43% (n = 114) had severe OSA (AHI > 30). Of these patients 109 (95%) were commenced on CPAP. In laboratory CPAP titration was conducted on 84 of these patients. At three months 96 patients were reviewed clinically and 81 were still compliant with cpap (usage per night >4 hours).

In 2011, 99 of the 109 patients commenced on CPAP were mailed surveys (10 deceased or moved address).

Results were; 60% (n = 59) CPAP compliant; 9% (n = 9) alternative treatment (MAS, lifestyle, surgery), 20% (n = 20) no treatment, 11% (n = 11) elicited no response (followed up by 'phone).

Conclusions: Assuming non-compliance amongst non-responders (worst case scenario), 54% of patients commenced on CPAP in 2007 were compliant with therapy in 2011. Including other modalities, 63% of patients were receiving ongoing treatment for their OSA. Amongst patients continuing to use CPAP therapy at 3 months, 72% were compliant at 4 years.

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PREDICTORS OF LONG TERM ADHERENCE TO CONTINUOUS POSITIVE AIRWAY PRESSURE THERAPY IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND CARDIOVASCULAR DISEASE IN THE SAVE STUDY

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Introduction: The Sleep Apnea cardioVascular Endpoints (SAVE) study is an international, multicentre, randomised controlled trial which aims to determine whether continuous positive airway pressure (CPAP) therapy will reduce cardiovascular (CV) events in patients with CV disease and moderate-to-severe obstructive sleep apnea (OSA) followed-up for an average of 4 years. In this study we report our early experience with CPAP in the SAVE study and identify several key demographic and clinical factors which appear to predict successful, long term treatment adherence.
Methods: Demographic characteristics and clinical variables (including age, gender, nationality, socioeconomic status [SES], CV disease type, early CPAP use and side effects, OSA symptoms, oxygen desaturation index [ODI], Epworth Sleepiness Scale [ESS], Short Form-36 and Hospital Anxiety and Depression Scale [HADS] scores) for patients randomised into the CPAP arm of the SAVE study prior to 1 July 2010 with complete 12 month CPAP adherence data were examined. Analysis was conducted using a linear mixed model with sites as a random effect, with average hours of daily CPAP use at 12 months as the dependent outcome variable. Independent variables with $p < 0.20$ on univariate analysis were included in the multivariate analysis to determine predictors of 12 month CPAP adherence.
Results: Data for 275 patients from China, Australia and New Zealand were analysed. Mean ± SD CPAP adherence at 1, 6 and 12 months were 4.4 ± 2.0, 4.0 ± 2.2 and 3.3 ± 2.4 hours per night, respectively. On univariate analysis, variables associated with 12 month CPAP adherence were baseline ESS, snoring loudness, hours of daily use during an initial 1–2 week sham CPAP run-in, and CPAP adherence at 1 month (all $p < 0.05$). On multivariate analysis, CPAP use at 1 month (effect estimate ± SE, 0.66 ± 0.07 per hour increase, $p < 0.001$) and side effects at 1 month (–0.27 ± 0.09 per additional side effect, $p < 0.001$) were independent predictors of long-term CPAP adherence.
Discussion: Long-term use of CPAP in patients with moderate-to-severe OSA and CV disease can be predicted by CPAP adherence and number of reported side effects at 1 month following initiation of therapy.

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VALIDATION OF AN AUTO-TITRATING CPAP DEVICE FOR THE TREATMENT OF OBSTRUCTIVE SLEEP APNOEA: A RANDOMISED CROSSOVER TRIAL

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Introduction: Auto-titrating CPAP devices are marketed as beneficial in the treatment of obstructive sleep apnoea (OSA) as they use algorithms to adjust delivered pressure to the minimum required to maintain airway patency across the night. We aimed to compare the efficacy of the Compumedics SPAP auto-CPAP (SPAP) with the ResMed S8 auto-CPAP (S8). To achieve this we conducted a double blind randomised crossover non-inferiority trial.
Methods: 30 patients (12 female, mean (SEM), age 51.5 (2.5) years, BMI 33.6 (1.5) kg/m^2) recently diagnosed with OSA (Apnea Hypopnea Index (AHI) 41.6 (6.0) events/h) and naïve to CPAP were studied. Each patient was randomised to receive either the SPAP or S8 during polysomnography (PSG). Each patient underwent a repeat study one week later with the alternate device. Standard PSG variables, side effects and pressure statistics were recorded. Paired t-tests and a linear mixed models analysis were performed.
Results: The SPAP was found to be effective in the treatment of OSA, (mean AHI/hr; baseline 41.6 (6.0), SPAP 5.0 (0.9), $t = 5.950$, $p < 0.001$). The SPAP device was found to be non-inferior to the S8 device on all measures. Use of the SPAP resulted in a superior reduction in AHI (SPAP 5.0 (0.87)/hr, S8 7.8 (1.79)/hr, $t = 2.118$, $p < 0.05$). A similar reduction in Respiratory Disturbance Index (RDI) was observed (mean RDI/hr; SPAP 6.1 (1.15), S8 8.6 (1.92), $t = 2.223$, $p < 0.005$)). Sleep quality measures were also significantly improved following use of the SPAP compared to the S8 (mean Sleep Efficiency %; SPAP 80.6 (2.39), S8 75.2 (2.93), $t = -2.386$, $p < 0.05$). Wake After Sleep Onset (WASO) was lower with use of the SPAP compared to the S8 (mean WASO minutes; SPAP 71.2 (9.07), S8 91.0 (10.57), $t = 2.113$, $p < 0.05$). The maximum pressures were similar for the SPAP and S8 (cmH_2O; SPAP 13.6 (0.54), S8 13.9 (0.47), $t = 0.500$, $p = 0.62$).
Discussion: The SPAP device is effective in the treatment of OSA and is non-inferior to the ResMed S8 auto-CPAP device in abolishing respiratory events and improving sleep quality.

048

COMPLIANCE WITH CPAP – A NEW ZEALAND WIDE SURVEY

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Compliance with CPAP has been a research interest in Wellington for the last few years. Data has shown initially ethnicity based differences which in a prospective study were shown to be related primarily to socio-economic status.
Aim: To determine local CPAP compliance rates in 4 regions of NZ varying by urban/rural and high/low Māori and PI populations.
Methods: Prospective standardised data collection was undertaken over 6 months in 4 regions: South Auckland, Gisborne, Wellington and Invercargill.

Objective CPAP compliance was measured following usual local protocols at 4 or 6 weeks. Data from 3 regions presented.
Results: CPAP compliance data was similar in all regions averaging around 5.3 hours per night. Gisborne had the highest proportion of high deprivation patients but compliance in this group was not lower than either other regions or subjects from areas of less deprivation.
Conclusion: All 3 regions show similar, good levels of CPAP compliance. All regions have close contact with patients following CPAP initiation and similar criteria for CPAP initiation and long term provision. No effect from SES was apparent.

049

DIFFERENCES IN NASAL RESISTANCE INFLUENCE THE TYPE OF CPAP MASK (NASAL VS FULL-FACE) ULTIMATELY PURCHASED BY A PATIENT

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Introduction: Initial experiences with CPAP therapy, and with the CPAP mask in particular, have a significant effect on ultimate CPAP compliance. Research has also shown that baseline nasal resistance, as measured by rhinomanometry, is a significant factor predicting the initial acceptance of CPAP therapy. The present study aimed to determine whether baseline nasal resistance could also predict whether a nasal or full-face mask was ultimately purchased by a patient.
Method: 70 patients (55 male, 15 female) underwent anterior rhinomanometry to determine their nasal airflow at 150 kPa. Patients assigned for CPAP therapy were fitted with a nasal and/or a full-face mask before deciding which mask to purchase. Their final mask choice was recorded. Data was subjected to analysis of variance (ANOVA) and to Sensitivity & Specificity analyses, with ROC analyses also performed.
Results: The mean baseline nasal flow was significantly ($p < 0.05$) higher for patients deciding to use a nasal mask with their CPAP therapy (mean = 783.4 ml/sec) compared with those using a full-face mask (mean = 451.6 ml/sec, $F68,1 = 71.03$). Exactly half of the patients (35) chose to purchase a nasal mask; while 33 patients had a basal nasal flow over 661 ml/sec. Using this value as a cut-off, the sensitivity was 0.83 & specificity was 0.89, thus giving a Positive Predictive Value (PPV) of 88% and a Negative Predictive Value (NPV) of 84%. ROC curve revealed the AUC was 0.91 ($p < 0.001$).
Discussion: As expected, patients who chose to use a nasal mask had a significantly higher baseline nasal flow than those selecting a full-face mask. The ROC analyses also indicated that a baseline rhinomanometry flow of over 661 ml/second to be the best determinant in predicting the type of mask selected. Using this criterion, 83% of subjects using nasal mask were correctly identified while only 11% of patients eventually using a full-face mask would be incorrectly identified as preferring a nasal mask. We propose that measurement of nasal airflow by rhinomanometry is a useful predictive tool for identifying the type of mask patients are likely to ultimately buy. This can be used to ensure that the first mask tried by a patient starting on CPAP therapy is the one eventually chosen for long term use, thereby maximizing compliance and minimizing cost of therapy.

050

A SYSTEMATIC APPROACH TO SELECTING STARTING PRESSURE RESULTS IN BETTER SLEEP OUTCOMES FROM CPAP TITRATION DURING SPLIT STUDIES

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Introduction: The AASM guidelines[1] for CPAP titration studies recommend starting pressures (P_{start}) and provide a titration algorithm to determine optimum pressure (P_{opt}). With less time to achieve optimal pressure during split studies, we have found that the low recommended P_{start} causes prolonged time at less than P_{opt} resulting in less sleep time at therapeutic levels. We aimed to evaluate a systematic approach to selecting CPAP starting pressure during split studies to enable more efficient and more successful CPAP titration.
Methods: P_{start} was determined from an empirically derived equation utilising markers of obesity. Sleep statistics from 42 consecutive patients using this new-protocol P_{start} were compared with 36 retrospective patients using the standard AASM[1] P_{start} of 4 cmH_2O or higher for elevated BMI. The AASM titration algorithm[1] was used for all studies.
Results: There was no significant between-group differences (standard versus new protocols) in age (50.7 y vs. 52 y, $p = 0.4$), gender distribution (28% male vs. 21%, $p = 0.3$), BMI (39.6 vs. 41, $p = 0.6$), OSA severity (AHI 56.0 vs. 53.9, $p = 0.4$). Mean P_{opt} was slightly higher using the new protocol however time to achieve P_{opt} was less and total sleep time at P_{opt} was 33 mins higher (see table, means and SDs shown). Using treatment AHI of <10/hr to define success[1], 38.9% of patients had unsuccessful titration using the standard protocol compared with 16.7% with the new protocol ($p < 0.01$).

Protocol	P_{start} (cmH_2O)	P_{opt} (cmH_2O)	Time to P_{opt} (mins)	TST @ P_{opt} (mins)
Standard	5.1 (0.1)	9.1 (0.4)	135.0 (11.6)	96.8 (11.9)
New	7.5 (0.1)*0.0001	9.3 (0.3)*0.3	89.8 (9.3)*0.002	129.7 (10.7)*0.02

(*$p < 9$).

Discussion: These data show that individual tailoring of P_{start} results in quicker attainment of P_{opt} (45 mins), however only 33 mins longer sleep at this therapeutic level. Considering the short time available to titrate during a split study to attain P_{opt} significantly more patients had a successful titration.
Reference
1. Kushida, CA et al. J Clin Sleep Med, 2008, 4: 157–171.

051

MODELS OF CARE FOR ACUTE NON-INVASIVE VENTILATION IN COPD – COMPARISON OF THREE TERTIARY CENTRES (ACT3 STUDY)

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Aim: Non-invasive ventilation (NIV) improves clinical outcomes in patients with acute hypercapnic COPD, although the optimal site of care (general ward v HDU v ICU) is not known.

Methods: Prospective observational non-inferiority study comparing the effectiveness of NIV treatment of acute hypercapnic COPD located on a general ward (1:4 nurse to bed ratio), a high dependency unit (HDU) (1:2 ratio) and an ICU (1:1 ratio) in three separate public teaching hospitals in Melbourne. The ward and HDU services have a full-time respiratory therapist experienced in NIV and a dedicated specialty registrar. Consultant ward rounds vary from twice weekly on the ward to twice daily in the ICU. Analysis of variance was used to compare the 3 centres.

Results: (mean ± SD). Over the first 9 month period, the ward-based service treated significantly more patients (n = 38) than the HDU (n = 20) and ICU (n = 10) corrected for hospital size ($p < 0.001$). There was no difference in baseline age (71 ± 1 yrs), FEV1 (1.06 ± 0.68 L), initial pH (7.27 ± 0.07) or PaCO2 (77 ± 20 mmHg) of patients treated at the 3 centres. There was no difference with NIV treatment in the increase in pH (0.12 ± 0.07) and the fall in PaCO2 (17 ± 17 mmHg) between the 3 centres ($p = 0.2$, 0.6 respectively). Patients in the ward centre (compared with HDU and ICU respectively) received significantly more NIV during the 1st 24 hours (12.7 ± 5.1 vs 9.6 ± 4.3 vs 10.1 ± 4.1 hrs $p < 0.05$) whilst more ICU patients were intubated (0 vs 0 vs 20%, $p < 0.05$) and had a longer hospital LOS (7 ± 6 vs 7 ± 3 vs 14 ± 6 days, $p < 0.001$).

Conclusion: The three NIV centres treat patients with COPD of similar disease severity and achieve equivalent physiological improvements. The ward-based service treats more patients, whilst the ICU service has significantly increased intubation rates and hospital length of stay. An economic analysis would indicate which model of care is most cost-effective.

052

SYMPTOMS OF AEROPHAGIA ARE COMMON IN PATIENTS ON CONTINUOUS POSITIVE AIRWAY PRESSURE THERAPY AND RELATED TO THE PRESENCE OF NOCTURNAL GASTROESOPHAGEAL REFLUX

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Introduction: Continuous positive airway pressure (CPAP), the mainstay treatment for obstructive sleep apnoea (OSA), involves administration of air under pressure to the upper airway. A well-known but poorly understood side effect of positive airway pressure therapies is air passage into the oesophagus and stomach, rather than the lungs. It is possible that the aerophagia-induced gastric distension may increase gastroesophageal reflux (GER) by increasing transient lower oesophageal sphincter relaxations, the most common cause of reflux. This study aimed to determine i) the prevalence of aerophagia symptoms in a large group of OSA patients on CPAP therapy and ii) whether they were related to an increase in prevalence of GER symptoms.

Methods: Consecutive OSA patients undergoing overnight polysomnography for the purpose of optimizing their CPAP therapy completed a validated questionnaire regarding GER symptoms (heartburn or acid regurgitation) and aerophagia symptoms (increased stomach noise, belching, bloating, decreased appetite, diarrhoea, or flatulence). On average patients had been on CPAP between 1 and 6 months at the time they completed the questionnaire.

Results: Complete data was available for 259 individuals (203 males). The group with aerophagia symptoms had a greater ($p < 0.05$) prevalence of frequent (once a week or more) GER symptoms (29% vs 10%) and nighttime GER symptoms (9% vs 2%) than those without aerophagia. The group with nighttime GER symptoms had a greater prevalence of aerophagia symptoms than those without nighttime GER symptoms (63 vs 23%, respectively).

Discussion: In a large patient sample, we have shown a higher prevalence of GER and nighttime GER symptoms in individuals with symptoms of aerophagia. Aerophagia as a side effect of CPAP therapy may precipitate GER, particularly nighttime GER. We speculate this is due to exacerbation of transient lower oesophageal relaxations, precipitated by gastric distension.

053

CRANIOFACIAL STRUCTURE AND OPTIMAL CPAP PRESSURE REQUIREMENT IN OBSTRUCTIVE SLEEP APNOEA

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Introduction: The optimal CPAP pressure to ameliorate obstructive events is generally determined by overnight titration. Prior indication of the likely pressure range may help improve CPAP titration success. Previously, baseline AHI, neck circumference and BMI had been used to predict pressure requirement. Craniofacial structure may also affect the level of CPAP required to prevent upper airway collapse. Our aim was to investigate whether craniofacial structure influences effective CPAP pressure.
Methods: Patients were participants in a randomised cross-over trial of CPAP and oral appliance therapy for OSA with 1 month optimal treatment with each device. Patients (AHI > 10/hr with ≥2 OSA symptoms) were CPAP-naive. Optimal fixed pressure was determined at home on autoset mode as the 95th percentile pressure from >4 hours sleep. Standardised lateral cephalometric radiographs taken as part of oral appliance treatment assessment. Cephalometric analysis included skeletal, airway and soft tissue variables.
Results: Cephalometric analysis was conducted in 52 OSA patients (65% male, 50.0 ± 12.0 years, BMI 28.9 ± 4.2 kgm^2, neck circumference 41.6 ± 9.0 cm). Baseline AHI was 34.0 ± 14.7 events/hr (range 10.2–68.8) with fixed pressure requirement 10.45 ± 1.85 cmH_2O (range 4–14). Preliminary results show CPAP pressure correlated with age ($r = 0.27$, $p = 0.047$) and a trend towards baseline AHI ($r = 0.25$, $p = 0.073$). In this sample BMI, NC and baseline AHI were not predictive of CPAP pressure requirement. No craniofacial variables from cephalometric analyses significantly correlated with CPAP pressure requirement. However, there were trends towards modest correlations between optimal CPAP and the angle of the mandible ($r = 0.24$, $p = 0.09$) and craniocervical angle ($r = 0.27$, $p = 0.05$). Cephalometric variables were not predictive of optimal CPAP pressure in multiple linear regression analysis.
Conclusions: In preliminary analysis, craniofacial structure assessed by lateral cephalometry did not relate to CPAP pressure in OSA and did not aid prediction of required pressure. Work is ongoing to complete this analysis in a larger sample of patients.

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CLINICAL AUDIT OF ADAPTIVE SERVOVENTILATION

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Introduction: Pathophysiology of Central Sleep Apnea/Cheyne Stokes respiration is often multifactorial and management of these complex conditions can be difficult. These conditions can be related to underlying medical problems such as cardiac failure, renal failure, stroke, thyroid disease or centrally-acting drugs e.g. opioids. Adaptive servoventilation is a relatively new modality for the treatment of these categories of sleeps disordered breathing. The adaptive servoventilator (ASV) counterbalances the shift between hyperpnoea and hypoventilation by applying variable pressure support and thus overcomes the ventilatory overshoot. Most of the evidence for ASV comes from its usage in Cheyne-Stokes Respiration in chronic systolic heart failure. When new technology is introduced, the clinical application of the technology can advance beyond the published literature, such that the technology is trialled by clinicians for a wider array of clinical conditions.

No survival or long-term data is available for ASV at this time. There is also some uncertainty as to the optimum device settings, reflecting an overall lack of experience with using these devices. We aim to perform a retrospective audit of ASV at The Prince Charles Hospital.
Methods: Retrospective audit. Review of chart and PSG of all patients established on ASV looking at: 1) Indications. 2) Predictors of success to treatment: Baseline Polysomnograph (PSG) characteristics, Overall Apnea-Hypopnea Index (AHI), Central Apnea Index, REM AHI, NREM AHI, Arousal Index, Oxygen statistics, Duty ratio-loop gain, Patient characteristic, Age, sex, BMI, LVF, RVF, diastolic characteristic on echo, ABG, FRC, FEV1, VC, NYHA, Epworth Sleepiness Score, Insomnia Severity Index. 3) Efficacy of ASV, Compliance at 3, 6 and 12 months, Epworth sleeping score (ESS) at 0, 3, 6, 12 months, Residual AHI, AI, and O2 statistics. 4) Cost-effectiveness, Number of studies leading to ASV, Other modalities of positive pressure ventilation trialled prior to ASV.
Results: Paired and non-paired testing for variables. Descriptive analysis.
Discussion: Based on final results.

055

NOCTURNAL USE OF THE BREATHE RIGHT® ADVANCED NASAL DILATOR STRIP IN PATIENTS WITH CHRONIC NOCTURNAL NASAL CONGESTION DOES NOT REDUCE SEVERITY OF SLEEP DISORDERED BREATHING (A PILOT STUDY)

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Introduction: Subjects with symptoms of chronic nocturnal nasal congestion (CNNC) often complain of disturbed sleep, and have a high prevalence of sleep disordered breathing (SDB). Nasal Dilator Strips (NDS) have been advocated for reducing snoring and SDB. However, objective data are lacking.
Methods: Using standard laboratory polysomnography (PSG), we studied 61 community volunteers, all reporting CNNC and disturbed sleep (43 males; age: 49.3 ± 14.8 yrs [mean ± SD]; BMI 28.6 ± 5.1 kg/m^2), at baseline (BL) and following 28 days of regular nocturnal use of an NDS (Breathe Right® Advanced; GSK, USA). Sleep respiratory events were quantified, at BL (without NDS) and at day 28 (with NDS), using current AASM rules (2007), while snoring was monitored with a room microphone. At day 28 subjects rated their total experience with

NDS on a Global Assessment Scale in terms of improvement in 'ease of breathing'. On a separate occasion, nasal resistance (Rn [at 0.2–0.4 l/sec]; posterior rhinomanometry; n = 35) was measured during wakefulness (seated) with and without NDS. Data were expressed as group mean ± SD and compared using a paired t test. $P < 0.05$ was considered significant.

Results: Almost all subjects (90.2%; 79.8–95.8 [95% Confidence Interval]) perceived increased 'ease of breathing' with NDS, while awake Rn decreased significantly from 4.1 ± 3.6 cm H2O/l/sec without NDS to 2.5 ± 2.1 cm H2O/l/sec with NDS ($P < 0.01$). However, there were no significant differences (all $p > 0.05$) between BL and day 28 values for: Respiratory Disturbance Index (20.1 ± 13.1 events/hr versus 22.6 ± 15.4 events/hr; Snore Index (305.3 ± 202.0 snores/hr versus 308.8 ± 230.1 snores/hr); Oxygen Desaturation Index (ODI 3%; 3.7 ± 5.7 events/hr versus 4.8 ± 6.8 events/hr); and nasal only breathing (29.2 ± 29.8% sleep time versus 31.2 ± 29.6% sleep time).

Conclusion: In subjects with CNNC, NDS reduced awake Rn and increased perception of improved 'ease of breathing', but did not reduce SDB or snoring during sleep. We conclude that either NDS effects on Rn are insufficient to alter SDB or that SDB is not related to nasal resistance levels in these patients.

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OSA OFTEN CO-EXIST WITH DEPRESSION AND CPAP THERAPY IMPROVES SYMPTOMS OF DEPRESSION

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Objective: To assess the presence of depressive symptoms in patients with recently diagnosed obstructive sleep apnoea (OSA) and whether this improves after acclimatisation to continuous positive airway pressure therapy (CPAP).

Patients/Methods: All patients diagnosed with OSA (Apnoea Hypopnoea index (AHI) > 5/hr) were invited to participate. 72 patients participated in this study. Patients completed Beck Depression Inventory (BDI) at baseline and after 4 to 6 weeks of treatment with CPAP. All data were collected prospectively and analysed with SPSS v19.0. Multivariate generalised linear models were employed to analysis the data.

Results: Patients were predominantly male (63.1%) with an overall mean age of 52.8 ± 14.2 yrs and BMI of 32.9 ± 6.8 kg/m^2. The median AHI was 31/hr (IQR 18–50), and mean BDI score at baseline 14.66 ± 10.76. 17 patients discontinued CPAP therapy and 7 patients did not complete BDI after CPAP therapy. 64% (46/72) patients were found to have mood disturbance and 40% (29/72) patients had some degree of depression at baseline. A significant improvement in BDI was found after CPAP therapy, with mean BDI 14.66 at baseline and 9.55 after CPAP ($p = 0.001$). Patients who pursued long term CPAP therapy demonstrated an improvement in BDI, while BDI of those who discontinued CPAP did not improve ($p = 0.05$). Also, daily compliance to CPAP of >4 hours was associated with improved BDI ($p = 0.04$) after adjusting for demographic factors and baseline AHI.

Conclusion: Patients with OSA often have coexisting depression. Successful CPAP therapy for treatment of OSA seems to be associated with improved symptoms of depression.

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A SYSTEMATIC APPROACH TO SELECTING STARTING PRESSURE RESULTS IN BETTER SLEEP OUTCOMES FROM CPAP TITRATION STUDIES

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Introduction: The AASM guidelines[1] for CPAP titration studies recommend starting pressures (P_{start}) and provide a titration algorithm to determine optimum pressure (P_{opt}). We have found that the low recommended P_{start} causes prolonged time at less than P_{opt} resulting in lesser sleep time at therapeutic levels. We aimed to evaluate a systematic approach to selecting CPAP starting pressure to enable more efficient and more successful CPAP titration.

Methods: P_{start} was determined from an empirically derived equation utilising markers of OSA severity and obesity. Sleep statistics from 153 consecutive patients using this new-protocol P_{start} were compared with 74 retrospective patients using the standard AASM[1] P_{start} of 4 cmH_2O or higher for elevated BMI. The AASM titration algorithm[1] was used for all studies.

Results: There was no significant between-group differences (standard versus new protocols) in age (57 y vs. 55 y, $p = 0.2$), gender distribution (67% male vs. 63%, $p = 0.2$), BMI (36.6 vs. 38.9, $p = 0.02$), OSA severity (AHI 48.8 vs. 46.7, $p = 0.3$). Mean P_{opt} was slightly higher using the new protocol however time to achieve P_{opt} was less and total sleep time at P_{opt} was significantly higher (see table, means and SDs shown). Using treatment AHI of <10/hr to define success[1], 24.3% of patients had unsuccessful titration using the standard protocol compared with 10.5% with the new protocol ($p < 0.001$).

Protocol	P_{start} (cmH_2O)	P_{opt} (cmH_2O)	Time to P_{opt} (mins)	TST @ P_{opt} (mins)
Standard	5.2 (0.7)	8.7 (0.2)	225 (9)	108 (7)
New	8.3 (0.1)*0.0001	9.5 (0.2)*0.2	140 (9)*0.0001	215 (12)*0.0001

(*$p < 9$).

Discussion: These data show that individual tailoring of P_{start} results in quicker attainment of P_{opt} and consequent longer sleep at this therapeutic level. Achieving a mean of over 3½ hours of sleep at therapeutic CPAP levels (compared with under 2 hours using standard protocol) may result in patients having a more favourable first-night CPAP experience and thereby potentially achieving more successful treatment outcomes.

Reference

1. Kushida, CA et al. J Clin Sleep Med, 2008, 4: 157–171.

059

AN OVERVIEW OF CPAP SERVICES IN AUSTRALIAN COMMUNITY PHARMACIES

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Background: Continuous Positive Airway Pressure (CPAP) services are provided at a variety of venues, including select community pharmacies. Pharmacies may offer an advantage over other venues, particularly public hospital sleep clinics, where long waiting lists for services may exist. The high public exposure and accessibility of community pharmacies makes them an ideal setting for the provision of specialised health services. For pharmacies supplying CPAP it is important to ensure a quality service for the patient, as research shows the patient's initial treatment experience with their health care professional may be key in influencing adherence. However, little is known about the quality or extent of CPAP services offered in pharmacies.
Aims: 1) Provide an overview of the range and quality of CPAP services currently offered in Australian community pharmacies. 2) Explore attitudes of pharmacists providing these services, including perceived barriers and limitations to current service models. 3) Gauge pharmacist perspectives on future directions and possible role expansion.
Method: A questionnaire designed to meet the study aims was developed by the researchers and pre-piloted. The inclusion criteria for the study were all community pharmacies in Australia that provide CPAP services (as identified by the current CPAP distributor lists or Internet search). A total of 200 pharmacies providing CPAP services were mailed the study questionnaire pack.
Results: This study is currently in week 1 of a 9 week staged data collection phase. To date 22 questionnaires have been received and are being analysed. The initial respondents comprise 13 (59%) metropolitan and 9 (41%) rural or regional pharmacies. In addition to sleep services 100% offer some form of other specialised health service. Accessibility and convenience of location was listed by 52% of respondents as the main advantage seen for patients sourcing CPAP through community pharmacy as opposed to other CPAP providers. The biggest benefit of providing a CPAP service was listed by 37% of pharmacists as meeting patient and community needs, despite 32% claiming their CPAP service was not financially viable. Further results are pending.
Potential Significance: To the best of our knowledge, this preliminary study will be the first to explore the range and quality of CPAP services currently offered in the Australian community pharmacy setting.

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COMPARING PATIENT COMPLIANCE ON AUTO CPAP THERAPY DURING HOME TRIAL

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Introduction: The health benefits of compliance with CPAP (Continuous Positive Airway Pressure) therapy in patients who have significant sleep disordered breathing such as sleep apnoea, have been poorly documented. This Study aimed to identify whether a follow up call would enhance short term home Auto-CPAP compliance.
Method: A review of the reports of thirty two male participants who were all referred to a Home Auto CPAP clinic was performed. Sixteen patients from this study were recruited in 2011 and received a scheduled follow up phone call from a sleep scientist two days after taking the device home. During this call, patients were assured of any uncertainties and further encouragement was made available to the patient. In contrast, the remaining sixteen participants were recruited in 2008 and did not receive a follow up call. Age, sex, BMI and Apnoea–Hypopnoea Index (AHI) were compared and matched in all thirty two participants. Average nightly usage was obtained for both groups via the therapy device control settings. A paired samples t-test was conducted to reveal the effects of a follow up call in relation to average nightly usage of short term home Auto CPAP therapy.
Results: The 2011 group displayed a mean compliance of 4.7 hours (SD ± 2.1 hours), while the 2008 group displayed a mean compliance of 4.2 hours (SD ± 2.5 hours). A paired samples t-test revealed that there were no significant increases or decreases of average hours of total usage for both years despite the 2011 group receiving a follow up call.
Discussion: This study indicates that giving a patient a follow up call two days after taking the CPAP device home, does not enhance short term home Auto CPAP compliance.

Compliance is therefore most likely affected by other factors such as age, comfort levels and psychosocial factors. Further studies will benefit from a larger sample size with simultaneous testing of both groups. A trial period longer than 5 nights would also be beneficial to effectively grasp an understanding of a patient's compliance with home Auto-CPAP therapy.

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LONG TERM CPAP COMPLIANCE AND CHANGES IN MEDICATION AFTER CPAP INITIATION

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Background: Obstructive sleep apnoea (OSA) is a common sleep related breathing disorder in New Zealand and has significant consequences for patients. OSA has been shown to be an independent risk factor for a number of conditions including hypertension and depression.
Aim: To determine if CPAP treatment can reduce the amount of medication OSA patients are prescribed specifically anti-hypertensives and anti-depressants. Also to examine long-term compliance with CPAP treatment.
Methods: Questionnaires were sent to consecutive patients who had been prescribed CPAP treatment for the last 12–18 months. Questionnaires included: current medication list, general demographics and sleep behaviour, compliance data and the SF-36 health questionnaire.
Results: 75 questionnaires were sent. Two reminder phone calls and repeat sending of questionnaires resulted in 48 questionnaires (64%) being returned. No statistically significant changes in patient medication were seen following CPAP initiation. Patients who returned the questionnaire were less likely to be on anti-depression medication and were more likely to have been prescribed a proton pump inhibitor. ESS was within normal limits at 7.8/24 (6.20–9.41). Patients reported lower SF-36 scores in all categories when compared to NZ adult averages. Mean CPAP compliance for the responders was 5.66 ± 2.52 hrs/day.
Conclusion: Patients do not reduce medication use after CPAP treatment. There are a number of possible explanations for this, which may form the basis for further research. We found that patient compliance remained high after the trial period ended and patient sleepiness remained within the normal range 12–18 months after treatment initiation.

This project was funded by the Wellington Medical Research Foundation.

062

SLEEPWISE – AN EVALUATION OF A MULTI-COMPONENT SLEEP EDUCATION AND HOME BASED INTERVENTION FOR OLDER CHILDREN AND ADOLESCENTS WITH DEVELOPMENTAL DISABILITIES AND SLEEP DISTURBANCE

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Over 80% of children with developmental disabilities present with disturbed sleep often with a combination of chronic sleep problems. Research into sleep interventions in this field has been limited by small sample sizes and a lack of randomised control trials.

This project evaluated the effectiveness of the *Sleepwise* approach for older children and adolescents with sleep disturbance and their families. Parents and carers attended two community-based education workshops to increase their awareness of typical sleep, sleep disturbance, sleep hygiene and a variety of communication, sensory and behavioural strategies to improve sleep patterns. Sleep diaries completed by the parents/carers and a sleep history completed in the home assisted the development of a sleep plan unique for each child. Allied health staff supported parents and carers to implement the sleep plan and monitor progress. A grant from the Apex Foundation for Research into Intellectual Disability Ltd supported the development of resources and the research.

Twenty-six families (with children aged 8–18 years) participated in the research project and were allocated to an intervention and a wait-list control group. Data was collected at week 1 (baseline), 10 and 18 (post-intervention) on measures of child and parent functioning. Results demonstrated that the *Sleepwise* approach was effective in significantly reducing sleep problems in older children and adolescents with developmental disabilities, and led to reductions in parent stress and improved parental self-efficacy.

We believe this is a first study to investigate the efficacy of a multi-component parent sleep education and individualised home based intervention for older children and adolescents with developmental disabilities and sleep disturbance with a wait-list control.

063

COGNITIVE BEHAVIOURAL THERAPY FOR INSOMNIA MADE ACCESSIBLE

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Introduction: Chronic **i**nsomnia is a common problem, affecting 20–40% of adults. Cognitive Behavioural therapy for insomnia (CBTi) is the gold standard treatment for long term relief from insomnia but access to this therapy is limited. We looked at the feasibility of Sleep Technologist administered CBTi. We present our findings on the first 57 referred patients.

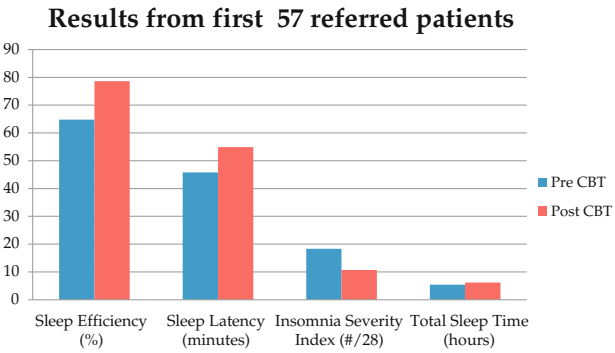
Methods: 57 Patients were referred by a General Practitioner for insomnia management. The patients were first assessed by a Sleep Physician to exclude any co-morbid problem such as Restless Leg Syndrome, Obstructive Sleep Apnoea and Depression.

Sleep was monitored using actigraphy for 2 weeks prior to commencing CBT and for 1 week at the conclusion. Therapy sessions were booked weekly where possible. Education was given on sleep hygiene and normal sleep architecture. Treatment plans were made using methods including sleep restriction, stimulus control and light therapy. A sleep diary was maintained throughout. Measurements of insomnia severity index, sleep latency, sleep efficiency and total sleep time were noted pre and post CBT.

Monthly meetings were scheduled for the sleep technologist with a Clinical Psychologist for ongoing clinical support.

Results: The entire group showed a decrease in average Insomnia Severity Index and sleep latency and an increase in average sleep efficiency and total sleep time.

Conclusions: We have shown that primary psychophysiological insomnia management can be effectively administered by sleep technologists provided the patients are screened and referred by a sleep physician.



064

PREDICTORS OF IMPROVEMENT IN SUBJECTIVE SLEEP QUALITY REPORTED BY OLDER ADULTS WITH SLEEP MAINTENANCE INSOMNIA FOLLOWING GROUP-BASED CBT-I

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Introduction: Cognitive-behaviour therapy is an efficacious non-pharmacological treatment for insomnia. However, individualized administration is costly and often results in substantial variability in treatment response across individual patients, particularly so for older adults. Group-based administration has demonstrated impressive potential for a brief and inexpensive answer to the effective treatment of insomnia in the older adult population. It is important to identify potential predictors of response to such a treatment format to guide clinicians when selecting the most suitable treatment for their patient. The aim of this study was to identify factors that predict improvement in subjective sleep quality of older adults following group-based CBT-I.

Method: Eighty-six ($N = 41$ male, mean age = 64.10, $SD = 6.80$) adults with sleep maintenance and/or early morning awakening insomnia were selected from a community-based sample to participate in a four-week, group-based treatment program of CBT-I. Participants were required to complete 7-day sleep diaries and a comprehensive battery of questionnaires related to sleep quality, daytime functioning and treatment credibility. Hierarchical multiple regression analyses were used to identify factors which predict improvement in subjective sleep quality immediately following treatment and at 3-month follow-up. Sleep diary reported average nightly sleep efficiency was used as the outcome measure of sleep quality.

Results: Participants who experienced the greatest improvement in sleep efficiency following treatment were younger, reported less severe insomnia and overall sleep disturbance, had more confidence in their ability to sleep at pre-treatment, and reported greater treatment credibility during treatment.
Discussion: These characteristics may be useful to guide clinicians when considering the use of a group-based CBT-I for sleep maintenance and/or early morning awakening insomnia in older adults. Younger, less severe insomniacs can benefit from small group therapy, however for the older, more severe insomniac, individualised therapy is recommended.

065

EFFECTS OF A NASAL DILATOR STRIP (NDS) ON SUBJECTIVE AND OBJECTIVE MEASURES OF SLEEP QUALITY IN PATIENTS WITH CHRONIC NOCTURNAL NASAL CONGESTION (CNNC)

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Introduction: Subjects with symptoms of chronic nocturnal nasal congestion (CNNC) often complain of disturbed sleep. Nasal dilator strips (NDS) have been suggested to improve sleep quality in CNNC. In this study, we examined the effects of NDS on both subjective and objective measures of sleep quality.
Methods: We studied 61 community volunteers, all reporting CNNC and disturbed sleep (43 males; age: 49.3 ± 14.8 yrs [mean ± S.D]; BMI 28.6 ± 5.1 kg/m^2), at baseline (BL) and following 28 days of regular nocturnal use of a NDS (Breathe Right® Advanced; GSK, USA). Sleep architecture was quantified with laboratory polysomnography (PSG) at BL (without NDS) and Day 28 (with NDS), using current AASM rules (2007). Daytime sleepiness was measured using Epworth Sleepiness Scale (ESS) at ~2 weeks before BL and Day 28 (with NDS). Using an 11 category Global Assessment Scale (GAS) self rated questionnaire, subjects were asked on Day 28 to rate their experience with the NDS in terms of perceived changes in quality, duration and refreshment of sleep, nocturia, dry mouth, and morning headache. Data were analysed using a paired t-test or one sample t-test as appropriate. Correlation was examined using Spearman's Rho Rank.
Results: ESS decreased from 8 ± 4 au (mean ± SD; arbitrary units) at BL to 7 ± 5 au at Day 28 ($p < 0.05$). From BL to Day 28, there were no significant changes in any PSG sleep quality variable except that REM latency decreased from 101.1 ± 53.5 mins to 83.4 ± 48.7 mins ($p < 0.03$) and Spontaneous Arousal Index (AI) decreased from 6.7 ± 4.4 arousals/hr to 5.6 ± 3.8 arousals/hr ($p < 0.02$). More than half of subjects reported 'somewhat improved' or 'much improved' ratings for sleep quality (77.0%; 65.0–85.9 [95% CI]); feeling refreshed in the morning (68.3%; 55.7–78.7); sleep depth and staying asleep (both 63.9%; 51.4–74.9) (all $p < 0.0001$). However, these perceived improvements did not correlate with measured changes in either REM latency or AI (all $p > 0.24$).
Conclusion: Sleep quality improved slightly both subjectively, and objectively, together with a reduction in subjective daytime sleepiness. However, the improved subjective perception of sleep quality with NDS in patients with CNNC was not related to the changes in objective measurements of sleep quality.

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066

WHY CAN'T PATIENTS SLEEP

REFLECTIONS FROM A CLINICAL PSYCHIATRIST

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Many, if not all psychiatric presentations affect sleep architecture, quality or quantity. Some treatments, such as SSRI antidepressants can also have direct effects on the physiology of sleep. Medications such as atypical antipsychotics can cause weight gain and induce the metabolic syndrome in our most sedentary patients, those with chronic schizophrenia and profound negative symptoms. These patients are high risk for the development of obstructive sleep apnoea, which may go undetected.

Despite all these effects, little is discussed regarding the psychological manifestations of trauma and a patient's long term belief that night is a dangerous place and one must 'sleep with one eye open'. It is my experience that patients whom present with chronic insomnia and parasomnias often have histories of early childhood trauma and abandonment. Taking a careful, respectful history of early childhood may glean these very significant factors leading to chronic sleep disturbance.

This oral presentation will demonstrate via a small series of de-identified cases how sleep quality and quantity improved in patients who received targeted psychotherapy for their histories of early childhood trauma.

067

SHIFT WORK AFFECTS MOOD AND SLEEPINESS, BUT NOT PERFORMANCE

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Introduction: Shift work results in disturbed sleep and decreased sleep duration and is thought to be related to an increase in work and road-related accidents. This study investigated the affective and neuropsychological functioning and driving simulator performance in shift workers compared to a control group.
Methods: Shift worker (n = 41) and control (n = 40) participants completed a 30 minute driving simulator task as well as the Psychomotor Vigilance Task (PVT) and two Oxford Sleep Latency Resistance Tasks (Osler). The Optalert™ Drowsiness Measurement System (ODMS), which measures eyelid movements, was used as an objective measure of sleepiness during each task. Three mood questionnaires were completed: the Beck Depression Inventory (BDI), the Stait-Trait Anxiety Scale (STAI) and the Profile of Mood States (POMS), in addition to several neuropsychological tasks: Logical Memory, Trails A & B, Digit Span and Stroop. Participants completed Epworth Sleepiness Scales (ESS) and provided information on their working and driving schedules as well as driving accident history. Testing sessions occurred in the afternoon for all subjects. Shift workers attended the day after the end of their night shift schedule allowing for at least a 24 hour recovery.
Results: The shift workers worked longer shifts ($p < 0.001$) and had less sleep on work nights ($p < 0.001$) than their control counterparts and were significantly sleepier on the ESS ($p < 0.001$). The two groups did not differ on the amount of driving they do or driving accident history. There were no significant differences in performance on the

driving simulator, Osler and PVT tasks. Maximum drowsiness scores on the ODMS were greater in shift workers for both Osler tasks (Osler 1: $p < 0.01$; Osler 2: $p < 0.005$), but not for either the driving simulator or PVT tasks. The shift workers scored significantly higher on the BDI ($p < 0.01$) and were more fatigued ($p < 0.001$) and less vigorous ($p < 0.005$) than controls on the POMS. Total POMS scores were greater for the shift workers ($p < 0.01$). No differences were observed on the STAI or across any of the neuropsychological tasks.
Discussion: Shift work schedules affect fatigue, mood and feelings of sleepiness but do not impact upon shift workers' performance on a range of driving, psychomotor and neuropsychological tasks outside of their work environment.

068

THE ROLE OF CIRCADIAN PHASE IN INDIVIDUAL RESPONSES TO SHORT-TERM SLEEP RESTRICTION

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Although sleep restriction is often associated with decrements in daytime alertness and neurobehavioural performance, considerable inter-individual differences in the degree of impairment have been reported. This study aimed to examine the effects of short-term sleep restriction on subjective and objective measures of daytime sleepiness, and to assess individual differences in sleepiness. Healthy adults ($n = 42$; 20 M, 22 F) aged 22.5 ± 3.0 (mean ± SD) years maintained a regular sleep-wake routine (2230–0630 h or 0030–0830 h) for at least three weeks prior to a laboratory visit. Participants were restricted to 5 hours time in bed on the night before the laboratory visit and to 3 hours on the night of the laboratory visit, with wake time remaining constant. In the laboratory participants remained in low light (<2 lux) and hourly saliva samples were collected from 5 h before until 5 h after pre-laboratory bedtime to assess melatonin onset as a marker of circadian phase. Following wake time in the laboratory, participants were maintained in constant posture and neurobehavioural performance was assessed hourly on a 10-min auditory Psychomotor Vigilance Task (PVT). Sleepiness was assessed using the Karolinska Sleepiness Scale (KSS) and electrooculographic (EOG) slow eye movements during the Karolinska Drowsiness Test (KDT, 3 min). Substantial inter-individual variability in sleepiness was observed in all assessments, particularly in the number of lapses in attention during the PVT. Delayed timing of melatonin onset during the previous evening was associated with higher levels of sleepiness two hours after waking according to the PVT ($r = -0.37$, $p < 0.05$), KSS ($r = -0.39$, $p < 0.05$) and EOG measurements ($r = -0.41$, $p < 0.05$). This study demonstrates considerable individual differences in response to short-term sleep restriction. The phase of an individual's circadian system may be an important consideration in predicting the degree of daytime sleepiness and performance impairment following sleep restriction.

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069

CIRCADIAN RHYTHMS OF CENTRAL EXECUTIVE FUNCTIONING IN GOOD SLEEPERS AND PEOPLE WITH DELAYED SLEEP PHASE DISORDER

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Introduction: Findings regarding the effects of circadian rhythms on daily cognitive performance are inconsistent and few. The present study utilised the ultradian methodology of measuring circadian rhythms to investigate their influence on the performance of executive function using the classic colour-word Stroop Task. In particular, the inhibitory control of executive function was examined by comparing the speed and accuracy of naming colours between an incongruent condition and a neutral condition. Effective inhibition involves the maintenance of cognitive processing when irrelevant stimuli are presented and requires a restraint on inappropriate responses. This cognitive ability is therefore important for decision making and problem-solving. To further investigate the effects of circadian rhythmicity on performance, the present study was extended to a sample of good sleepers as well as a clinical sample of individuals with Delayed Sleep Phase Disorder (DSPD).
Method: Twelve good sleepers and 12 individuals who met the criteria for DSPD were recruited for a 30-hour constant ultradian study. This method consisted of 1-hour 'days' with 20-minute sleep opportunities and 40-minutes of enforced wakefulness. The Stroop task involving an incongruent and neutral session was administered hourly, 25-minutes into wakefulness. The difference in speed of task completion between the two Stroop sessions was measured as the amount of inhibition. This behavioural rhythm was compared to the gold-standard measure of circadian rhythms, namely core body temperature which was recorded at minute intervals during the 30-hours.
Results and Discussion: The effect of circadian rhythm on inhibitory executive function will be discussed. Since the process of inhibitory control is important for effective problem solving and decision making, findings from this study would identify the optimal daily times for processing complex tasks which can be implemented to shift work. Additionally, differences in performance of the control and clinical DSPD sample will be presented in an attempt to develop a more comprehensive neuropsychological profile of DSPD.

070

ASSOCIATION BETWEEN NIGHT SHIFT FREQUENCY AND NEUROBEHAVIOURAL IMPAIRMENT DURING A SIMULATED NIGHT SHIFT

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Night shift work is associated with increased sleepiness and impairments in neurobehavioural performance. Poor quality and reduced duration of sleep due to misalignment of circadian phase is common in

night shift workers. The relationship between shifts worked and the degree of impairment in neurobehavioural performance during work periods is not well understood. The current study aims to examine the impact of the number of nights and hours worked during a 7-day period on sleepiness during a simulated night shift.

Sixty night shift workers with no medical, psychiatric or sleep disorders were recruited from various organisations. To date, 47 night shift workers (30 male, 17 female; mean age: 32.0 ± 1.6 years) have been analysed. Participants were required to work at least 5 nights per month with a minimum of 6 h worked between 22:00 and 8:00. Habitual sleep-wake patterns were monitored for 1–3 weeks using sleep diaries and wrist actigraphy. Following 2–7 consecutive night shifts, participants attended the sleep laboratory for a simulated night shift. During the 13-h simulated shift, sleepiness and neurobehavioural performance were assessed every 1–2 h using the Karolinska Sleepiness Scale (KSS) and the Psychomotor Vigilance Task. Circadian phase was assessed by 6-sulfatoxymelatonin concentration in urine samples collected for 48-h prior to the simulated night shift.

Mean self reported sleepiness in the first 3 h of night shift positively correlated with the number of **consecutive** nights ($r = 0.35$, $p = 0.02$) and hours ($r = 0.32$, $p = 0.04$) worked immediately prior to the simulated night shift. In addition, the **total** number of hours worked in a 7-day period significantly correlated with subjective sleepiness at the start of a night shift ($r = 0.37$, $p = 0.01$). Relationships between circadian phase, sleep duration and neurobehavioural performance are being assessed.

These data suggest that both the number of **consecutive** night shifts and the **total** number of hours worked in a 7-day period impact on sleepiness levels during a subsequent night shift. Results from the simulated night shift setting will be compared with data from an additional 30 workers during night shift in their natural work environment.

071

PHARMACIST DELIVERED BEHAVIOURAL INTERVENTIONS FOR INSOMNIA: A FEASIBILITY STUDY

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Background: In the industrialised world, insomnia is highly prevalent and results in significant negative costs to society. Recent evidence suggests that behavioural therapies are as effective as sedative/hypnotics and should always be considered as an option in the treatment of chronic insomnia. The primary objective of this study was to demonstrate the feasibility of pharmacist delivered behavioural interventions for insomnia in pharmacy.
Method: Patients ≥18 years and who scored ≥7 on the Insomnia Severity Index (ISI) were recruited from one community pharmacy and randomised into control and intervention groups. The intervention group attended an individualised behavioural therapy session with a trained pharmacist. Validated questionnaires and sleep diaries were completed at baseline and one-month follow-up in both groups. The primary outcome measure was the mean change in score of the ISI between and within groups.
Results: Sixteen patients were recruited (eight in each group). Groups were comparable in terms of demographic characteristics. For the intervention group, the behavioural therapy session required an average of 31 minutes and patients set approximately two sleep goals each. Six intervention and six control patients completed the one-month follow up. A significant reduction in ISI scores were observed for the intervention group at follow-up (Baseline ISI = 14.6 ± 3.3, Follow-up ISI = 8.5 ± 4.0, $p = 0.02$). However the mean difference between baseline and follow-up and between groups was not significant (Intervention −6.0 ± 4.5, control 0.3 ± 2.5, $p = 0.06$). At follow-up patients wake after sleep onset (WASO) was significantly decreased in the intervention group (Baseline 61.1 ± 61.1 mins, Follow-up 38.3 ± 23.6 mins, $p = 0.008$). WASO at follow-up was also significantly different between groups (−29.3 ± 13.4 mins, $p = 0.02$). A significant increase was shown in sleep efficiency (SE) between baseline and follow-up in the intervention group (Baseline 82.0 ± 8.5%, Follow-up 85.2 ± 8.9%, $p = 0.035$). However the mean difference between baseline and follow-up and groups was not significant ($p = 0.47$).
Discussion: This study provides preliminary evidence for the potential role for pharmacy providing an alternative evidence based treatment option for people with insomnia. Future research is required on a larger scale to determine the effectiveness of these interventions.

072

IDENTIFY AND EVALUATE THE BASIS OF DRUG CHRONOTHERAPY FOR DISEASES WITH SIGNIFICANT CIRCADIAN RHYTHMS

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Introduction: Chronotherapy is an emerging concept in the field of pharmacy and this review presents the basis of chronotherapy for diseases with significant circadian rhythms from pharmacy point of view.
Methods: An extensive search of the literature was conducted in to identify publications focusing on Chronotherapy. The Embase, International Pharmaceutical Abstracts (IPA) and MEDLINE databases were used for the search. Articles were limited to English language, Humans, year 2008–2011 and non-review articles.
Results: Our search revealed a total of 195 journal articles, of which 44 articles were selected for review. A third of the reviewed studies (n = 15) did not support the notion of chronotherapy, i.e. the outcome of the clinical trial showed no difference in effect with respect to the time of the day the drug was administered. However the rest demonstrated a positive outcome i.e. supported chronotherapy. The hypothesis for the effectiveness of chronotherapy that was tested in these 44 studies was chronoeffectiveness (n = 36), followed by chronopharmacokinetics (n = 6), chronomodulation (n = 3) and chronopharmacodynamic (n = 2). Around 20% of the reviewed studies (n = 9) involved fixed combination therapy, whereas the rest (n = 34) involved monotherapy.
Discussion:

[1] Chronotherapy trends are clearly evident in hypertension. Nighttime administration is found to be beneficial compared to morning administration of drugs.
[2] Most of the chronotherapeutic studies have been performed with conventional or already marketed drugs. There is a need to consider chronotherapy in the earlier phases of drug development.
[3] Apart from drug efficacy, patient compliance is expected to be higher when drug is formulated as chronotherapies. However, studies have either not reported or not studied compliance in the details it deserves.
[4] Most of the studies were conducted in Europe considering Caucasians subjects. In our view it is difficult to generalise the results to all the races till clinical trials are done with other races included in the trials.

073

THE PERIODICITY OF HABITUAL SLEEP DURATION

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Introduction: Sleep and wake is governed by the interaction of a homeostatic and a circadian component. The sleep-wake system is also controlled by cognitive influences, for instance, making conscious decisions about bedtimes and waking times. Given that the timing of sleep and wake is impacted by sleep homeostasis, circadian timing and lifestyle influences, the periodicity of sleep duration is of interest.
Methods: Actigraphy data for 13 healthy young male adults were collected over 14 consecutive days under spontaneous living and analysed for habitual sleep duration. Using iterative processes, the sleep cycles for each 24 h were fitted with a sinusoidal function to model the sleep cycles for each individual across the fortnight.
Result: The sleep cycles for the group show periodicity with a range of 1.8 to 7.5 days, and a cycle peak-to-trough amplitude range of 72 to 292 min.
Conclusion: Our findings confirm the existence of periodicity in habitual sleep duration which is exclusive to each individual, and curtailed sleep beyond their respective threshold brings on sleep recovery.

074

SLEEP RELATED MOTOR SKILL LEARNING: IMPAIRED CONSOLIDATION IN OBSTRUCTIVE SLEEP APNOEA (OSA) PATIENTS

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Acquiring a motor skill is believed to be dependent on an initial rapid acquisition and a slow process of consolidation. An OSA group (N = 24) and a control group matched for age and level of education completed a PC-based Sequential finger tapping motor task at 10 pm prior to a night of PSG recorded sleep. They were then retested on the same task the following morning at 7 am. A mixed design ANOVA showed a significant main effect for Test Time, indicating improved overnight task performance across groups ($F(1,22) = 65.66$, $p < 0.001$). The OSA group performed significantly poorer overall ($F(1,22) = 8.66$, $p < 0.01$). A significant interaction effect indicated that the overall overnight improvement could be attributed to improvement in the control group ($F(1,22) = 9.63$, $p < 0.005$). These results suggest that OSA patients may also be deficient in the acquisition of motor skills due to reduced or impaired overnight consolidation of motor learning during sleep.

075

THE CYCLIC ALTERNATING PATTERN (CAP) AS AN INDICATOR OF SLEEP DISRUPTION IN TRAUMATIC BRAIN INJURY PATIENTS

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Traumatic Brain Injury (TBI) causes behavioural, cognitive and neurological disruption with sleep disruption being a prevalent complaint from TBI survivors. While previous studies have examined TBI related disruption in sleep, none have explored it on a microstructural level through analysing the Cyclic Alternating Pattern (CAP). CAP analysis allows exploration of the fluctuations in sleep's phasic events. Higher levels of CAP rate have been linked to sleep instability, even in cases when sleep macrostructure has not reflected this. The aim of this study was to explore CAP in moderate-severely affected TBI participants and healthy controls. It was hypothesised that the TBI participants would exhibit higher levels of CAP rate, CAP incidence and mean CAP sequence time. Furthermore, it was hypothesised that the CAP rate in the TBI group would show an association with the Epworth Sleepiness Scale (ESS) scores, arousal incidence and night-time awakenings. To investigate these hypotheses TBI participants ($n = 8$) and controls ($n = 11$) completed a sleep diary and were required to sleep at the sleep laboratory for two consecutive nights. Polysomnographic recording of participants' sleep was obtained on the second night for sleep staging and CAP analysis. Results partially supported the hypothesis. CAP analysis demonstrated significantly higher CAP rate in the TBI group, $t(17) = 2.43$, $p < 0.05$, two tailed, and higher mean CAP sequence time, $t(17) = -0.51$, $p > 0.05$. The TBI group also presented with higher levels of sleepiness than the controls. However, CAP incidence, as well as the associations between CAP and the ESS, arousals and night-time awakenings, was not significant. This could be due to the small sample size in the study. These results may indicate that CAP sequence time and rate are indicative of the brain's attempt to achieve unfragmented macrostructural sleep and indicate disruption on a microstructural level. These results are in line with previous studies on sleep disordered groups. Future studies will benefit from larger samples sizes and study of the specific CAP subtypes present.

076

NEUROCOGNITIVE CORRELATES OF NOCTURNAL OXYGEN DESATURATION IN PATIENTS WITH MILD COGNITIVE IMPAIRMENT

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Introduction: Older adults with sleep apnoea show deficits in a wide range of cognitive functions including attention, processing speed, memory and executive functioning. Despite being a prognostic risk factor for cognitive decline, little is known about the impact of nocturnal oxygen desaturation on neurocognitive performance in patients with mild cognitive impairment (MCI), a clinical group who are at increased risk of transitioning to dementia, and in whom modifiable risk factors are desirable.
Methods: Cross-sectional analyses were performed on 25 health-seeking older adults with non-amnestic MCI (mean age = 65.0 ± 9.0 SD) and 25 age and sex matched healthy controls recruited from the community (mean age = 62.0 ± 7.7 SD). Nocturnal oxygen desaturation measures were obtained from pulse oximetry during in-lab polysomnography. A Neuropsychologist administered a battery of cognitive tests evaluating *attention* (WAIS-III Digit Span), *processing speed* (Trailmaking Test; Part A), *verbal learning* and *memory* (WMS-III Logical Memory I & II), and *mental flexibility* (Trailmaking Test; Part B) with all scores adjusted for age and level of education in accordance with published norms. All correlational analyses employed Spearman rank correlations with a Bonferroni correction applied for multiple comparisons.

Results: MCI patients had greater impairment than controls in the cognitive domains of *attention* (p = 0.030), *verbal learning* (p = 0.006), *verbal memory* (p = 0.003), and *mental flexibility* (p = 0.003). No significant differences in nocturnal oxygen desaturation measures were found between the MCI and control groups (p > 0.05). In the control group, no relationships between nocturnal oxygen desaturation and cognition were observed. In the MCI group however, poorer *verbal learning* correlated with a greater percentage of time spent below 90% oxygen saturation ($P = 0.515$, p = 0.008).
Conclusion: In contrast to healthy older adults, persistent nocturnal oxygen desaturation below 90% in MCI is associated with compromised verbal learning, and suggests such deficits may be related to hypoxemia. Early screening for sleep-disordered breathing with hypoxemia is warranted in older adults, with a view to implementing early intervention of appropriate strategies including continuous positive airway pressure.

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INFLAMMATORY BIOMARKERS AND HORMONE LEVELS IN OBESE ASIAN INDIAN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Purpose: Obstructive sleep apnea (OSA) is known to be associated with metabolic, cardiovascular and neuropsychological disorders. Metabolic syndrome, obesity and OSA are increasing in Asian Indian. The link between metabolic syndrome and obesity with inflammatory markers and hormones is unclear. We looked for the relationship between interleukin-6 (IL-6), Hs-C-reactive protein (CRP), serum cortisol, growth hormone (hGH) and insulin like growth factor-1 (IGF-1) levels in obese Indian subjects with and without OSA.
Methods: 80 obese subjects (BMI > 25 Kg/m^2), without significant comorbid condition were evaluated. All subjects underwent a full – montage digital Polysomnography. Detailed demographic data and fasting blood samples was collected. Plasma levels of IL-6, CRP, Cortisol, GH, and IGF-1 were estimated. Subjects with AHI > 5/h were diagnosed with OSA.
Results: Of the 80 obese subjects, 68 were diagnosed with OSA &12 subjects did not have OSA. The mean cortisol levels in obese subjects with OSA and those without OSA was 128.3 ± 43.5 ng/ml and 88.3 ± 36.6 ng/ml respectively (p ≤ 0.001), CRP levels in obese with OSA and without OSA was 3.7 ± 2.0 mg/l and 1.5 ± 1.5 mg/l respectively (p ≤ 0.001), IL-6 levels in obese subjects with OSA and without OSA were 1.8 pg/ml and 1.6 pg/ml respectively (p = 0.268), GH levels in obese subjects with OSA and without OSA were 1.3 ± 1.8 ng/ml and 1.2 ± 1.6 ng/ml respectively (p = 0.67) and IGF-1 levels in obese with OSA and without OSA were 97.5 ± 57.2 ng/ml and 106.7 ± 58.8 ng/ml respectively (p = 0.33).
Conclusions: Serum cortisol, and CRP levels was significantly higher in obese OSA subjects as compared to obese subjects without OSA. There was no significant difference in growth hormone, insulin like growth factor-1 and IL-6 in the two groups. A larger study is needed to confirm these finding and evaluate the relationship of IL-6, CRP, GH, IGF-1 and cortisol levels in obese subject with OSA.
Clinical Implications: Systematic inflammatory biomarker CRP was higher in patients with OSA and this was not related to obesity. Also, OSA in obese subjects leads to alteration in the cortisol levels. This may contribute to the significantly to the systemic effect that occurs in OSA.

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A DESCRIPTIVE ANALYSIS OF SLEEP DISORDERED BREATHING IN PATIENTS WITH MOTOR NEURONE DISEASE (MND)

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Introduction: Sleep disordered breathing (SDB) has been documented in patients with MND and has been attributed to hypoventilation due to muscle weakness. However we have observed different types of SDB in patients who were referred for non-invasive ventilation (NIV) and this cannot be explained on the basis of respiratory muscle weakness alone.
Aims and Objectives: To analyse the characteristics of SDB in MND patients, who have been referred for NIV support.
Material and Methods: Retrospective analysis of sleep studies (PSG) of patients with MND who were referred to Sleep medicine department for assessment for NIV. The data was collected in anonymised forms from the sleep medicine database and analysed.
Results: Nine patients had diagnostic PSG and nine patients had PSG while on NIV. Sixty seven percent of patients had evidence of obstructive sleep apnea on diagnostic PSG. All the patients (100%) had evidence of hypoventilation during sleep. Three patients had evidence of central apnoeas in diagnostic PSG. Seventy eight percent (n = 7) of patients had evidence of irregular pattern of breathing in REM and/slow wave sleep, in their diagnostic PSG. Four patients who had diagnostic PSG also had PSG while on NIV. Three of them had irregular breathing pattern on diagnostic PSG. Two of these three patients showed central apnoeic events, which were not manifested in diagnostic PSG.
Discussion: The MND patients manifest a wide variety of SDB. We have found a higher incidence of OSA and central apnoeas in MND patients, than previously reported. There appears to be a pattern of irregular breathing, which herald onset of central apnoeas in patients initiated on NIV (spontaneous mode). Dysrhythmic and arrhythmic respiration due to involvement of Pre-Botzinger complex due to neurodegenerative conditions like multiple system atrophy has previously been reported. We propose that our findings suggest involvement of Pre-Botzinger complex in MND. Further studies are needed to investigate this phenomenon which is likely to have potential impact on the ventilator settings, when MND patients are initiated on non-invasive ventilation.

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OBSTRUCTIVE SLEEP APNOEA IS NOT AN INDEPENDENT DETERMINANT OF PLASMA TESTOSTERONE

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Introduction: It is generally considered that obstructive sleep apnoea (OSA) lowers testosterone in men, although the data supporting this is relatively limited.
Methods: We determined the relationship between the presence and severity of sleep disordered breathing and plasma testosterone in a comprehensively characterized community based cohort of men aged over 40 yrs (MAILES) from whom fasting morning plasma samples were drawn in 2008–2010 (n = 1869). Plasma total testosterone (T) was measured by liquid chromatography mass spectrometry (LC-MS/MS). In 2011, home polysomnography was performed in 810 randomly selected men from the cohort using an 8 channel Embletta X100 device. The Apnoea Hypopnea Index (AHI), and absence or presence and severity (mild: AHI 10–20; moderate AHI 21–30; severe: AHI > 30) of OSA were classified according to the International Classification of Sleep Disorders (ICDS-2) from the American Academy of Sleep. After excluding men with pathological conditions or taking medications affecting testosterone, with missing values or using CPAP, 654 men aged 41–85 remained. The effect of OSA severity, or AHI, on T were analysed using generalized linear models controlling for potential confounders (age, BMI, smoking, marital status, presence of depression (self-report), HbA1c and SHBG).
Results: The mean (±SD) characteristics of the men were: age 59 (10) yrs, T 16.5 (5.4) nmol/L, SHBG 33.1 (13.4) nmol/L, BMI 28.4 (4.2) kg/m^2, AHI 14.1 (14). OSA was present in 53.7%, (mild 28.6%, moderate 13.6, and severe 11.5%). A significant inverse relationship between AHI and T (b −0.118, p = 0.002), remained after adjustment for age, smoking, marital status, presence of depression, and HbA1c (b −0.109, p = 0.007), and SHBG (b −0.077, p = 0.017), but not after additional adjustment for BMI (b −0.022, p = 0.504). The results using OSA category rather than AHI were similar.
Discussion: These data suggest that obesity, or sleep related factors rather than OSA per se, determine T. This accords with the graded effect of weight loss, but limited effect of CPAP to increase T and highlights the importance managing obesity effectively, particularly in the context of OSA.

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WITHIN-BREATH SENSORY TRIGGERS OF RESPIRATORY AROUSAL IN OBSTRUCTIVE SLEEP APNOEA

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Background: Respiratory and arousal events in sleep are tightly coupled events, with ~80% of respiratory events in obstructive sleep apnoea (OSA) resolving with brief arousal. Classic studies show arousals occur at a similar level of peak oesophageal pressure (arousal threshold), independent of the respiratory stimulus (hypoxia, hypercapnia and resistive loads) and despite different time-courses and blood gas status preceding arousal. These data strongly support that sensations arising from mechanoreceptor systems and/or increased motor command with augmented breathing effort provide the main stimulus for respiratory arousal in sleep. However, the more precise nature of sensory inputs and the within-breath timing of arousal to increased inspiratory effort remain unclear. This observational study aims to examine the within-breath timing of respiratory arousals and relationships to within-breath changes in inspiratory effort potentially involved in precipitating respiratory arousal in sleep.
Methods: To date, 6 male OSA patients with severe OSA have undergone detailed observational in-laboratory sleep studies. Measurements include conventional sleep signals plus mask/pneumotachograph and oesophageal pressure to assess ventilation and within-breath inspiratory effort breath-by-breath. Following conventional sleep, respiratory and arousal scoring, all apnoea and hypopnoea events associated with arousal from stage 2 sleep were assessed to determine the timing of arousal onset relative to inspiratory effort onset and offset, and the number of arousals commencing in each quartile of inspiratory and expiratory phases of breathing effort.
Results: Arousal onset occurred more frequently during inspiration than expiration at the termination of both apnoea and hypopnoea events (between subject mean ± SEM 69.4 ± 14.5%, 172 vs 47 events, Fishers exact test $p < 0.001$ and 72.3 ± 7.1%, 115 vs 73 events, $p = 0.002$ respectively), and occurred most frequently in the first quartile of inspiratory effort (apnoeas; 69/219, 32% Chi^2 $p < 0.001$, hypopnoeas; 41/188, 22%, $p = 0.006$).
Discussion: These data support that motor output and/or mechanoreceptor inputs stimulated during inspiration provide a key stimulus for respiratory arousal in OSA.

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VENTILATION HETEROGENEITY IS NOT AFFECTED BY SUPINE POSTURE IN STABLE HEART FAILURE PATIENTS NOR IN NORMAL CONTROLS

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Introduction: Sleep disordered breathing is common in chronic heart failure (CHF). There is evidence that rostral fluid shift in the supine

position contributes significantly to the development of SDB in patients with and without CHF. It has been postulated that the development of central sleep apnoea is due to movement of fluid into the lung and that this shift occurs rapidly (within 30–60 minutes)[1]. We hypothesized that this fluid shift would be detectable as a change in small airway function as measured by ventilation heterogeneity.

Methods: We recruited ambulatory patients with known CHF (n = 17) as well as normal (no history of cardiac, respiratory or renal disease) controls (n = 6). CHF patients were clinically stable and euvolaemic on examination. Subjects underwent multibreath nitrogen washout (MBNW) in the sitting position, followed by repeat MBNW measurements after five and forty-five minutes in the supine position. Lung clearance index (LCI) as well as acinar (S_{acin}) and conductive (S_{cond}) heterogeneity were calculated from these measurements.

Results: There was no significant change from baseline in any of the MBNW indices after 5 or 45 minutes in the supine position for either group.

	CHF Subjects		Normal Controls	
	Seated	Supine 45 mins	Seated	Supine 45 mins
LCI (lung turnovers)	8.501 ± 1.064	8.604 ± 1.246	7.613 ± 1.113	7.561 ± 0.756
Sacin (L^{-1})	0.228 ± 0.120	0.216 ± 0.121	0.180 ± 0.123	0.149 ± 0.047
Scond (L^{-1})	0.026 ± 0.015	0.021 ± 0.010	0.018 ± 0.009	0.009 ± 0.011

Conclusion: Ventilation heterogeneity does not change following 45 minutes in the supine posture. Further study is required to determine if this is due to a lack of fluid shift into the lung or if ventilation heterogeneity is unaffected by rostral fluid shifts.

Reference

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082

ASSESSMENT OF NASAL AIRFLOW USING NASAL PRESSURE MEASUREMENTS IN THE PRESENCE OF THE PROVENT® DEVICE

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Introduction: Provent® is an external expiratory nasal resistive device proposed as a novel therapy for obstructive sleep apnoea (OSA). The efficacy of Provent® in reducing sleep disordered breathing is assessed via nasal pressure measurements (surrogate for nasal airflow; V) recorded using an attached proprietary cannula (Provent Nasal Pressure Cannula [PNPC]). We compared the sensitivity for detecting a change in nasal airflow with Provent® plus PNPC versus measurements with a standard nasal pressure cannula (NPC).

Methods: Using an anatomically correct bench model of the human nasal passages, either NPC or Provent® plus PNPC were attached to the anterior nares, and nasal pressure values (P) from each quantified using a pressure transducer. Graded inspiratory and expiratory direction airflows (V, 0 to ±1 L/s) were generated through the nasal passages of the model using a pump with an attached pneumotachograph. Differentiation of power functions fitted to inspiratory and expiratory P/V plots was used to obtain sensitivity (dP/dV) data at V = ±0.3 L/s.

Results: During expiratory V, $P = 0.96V^{1.92}$ with NPC and $P = 24.31V^{1.64}$ with PNPC. During inspiratory V, $P = 1.1V^{1.93}$ with NPC and $P = 2.40V^{2.17}$ with PNPC. At 0.3 L/s, expiratory dP/dV values were 0.61 cmH2O/L/s with NPC versus 18.42 cmH2O/L/s with PNPC, while inspiratory dP/dV was 0.69 cmH2O/L/s with NPC versus 1.28 cmH2O/L/s with PNPC.

Conclusion: Overall measurements of P with PNPC are greater than with NPC for the same V. Using NPC, the sensitivity for detecting a change in nasal airflow is similar for inspiration versus expiration but these values differ markedly with PNPC plus Provent®. When compared with NPC, measurements with PNPC appear more sensitive to changes in bulk nasal airflow. Implications of these findings for the quantification of nocturnal obstructive events in the presence of Provent® and PNPC require further investigation.

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MORNING HEADACHE AND OBSTRUCTIVE SLEEP APNOEA: A RETROSPECTIVE EVALUATION

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Introduction: The aim of the study was to clarify the nature and magnitude of the relationships between morning headaches and nocturnal hypoxaemia, respiratory disturbance indices and/or the presence of snoring or its intensity. The differential impact of gender, age and co-existing conditions including obesity and depression was directly tested.

Methods: Data from 608 consecutive patients who had been referred to a sleep disorders centre in a tertiary health care facility for diagnostic polysomnography over a 10-month period from June 2009 and April 2010 were included in this retrospective evaluation. Of these patients, 65% were male (n = 394) and 35% were female (n = 214). The average age was almost 53 years (52.93 ± 13.95 years).

Odds ratio (OR) estimates were generated using logistic regression models to describe the associations between variables and the presence of headache on waking. Potential confounding variables of depression and body mass index were controlled. All cases were included in the preliminary model. Regression analyses were then applied to RDI severity groups. Factors treated as covariates in the analysis were age, total sleep time, total respiratory disturbance index, snoring intensity as measured in decibels, total sleep time with a blood oxygen reading of less than 90% and the longest apnoea and longest hypopnoea as measured in seconds.

Results: Morning headache was acknowledged by 15.7% those with OSA. No significant association was found between hypoxaemic predictors and the report of morning headache. However, a statistically significant association between the RDI in females with severe OSA and morning headache was found. The data suggest an increase in the RDI of women with severe sleep apnoea increased the likelihood that these women would wake up with a headache by 5.7% (p = 0.012, OR 1.057, CI 1.012–1.103). It also appears the louder females snore, the higher the prevalence of morning headache. The presence of depression was found to be a significant predictor in both males and females, more than doubling the likelihood of having a headache on waking (p = 0.025, OR 2.067; p = 0.036, OR 2.071 respectively).

Conclusions: This study confirms previous studies that demonstrate a higher prevalence of headache in females generally. It also confirms

previous findings that morning headache is strongly associated with depression. This study shows a prevalence of morning headache in those with OSA that is higher than that found in the general community. The association however, is not predictive for the whole OSA group. Morning headache appears to be a non-specific component of the symptom cluster found with OSA. The data do however suggest a predictability of morning headache in those females with severe OSA. The presence of snoring and the sound intensity of snoring are unlikely to be clear diagnostic indicators of morning headache, however, the complaint of morning headache to the clinician may flag the possibility of sleep-disordered breathing in females.

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RESPIRATORY EFFORT DURING SLEEP IN CHRONIC HEART FAILURE PATIENTS IS SIGNIFICANTLY REDUCED DURING CENTRAL SLEEP APNOEA

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Introduction: Central and obstructive sleep apnoea (OSA and CSA respectively) are common in chronic heart failure (CHF) yet their impact on work of breathing has not previously been described. We sought to evaluate the respiratory effort (RE) during sleep in CHF patients as a marker of work of breathing.
Methods: We recruited ambulatory patients with CHF (n = 7), who underwent polysomnography with oesophageal pressure (PES) measurement. Representative 1 minute samples of stable breathing were selected and the PES swing for each breath in the sample was recorded. For periods of OSA and CSA, a complete ventilatory cycle (ventilatory period plus apnoeic period) was selected and PES swing for each attempted breath was recorded as was the total cycle length. RE was calculated by taking the sum of the PES swings normalised for time (1 minute for stable breathing and cycle length for OSA or CSA).
Results: (mean ± SD):
RE did not vary statistically between sleep stages during stable ventilation (p = 0.094).

	Awake	1	2	3	4	REM
Events	13	7	13	9	12	9
RE (mmHg/min)	159 ± 45	186 ± 62	206 ± 79	255 ± 115	183 ± 83	227 ± 72
breaths/min	14 ± 3	15 ± 2	16 ± 5	17 ± 3	12 ± 2	18 ± 4

RE was higher in periods of OSA (p = 0.028) and lower during periods of CSA (p = 0.003) compared to stable ventilation.

	CHF Stable (n = 63)	CHF OSA (n = 21)	CHF CSA (n = 18)
RE (mmHg/min)	200 ± 81	241 ± 70	139 ± 26
breaths/min	16 ± 3	18 ± 4	11 ± 2

Conclusion: Respiratory effort varies considerably during sleep in CHF patients. Respiratory effort compared to stable ventilation is higher during OSA and lower during CSA. Whilst correction of OSA may reduce respiratory effort, correction of CSA may result in increased respiratory effort.

085

THE EFFECT OF OBSTRUCTIVE SLEEP APNOEA ON SLEEP-RELATED GASTROESOPHAGEAL REFLUX

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Introduction: Gastroesophageal reflux (GOR) symptoms and events are extremely common in individuals with obstructive sleep apnoea (OSA). The role of obesity vs. upper airway obstruction in the high prevalence of GOR in OSA patients remains unclear. The present study investigated the additional risk of OSA on the presence and severity of GOR in obese individuals.
Methods: Ten obese individuals with moderate to severe OSA (apnoea-hypopnoea index >15 events per hour) and 10 obese individuals without OSA (apnoea-hypopnoea index <5 events per hour) underwent 24-hour oesophageal pH-impedance monitoring and polysomnography. Reflux events were classified as distal *vs.* proximal (migrating >15 cm above the lower oesophageal sphincter) or acidic (pH < 4) *vs.* non-acidic. For analysis, the study was divided into a wake period, a sleep period (time after sleep onset) and the combined 24-hour period.
Results: There were no significant differences in age or BMI between the two groups; however there was a significantly greater proportion of males in the obese with OSA group (100% *vs.* 40%). There were no differences between groups in any pH or impedance variable, including acid contact time, during the sleep period. Over the 24-hour period, however, the number of GOR events was significantly greater in the OSA group in the distal oesophagus (55 ± 21 *vs.* 38 ± 13, p = 0.05) and the proximal oesophagus (32 ± 17 *vs.* 17 ± 12, p = 0.03). Likewise the average duration of GOR events was significantly longer in the OSA group (5 ± 6 *vs.* 1 ± 0.5 min, p = 0.02) during the 24-hour period.
Discussion: There were no differences in GOR measures between groups during the sleep period, arguing against a significant role of OSA in the occurrence of GOR during sleep. GOR during sleep in these subjects is most likely secondary to obesity. However, OSA was associated with an increase in number and duration of GOR events over a 24-hour period.

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CORTISOL AND PSYCHOLOGICAL AND PHYSICAL HEALTH IN MALES WITH OBSTRUCTIVE SLEEP APNOEA

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Objectives: Obstructive Sleep Apnoea (OSA) is known to deleteriously impact physical and psychological health. Cortisol, a hormone characterised by a marked circadian rhythm and stress responsiveness, is also thought to be affected in OSA. However it is unknown if diurnal patterns of cortisol secretion are connected with physical or psychological health outcomes in OSA. The purpose of this pilot study was to assess the relationship between cortisol and psychological and physical health in OSA patients.
Methods: Twenty-nine adult males diagnosed with OSA (AHI 42.9 ± 16.1; Age 53.4 ± 8.7) undertook the 2-day in-home study. Participants completed the Depression-Anxiety-Stress Scale (DASS-21) and the Short Form 36 Health Survey (SF-36) to measure psychological and physical health respectively. Salivary cortisol samples were collected immediately upon awakening, every 15 min thereafter until 45 min and 12 hr post-awakening to measure the diurnal pattern of cortisol secretion, with diurnal decline calculated as peak minus the 12 hour cortisol level.
Results: Data were analysed using Pearson correlations. While not statistically significant a trend for a negative association between cortisol diurnal decline and stress ($r = -0.30$, $p = 0.059$) and anxiety ($r = -0.30$, $p = 0.059$) was observed. Depression ($r = -0.04$, $p = 0.420$) and physical health were not associated with cortisol ($r = 0.16$, $p = 0.204$).
Conclusions: Trends in the current data suggest there may be links between stress, anxiety and the diurnal pattern of cortisol secretion in individuals with OSA. Further investigation is needed to examine if there are causal relationships between these factors.

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DOES HAVING A LARGE VENTILATORY RESPONSE TO AROUSAL PREDISPOSE TO REDUCED UPPER AIRWAY DILATOR MUSCLE ACTIVITY AND AIRWAY COLLAPSE?

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Introduction: Arousals from sleep occur at the end of most respiratory events in OSA. Arousals could perpetuate cyclical breathing via hyperventilation, hypocapnia and dilator muscle hypotonia leading to airway collapse on the return to sleep. However, several studies have not shown reduced dilator muscle activity following the return to sleep after induced arousal. The magnitude of hyperventilation at arousal varies between individuals and it is possible that dilator muscle hypotonia only occurs in individuals with a large ventilatory response to arousal (VRA). This study aims to: 1) assess the variability of the magnitude of the VRA and 2) compare dilator muscle activity changes following arousal between individuals with large and small VRA.
Methods: To date 38 healthy individuals have been instrumented with: EEG, EOG and chin EMG; nasal mask with pneumotachograph; epiglottic pressure catheter, 2 intramuscular genioglossus (GG) electrodes and mask end-tidal CO_2. Once more than 2 minutes of stable supine N2-N4 sleep was achieved, auditory tones (40–100 dB, 0.5 s, 1000 Hz) were played to induce brief 3–15 s arousals.
Results: Adequate data were obtained in 21 subjects. The peak VRA ranged from 7% to 58% above the pre-arousal level of ventilation (median 32%). Physiologic data were compared between extreme groups: 4 subjects with large VRA (>50% increase in ventilation) and 5 subjects with small VRA (<25% increase in ventilation). The mean ± SEM duration of arousal did not differ between large and small VRA groups (6.3 ± 0.9 and 7.4 ± 0.9 sec respectively). By design, post arousal ventilation was significantly different between groups (9.4 ± 0.8 vs 6.6 ± 0.3 L/min, p = 0.03). No other variables differed significantly, although $PETCO_2$ and peak inspiratory GG activity tended to show a greater reduction on the 2nd and 3rd breaths following arousal in the large VRA group (Breath 2: −1.1 ± 0.3 vs −0.1 ± 0.5 mmHg and 111 ± 7 vs 131 ± 11% baseline activity respectively). GG activity was not reduced below baseline following the return to sleep in either group.
Conclusions: More data are required before firm conclusions can be made, but these data do not support that genioglossus muscle activity is diminished on the return to sleep following arousal, at least in healthy individuals, including those with a large VRA.

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DOES CHRONIC OBSTRUCTIVE SLEEP APNOEA ALTER DAYTIME OESOPHAGEAL FUNCTION?

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Introduction: Obstructive sleep apnoea is associated with an increase in daytime and nighttime gastroesophageal reflux (GER) events and symptoms. The increase in GER events and symptoms appears to be independent of obesity, a known risk factor for both GER and OSA. Chronic nighttime upper airway obstruction and the associated negative thoracic pressure fluctuations may alter daytime oesophageal and lower oesophageal sphincter (LOS) function, however little research exists to examine this possibility. This study investigates daytime oesophageal function in obese patients with and without OSA.
Methods: Twenty obese individuals with moderate-severe OSA (apnoea-hypopnoea index >15 events per hour) and 15 obese individuals without significant sleep apnoea (apnoea-hypopnoea index <5 events per hour) underwent high resolution oesophageal manometry/impedance evaluation during 10 swallows of 5 cc saline and 10 swallows of 5 cc viscous solution.
Results: The OSA group had a higher BMI than the obese control group (40 vs 34 $kg \cdot m^{-2}$, p = 0.004), however there was no difference in age between groups. LOS pressure tended to be higher in the OSA group (14.4 vs 11.2 mmHg, p = 0.08). The LOS and the intra-abdominal portion of the sphincter were significantly longer in the OSA group (3.2 vs 2.4 cm, p = 0.004 and 1.3 vs 0.5 cm, p = 0.037 respectively). Amplitude and velocity of the peristaltic wave in the distal-oesophagus

during water swallows was not different between the two groups. There were no significant differences in the proportion of peristaltic contractions compared to simultaneous or non-propagated contractions between groups. There were no differences in bolus transit through the oesophagus between groups.
Discussion: 1) These data do not support the notion that chronic upper airway obstruction during sleep alters waking oesophageal function. 2) It appears that the OSA patients may have a 'stronger' LOS with a higher resting pressure, longer sphincter and a greater portion of the LOS in the abdominal cavity.

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OBSTRUCTIVE SLEEP APNOEA IS ASSOCIATED WITH INCREASED FREQUENCY OF CARDIAC ARRHYTHMIAS

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Introduction: Obstructive sleep apnoea (OSA) is associated with fatal and non-fatal cardiovascular events. In addition, the proportion of sudden death in OSA peaks between midnight and 6 am, compared with 6 am to midday in the general population. The mechanism for cardiovascular events and sudden death in OSA may be acute arrhythmia without reversal. We aimed to test the hypothesis that patients with OSA have an increased frequency of cardiac arrhythmias during sleep compared to those without OSA.
Methods: Subjects were selected sequentially from a clinical cohort attending for nocturnal polysomnography and consisted of 23 patients (10 male) without OSA (AHI < 5 events/h) and 36 patients (24 male) with moderate-severe OSA (AHI > 20 events/h). The electrocardiogram (single modified lead II) was reviewed for cardiac arrhythmias whilst blinded to subject group. The proportion of subjects with each arrhythmia type was compared between groups using z-tests. Data are presented as mean ± SEM.
Results: The OSA group had a significantly increased AHI (25.3 ± 0.5 vs. 0.6 ± 0.2 events/h, $p < 0.05$) and were significantly older (55.5 ± 2.4 vs. 39.5 ± 2.7 y, $p < 0.05$) than the no-OSA group. There was no difference in BMI (33.0 ± 1.2 vs. 29.9 ± 1.4 kg/m^2) or average heart rate between groups (66.4 ± 1.3 vs. 68.3 ± 2.5 bpm). Overall, significantly more subjects in the OSA group had arrhythmias identified on the polysomnogram compared with the no-OSA group (28% vs. 4%, $p < 0.05$). More subjects in the OSA group exhibited ventricular premature beats (>20 beats, 25% vs. 4%), non-sustained ventricular tachycardia (6% vs. 0%) and atrial fibrillation (6% vs. 0%) than the no-OSA group.
Conclusion: Our dataset shows that OSA is associated with an increased frequency of cardiac arrhythmia, however age is likely to also have an effect. Increased risk of nocturnal arrhythmia may add to the cardiovascular morbidity in this group.

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A META-ANALYSIS OF EXECUTIVE DYSFUNCTION IN OSA: BEFORE AND AFTER TREATMENT, AND CORRELATES OF NOCTURNAL SYMPTOMS

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Study Objectives: To investigate the impact of OSA in adult patients on executive function. We aimed to: (1) describe executive dysfunction specific to OSA patients; (2) explore the relationship of executive deficits to oxygen desaturation and sleep fragmentation; and (3) examine the impact of treatment on executive dysfunction.
Design: Meta-analysis was used to synthesise results from 64 studies examining the impact of OSA on executive functioning before and after treatment, and the relationship to nocturnal indices.
Measurements: Participants were assessed with a range of tasks that assessed different facets of executive function: flexibility of thinking, inhibition/impulse control, problem-solving, planning, concept formation, and abstract thinking/creativity.
Results: The range of executive dysfunctions for which systematic effects have been found in the literature will be reported.
Discussion: Most meta-analyses of cognitive deficits in OSA have treated executive function as a unitary cognitive function. This meta-analysis will contribute to understanding the multifaceted nature of executive function and how functions may be differentially impaired in OSA, how treatment impacts upon impairments and the relationship to nocturnal symptoms.

091

OVERNIGHT HOLTER MONITORING AS A POTENTIAL LOW-COST SCREENING INVESTIGATION FOR OSA

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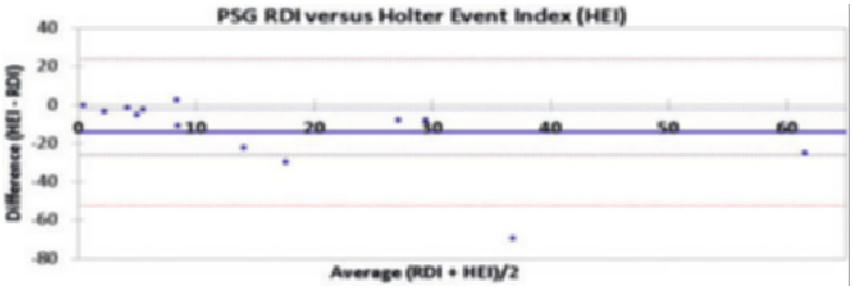
Introduction: Obstructive sleep apnoea (OSA) is common and under diagnosed in cardiovascular disease. ECG algorithms exist from which respiratory events can be detected.
Aim: To compare Holter recordings with polysomnography (PSG) for the detection of OSA.
Methods: Simultaneous PSG (Compumedics E-Series) and Holter (Medilog Darwin) recordings were obtained in an attended overnight laboratory setting. Agreement between the two methods was determined by the Bland-Altman method.
Results: 13 consecutive patients (mean ± SD) age = 49.2 ± 10.8 yrs, M : F = 9:4, BMI = 30.2 ± 4.8, ESS = 8.4 ± 4.3, median RDI = 14 (IQR 5.9,33.0). Holter Event Index (HEI) systematically underestimated PSG Respiratory Disturbance Index (RDI) with mean difference of −14.2 (95% CI −26.0, −2.5). Limits of agreement show that 95% of the differences were between −52.4 and 24.0.
Discussion: HEI was systemically less than RDI, with wide limits of agreement. This may be due to Holter sensitivity to detect events and use of total recording time versus PSG total sleep time in calculation of indices.
Conclusion: Holter recordings may be useful in screening for OSA. Further data are required to determine the sensitivity and specificity of Holter to detect OSA at different levels of severity.



092

CHARACTERISTICS OF PATIENTS DIAGNOSED WITH REM RELATED OBSTRUCTIVE SLEEP APNOEA (OSA) USING REVISED DIAGNOSTIC CRITERIA

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Introduction: The term 'REM related OSA' is used to describe sleep disordered breathing (SDB) events that occur predominantly during REM sleep. Previous diagnostic criteria have used a ratio of the apnoea-hypopnoea index (AHI) during REM and NREM sleep, thus incorporating substantial NREM sleep disease. Revised criteria have been proposed which exclude any patients with a NREM AHI ≥ 5 events/hour. The aim of this study was to use the revised diagnostic criteria for REM related OSA to determine if this defines a specific patient clinical phenotype.

Methods: We undertook a retrospective analysis of all patients (n = 621) who presented to our laboratory in 2006 for diagnostic polysomnography (PSG; scored with Chicago criteria). We applied the revised diagnostic REM criteria of (a) an AHI NREM < 5 events/hr and (b) an AHI REM ≥ 5 events/hr with a minimum 30 minutes of REM sleep, to define REM OSA. From the remaining patients, NREM OSA was defined as an AHI ≥ 5 events/hr. From our database, we analysed patient demographics, Epworth Sleepiness Score (ESS), total and REM AHI, minimum oxygen saturation during REM sleep (Min SpO_2), and morning systolic blood pressure (SBP am) for both REM and NREM OSA groups.

Results: REM OSA patients (n = 33; M : F 14:19) were 5.4% and NREM OSA (n = 579; M : F 377:202) were 94.6% of the total OSA patient population (n = 612).

Conclusions: The prevalence of REM related OSA appears low at ~5% of PSG determined OSA. REM related OSA patients are female predominant, younger, less obese, have less severe SDB (AHI and Min SpO2), have lower blood pressure, but have similar levels of sleepiness (ESS) compared with NREM OSA. Longitudinal outcome studies are required to determine if REM related OSA patients form a specific phenotype of OSA or if this simply represents an early stage in the development of the clinical OSA disorder.

OSA	Age (years)	BMI (kg/m^2)	ESS (a.u.)	Total AHI (events/h)	REM AHI (events/h)	Min SpO2 (%)	SBP am (mmHg)
NREM	53.3 ± 0.6	32.9 ± 0.3	10.3 ± 0.2	36.2 ± 1.1	41.4 ± 0.9	84.6 ± 0.5	124.5 ± 0.8
REM	43.4 ± 2.4†	30.0 ± 1.2†	9.7 ± 1.1	6.1 ± 0.5†	19.9 ± 2.1†	91.6 ± 0.6†	115.4 ± 2.9†

Data are mean ± SD. †$p < 0.05$, relative to NREM OSA (t-test). BMI = body mass index.

093

DEPRESSIVE SYMPTOMS ARE STRONGLY ASSOCIATED WITH FATIGUE AND SLEEPINESS AMONG AN OBSTRUCTIVE SLEEP APNOEA CLINIC POPULATION

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Introduction: Fatigue is a common manifestation of obstructive sleep apnoea (OSA) that correlates poorly with sleepiness and inconsistently with polysomnographic (PSG) measures of OSA severity. The aim of this study was to investigate the prevalence of fatigue and sleepiness and their predictors in untreated OSA patients.

Methods: Unselected patients from a tertiary public hospital sleep clinic with untreated OSA completed questionnaires including Epworth Sleepiness Scale (ESS), Fatigue Severity Scale (FSS) and Centre for Epidemiological Studies Depression Scale (CES-D). PSG variables, age, gender, BMI, and self-reported smoking, alcohol use, educational level and employment status were collected. Univariate predictors were sought then stepwise multiple linear regression was used to determine independent predictors (entry probability = 0.05, removal = 0.1). Analysis was restricted to those with apnoea-hypopnoea index (AHI) > 5 events per hour.

Results: Patient (n = 382) characteristics were typical for an OSA clinic population: 56% were male with a mean (SD) age of 50.4 (13.4 yrs), mean (SD) BMI of 33.0 (7.4 kg/m^2). 58% had a past or current smoking history, 21.7% reported tertiary education and 32.7% reported full-time employment. The median (interquartile range) AHI and arousal index were 26.2 (14.9–47.1/hr) and 32.1 (22.9–46.4/hr),

respectively. The mean (SD) ESS was 9.49 (5.13) and FSS 4.72 (1.43). Pathological fatigue (FSS score ≥4 out of 9) was found in 64.6% and excessive day time sleepiness (ESS score >10) in 43.7%. The independent predictors for sleepiness were CES-D score, tertiary education and total arousal index ($AdjR^2 = 0.125$, $p < 0.001$). BMI was significant on univariate analysis only. The independent predictors of fatigue were CES-D score and BMI ($AdjR^2 = 0.258$, $p < 0.001$). Female gender and non full-time employment were significant on univariate analysis only. The presence of depressive symptoms was the strongest predictor of both sleepiness ($R^2 = 0.11$, $p < 0.001$) and fatigue ($R^2 = 0.25$, $p < 0.001$).

Discussion: This large sleep clinic cohort confirms a high prevalence of fatigue, affecting close to two thirds of patients with OSA. PSG measures of OSA severity correlate poorly with fatigue, whilst depressive symptoms are strongly and independently associated with worse fatigue and sleepiness.

094

PREVALENCE OF CO-MORBIDITIES IN OBESITY HYPOVENTILATION SYNDROME COMPARED TO OBSTRUCTIVE SLEEP APNOEA SYNDROME

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Introduction: The prevalence rates of type 2 Diabetes Mellitus (T2DM), hypertension (HTN) and high cholesterol have not been described in obesity hypoventilation syndrome (OHS). Increased rates are seen in obstructive sleep apnoea (OSA) but it is unclear if OHS is associated with rates above those seen in OSA. The aim of this study is to determine the prevalence rates of these 3 co-morbidities in a sample of OHS patients, compared with a sample of OSA patients.

Methods: OHS patients seen in a tertiary referral hospital in Newcastle, NSW, between 2010–12 were compared with consecutively diagnosed OSA patients from January through June 2010. Data were collected from diagnostic polysomnography (PSG) and standardized sleep questionnaire. Demographic, PSG and co-morbidity data were analysed for differences between the OHS and OSA groups. Indirect adjustment of the prevalence rates was performed to account for differences the distributions of age and BMI between the groups.

Results: 255 OSA and 40 OHS patients were identified. OHS patients had higher BMI 48.9 (43.4–57.6) vs OSA 33.7 (29.6–38.2), $p < 0.0001$ and were more likely to be female 77.5% vs 31.8%, $p < 0.0001$. Apnoea-hypopnoea index was not significantly different between the groups, 22.8 (8.7–51.8) vs 26.1 (13.9–50.5) respectively. Significant differences were seen in % time spent with SpO2 < 90%, 92% (51.1–100) vs 1.8% (0.1–12.3) respectively. Age standardized and BMI standardized prevalence ratios were calculated to correct for differences in distributions across the different samples. Age standardized prevalence ratios for T2DM were 6.52 in the OHS sample and 2.87 in OSA. Similarly for HTN, age standardized prevalence ratios were 2.11 for OHS and 1.16 in OSA and high cholesterol ratios were 5.43 and 2.32 respectively.

Discussion: Significantly higher prevalence rates of T2DM, HTN and high cholesterol were seen in OHS compared to OSA. This result persisted when adjustments for the differences in BMI and age distributions were made. Whether this is secondary to the underlying pathophysiology that causes OHS or an effect of the OHS itself is unable to be determined from this study.

095

PREVALENCE OF SLEEP APNOEA HEADACHE IN PATIENTS HAVING SLEEP STUDIES

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Introduction: Patients with sleep apnoea commonly report recurrent morning headaches. Published rates of headache range from 11 to 60%, verses 3 to 11% in the general population The International Headache Society (IHS) have recently provided diagnostic criteria used to define 'sleep apnoea headache', which require fulfilling four criteria:

(A) a recurrent headache: occurring >15 days per month; OR bilateral or pressing in quality without nausea, photophobia or phonophobia; OR resolves within 30 minutes;
(B) RDI > 5 demonstrated by polysomnography;
(C) Headache upon awakening;
(D) Headache resolves after treatment of sleep apnoea.

Our aim was to test the prevalence in our institution of sleep apnoea headache in patients undertaking diagnostic sleep studies.

Methods: Patients were given a 2 page questionnaire, asking about the frequency and quality of headaches. These questions included the Headache Impact Test (HIT-6), the IHS criteria for sleep apnoea headache, as well as briefly asking about psychiatric comorbidities such as depression and anxiety.

Results: Between January and July 2012, 126 patients undertook a sleep study, consented to participate and completed the questionnaire. 57% were men. 68.3% of those surveyed had sleep apnoea (AHI > 5). The prevalence of sleep apnoea headache as defined by IHS criteria (excluding criteria (D) was 34%, compared with 27% in those with an RDI < 5 but fulfilling criteria (A) and (C) (CI of difference −0.35 to 0.19, $p = 0.7$). On the HIT6 questionnaire, indicating a severe impact on day-to-day life, there was no increase in scores in those patients with AHI > 5.

Conclusion: In our sample to date, we found no relationship between OSA and headache as defined by IHS criteria. The study is ongoing to increase the sample size.

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METABOLIC FUNCTION, DIABETES AND OBSTRUCTIVE SLEEP APNOEA

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In the last two decades, obstructive sleep apnoea (OSA) has been identified as a common clinical condition. Epidemiological studies have confirmed a high prevalence of the disease in middle-aged adults. OSA is associated with significant excessive daytime sleepiness and cognitive impairment, as well as marked cardiovascular and metabolic morbidities, leading to a significant increase in mortality. Sympathetic activation, oxidative stress and systemic inflammation have been shown as the main intermediary mechanisms associated with sleep apnoea and intermittent hypoxia. There are now convincing data regarding the association between hypertension, arrhythmias, stroke, coronary heart disease, increased cardiovascular mortality and OSA. There are also data in OSA and in animal models supporting the link between sleep apnoea and atherosclerosis and dysmetabolism. There have been several studies reporting an independent association of OSA with several components of the Metabolic Syndrome, particularly insulin resistance and abnormal

lipid metabolism. Recent reports have indicated that the majority of patients with type 2 diabetes also have OSA. Both epidemiologic and clinical studies suggest that OSA is independently associated with alterations in glucose metabolism and places patients at an increased risk of the development of type 2 diabetes. CPAP treatment assessment suggests that in obese individuals insulin sensitivity is likely to be determined primarily by obesity and, to a lesser extent, by sleep apnoea. When evaluating metabolic outcomes with therapeutic or sham CPAP in obese non-diabetic and diabetic patients, there was no change in glucose, lipids, insulin resistance or the proportion of patients with metabolic syndrome. However, this is still a conflicting issue at least in case of moderate obesity. For instance, there has been one positive RCT recently published. Whether part of these positive findings could be related either to selection of healthier individuals or to reduction in weight during the course of the trial, remains to be elucidated. In any case, large randomised controlled trials are needed in order to establish a rationale for treatment in various subsets of patients taking into account age, sex and co-morbidities.

098

DOES OSA PROMOTE THE DEVELOPMENT OF OBESITY?

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Obesity is a significant risk factor for obstructive sleep apnea (OSA). To date, most discussion of obesity and OSA assumes a one-way cause and effect relationship, with obesity contributing to the pathogenesis of OSA. However, OSA itself may contribute to the development of obesity.

OSA has a potential role in the development and reinforcement of obesity via changes to energy expenditure during sleep and wake periods, alteration of dietary habits and the neuro-humeral mechanisms that control satiety and hunger, and sleep duration arising from fragmented sleep. There are conflicting data as to the effect of CPAP on these factors. There is therefore emerging evidence that OSA itself feeds back into a complex mechanism that leads either to the development or reinforcement of the obese state.

The evidence for OSA as a risk factor for obesity is reviewed and suggests that the potential role OSA (and its treatment) plays in obesity and weight loss deserves further research.

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IS BEING BIG BAD FOR SLEEP AND BREATHING IN CHILDHOOD?

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Concerning increases in child body mass have been observed in most western societies over the last 1–2 decades. In response, the potential impact of being overweight on upper airway obstruction during sleep in childhood has been highlighted more recently. While there is a general consensus that being overweight poses a degree of risk for development of sleep-related respiratory conditions such as obstructive sleep apnoea (OSA), the precise pattern of this effect and the specific mechanisms at play are less clear.

A review of the literature on the association between body mass and upper airway obstruction suggests there are developmental changes in level of risk, as well as ethnic differences, which combined may be important indicators of factors placing overweight children at risk for OSA. One study by our group showed that amongst a predominantly Caucasian Australian population (n = 190) aged 4–12 years there was a mild association only between body mass and severity of upper airway obstruction. However, across a larger age range (2–18 years, n = 234) the risk of OSAS due to increasing body mass was substantially increased after age 12 years, but not for younger children.

More recent findings demonstrate a close association between upper airway obstruction, body mass, and cognitive outcomes in children – suggesting a possible mediation by body mass of the well documented cognitive deficits experienced by children with OSA. Consistent with this, analysis of our 4 year follow-up of children treated for upper airway obstruction implicates changes in body mass from pre- to post-treatment as an important determinant of long term cognitive outcome. Possible associations between body mass, upper airway obstruction and metabolic changes provide one avenue of future research to investigate this complex interaction, and the ultimate impact on daytime cognition.

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A RANDOMIZED CONTROLLED TRIAL OF A COMBINED TREATMENT OF COGNITIVE BEHAVIOUR THERAPY AND EVENING BRIGHT LIGHT THERAPY FOR INSOMNIA IN OLDER ADULTS

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Introduction: Insomnia is a prevalent health problem, particularly for older adults for which the current treatment of choice is cognitive-behaviour therapy. Recent research however suggests sleep maintenance and early morning awakening insomnia, typically observed in the older population, is associated with an early timed circadian phase, which can be effectively treated using evening bright light therapy. The present study evaluated the efficacy of a combined treatment of cognitive-behaviour therapy and evening bright light therapy in a group of older adults with sleep maintenance/early morning awakening insomnia.
Method: One-hundred and eighteen (N = 55 male, mean age = 63.76, SD = 6.45) adults with sleep maintenance and/or early morning awakening insomnia were selected from a community-based sample. Participants were randomly allocated to receive either a four-week, group-based treatment program of CBT-I and evening bright light (CBT + EBL), CBT-I alone (CBT only), or to a waitlist control condition. The efficacy of these treatment programs was assessed using 7-day sleep diaries and actigraphy, a comprehensive battery of questionnaires to evaluate subjective daytime functioning, and a challenging working memory task to measure objective cognitive performance. All participants completed these outcome measures at pre-treatment, post-treatment and 3-month follow-up. Participants allocated to the two treatment groups (CBT + EBL and CBT only) also completed these measures at 6-month follow-up.
Results: Both treatment groups produced robust and durable improvements in the timing and quality of their sleep and daytime functioning. However, despite a more durable improvement in some outcomes measures of sleep timing and quality, the addition of evening bright light to traditional CBT-I did not produce reliably superior improvements relative to stand alone CBT-I.
Discussion: Although there are several explanations for the lack of superior improvements following the addition of evening bright light

to CBT-I, the treatment program used in the current study has demonstrated impressive potential for a brief and inexpensive answer to the effective treatment of insomnia in the older population.

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SALIVARY CORTISOL ACTIVITY IN RESPONSE TO BRIEF SLEEP RESTRICTION THERAPY FOR INSOMNIA DISORDER: AN EXPLORATORY MECHANISTIC STUDY

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Introduction: Differences in salivary cortisol activity levels have been found in Insomnia compared to good sleeping controls (Vgontzas *et al.*, 2001). Yet, further studies have yielded mixed results (Riemann *et al.*, 2010). This study investigated salivary Cortisol levels via repeated sampling in response to brief Sleep Restriction Therapy (SRT).
Methods: Participants (n = 8, 5 female, mean age = 46.4) collected a total of 36 Cortisol saliva samples before and during brief SRT. Over 12 stipulated days at 3 time points per day (two hours before bed, bedtime, and awakening) for Baseline (before SRT; days 1–2 of sample collection), Early (first week of SRT; days 3, 4, & 8), Late (second week; days 9–11), and Follow-up (week four; days 22–25). SRT comprised one, 40-minute face-to-face session, two in-person sessions and two telephone calls (each 5–10 minutes) to titrate SRT. (Spielman, *et al.*, 1987). Participants' slept one night in the laboratory during Weeks 1, 2, and 4 home adherence to SRT was monitored via sleep diary (subjective) and actigraphy (objective). The Insomnia Severity Index (ISI) was completed before and after therapy.
Results: The ISI decreased significantly pre-to-post treatment ($p < 0.05$). Cortisol salivary activity levels significantly reduced pre-to-post SRT ($p = 0.005$). Simple main effects revealed differences between Follow-up and all other Cortisol assessment time points ($p = 0.007$–0.01). A significant main effect was also found for Time of Day ($p < 0.001$). The Phase X Time of Day interaction was not significant $p = 0.364$ indicating a gradual decline of salivary Cortisol activity at all assessment points pre-to-post treatment.
Conclusion: Salivary cortisol activity levels were found to decrease significantly at the Follow-up phase compared to before and during treatment; suggesting a possible mechanism of action through a reduction of hypothalamic-pituitary-adrenal axis activity in response to brief SRT for Insomnia Disorder.

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SLEEP AND SLEEPINESS IN LATE PREGNANCY: COMPARISONS WITH WOMEN IN THE GENERAL POPULATION

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Introduction: Although changes to sleep during pregnancy are well recognised and widely reported, there is still limited information available on what constitutes 'normal' sleep at this time and how sleep compares with that of the general population.
Method: As part of the *E Moe, Māmā: Maternal Sleep and Health in Aotearoa/New Zealand* study, 1091 women (16–46 yrs) completed comprehensive questionnaires on sleep, health and mood between 35–37 weeks gestation. Self reported usual sleep duration in 24-hrs and daytime sleepiness (Epworth Sleepiness Scale) of women in late pregnancy was compared with identical measures from a large, representative sample of 1,063 New Zealand women of the same age[1,2].
Results: Average sleep duration in 24-hrs is similar in pregnant women compared to the general population. However, at least twice as many pregnant women obtain ≤6 hrs sleep in a 24-hr period compared to the general population, and the proportion of pregnant women obtaining ≥9 hrs is also greater. Nearly 20% of pregnant women report ESS scores >10, although sleep duration was not related to daytime sleepiness in this population ($\chi^2_{(2)} = 4.33$, $p = 0.16$).

	General Population Sample	Pregnant Population Sample
Sleep in 24-hrs (mean, SD)	7.7 (1.3)	7.4 (1.8)
≤6 hrs (%, 95% CI)	13.4 (11.4–15.6)	29.1 (26.5–31.9)
6.1–8.9 hrs (%, 95% CI)	71.3 (68.5–74.0)	50.6 (47.6–53.6)
≥9 hrs (%, 95% CI)	15.3 (13.2–17.7)	20.3 (18.0–22.8)
ESS > 10 (%, 95% CI)	14.5 (12.5–16.8)	19.3 (17.0–21.8)

Conclusion: These findings suggest that more extreme sleep durations (both short and long) are common in late pregnancy. Although sleep duration was unrelated to daytime sleepiness in pregnant women, further investigation of the consequences of short and long sleep for health and mood during pregnancy is necessary.
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INSOMNIA PATIENTS' HELP-SEEKING EXPERIENCES

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Background: There is a strong propensity among patients with insomnia to engage in various forms of self-help to induce sleep while deferring professional medical help. Poor insight into insomnia patients' help-seeking behaviours has been suggested as a reason for poor patient engagement with the available health care resources for insomnia. However little is known about the nature of how, when or why insomnia patients use these health care resources during the course of their sleep complaint. This study sought to map out the treatment pathways and experiences that patients undergo when seeking medical help for insomnia.
Method: An interview guide was used to conduct a series of semi-structured interviews with 23 insomnia patients that were recruited from a sleep psychology clinic. Interviews were digitally recorded, transcribed verbatim and analysed using 'Framework Analysis' to identify emergent themes.
Results: Initial patient responses to insomnia were varied depending on what they believed were the causative factors. Self-help in the form of sleep hygiene, complementary medicine and meditation strategies were commonly initiated. General practitioners (GP) were often the first source of medical help patients received after self-help strategies fail. However patients were dissatisfied with the paucity of treatment options provided. This prompted them to search for other strategies which resulted in many patient-initiated referrals for specialist insomnia psychotherapy. Issues patients face when accessing these specialist services include that they are not widely known, expensive and geographically challenging.
Discussion: This is one of the first qualitative studies mapping out the insomnia treatment pathway through exploring patient help-seeking experiences. Refining GP referral mechanisms to specialist insomnia care, increasing the government subsidy for psychological insomnia services and increasing community awareness about treatment options for insomnia are important public health agendas for optimising the management of insomnia.

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DOES SLEEP EDUCATION LEAD TO CHANGES IN SLEEP DURATION?

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Introduction: A key aim of school based sleep education programs is to promote sleep duration changes. In order to do this, programs must disseminate knowledge, improve attitudes towards sleep and impart a need for change. However, only two studies have found an improvement in sleep duration post sleep education. The current study aimed to analyse preliminary sleep data to assess whether an ongoing sleep education program has been successful in bringing about sleep duration changes.
Method: In a randomised controlled trial, one Year 6/7 class from six schools participated. Four schools were intervention (N = 59), two were control (N = 27). The study employed a 2 (group: intervention and control) × 3 (time: baseline (T1), immediately post-intervention (T2, 6 weeks post-baseline) and follow up (T3, 18 weeks post-baseline) mixed model design. Intervention schools received four classroom lessons about sleep and completed a sleep focussed research project. Sleep quantity was measured with seven days actigraphy at each time point. Primary outcome measures obtained were total sleep time (TST) and time in bed (TIB).
Results: Linear mixed model analyses revealed a significant interaction between group and time for TIB ($F(2) = 5.567$, $p = 0.005$), and a trend for TST ($p = 0.06$). Between the start and end of the intervention, TIB increased by 14 min in the Intervention group ($p = 0.02$) compared to a 9 min decline in the Control group. However, at follow-up, the Control group had returned to just 2 min below baseline, while the Intervention group had fallen to 12 min below baseline. At T3 there was a significant group × time effect ($p = 0.005$). TST showed similar trends, although they did not reach statistical significance.
Discussion: This trial is still underway, however preliminary results are promising, suggesting that sleep duration does indeed improve from baseline to immediately post intervention, although, such improvement may not be sustained. This suggests that sleep education is effective in promoting increases in sleep duration. Future studies need to assess how to attain long-term sleep behaviour change. One possibility is to embed sleep education into school curriculum so that it becomes an on-going learning process, rather than a short-term program.

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TECHNOLOGY USE OF AUSTRALIAN HIGH SCHOOL STUDENTS AND ITS ASSOCIATION WITH SLEEP DURATION AND SLEEP AND WAKE TIMES: THE AUSTRALIAN BROADCASTING CORPORATION'S NATIONAL SCIENCE WEEK BIG SLEEP SURVEY

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Introduction: Sleep hygiene advice given to both the general population and also to specific clinical groups generally recommends the removal of electronic devices from sleeping environments. We aimed to ascertain whether there is a dose-response relationship between use of Electronic Devices (EDs; computers, mobile telephones, televisions and radios) prior to sleep and problematic sleep patterns in Australian High School Students.
Methods: Nationwide online questionnaire examining sleep patterns, sleepiness, sleep disorders, the presence of EDs in bedrooms and frequency of use at night.
Results: 1184 Australian high school students aged 11–17 yrs (67.6% female) with Australian IP addresses responded. Sleep duration averaged 8.1 ± SD 1.3 hr/night during the week and 9.48 ± 1.74 hr/night on weekends. Sleep onset was later on weekends (00: 39 ± 1.66 hr) than on weekdays (23:50 ± 1.26 hr). On average they woke at 07:55 am (±0.81 hr) on weekdays and 10:03 am (±1.75 hr) on weekends. Computer use was associated with short sleep duration on weekdays, later sleep onset and wake on weeknights and weekends, and a greater amount of social jetlag (SJ is having a later wake times on weekends

than weekdays). Mobile phone use was also associated with later wake on weekdays and weekends, and greater social jetlag, but only later sleep onset and short sleep on weekends. TVs and radios did not show a dose-response relationship with sleep patterns. ED use was not associated with greater magnitudes of Catch-up sleep (longer weekend than weekday sleep duration) than was being observed on average.
Conclusion: EDs are commonly present in the bedrooms of Australian high-school students. We observed dose-dependent associations between ED use and later sleep onset and wake times, short sleep duration on weekdays and weekends, and social jetlag, but not catch up sleep. Computers and mobiles were the most evident associates. Bedroom technology use by young Australians is filling and/or moving typical sleep behaviours in a way that might cause social jetlag, which may have deleterious effects on health and educational outcomes. However, the mere presence of these devices in the bedroom is not associated with sleep changes – the devices must be used frequently in order to be associated with deleterious sleep schedules.

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WHAT HAPPENS TO MOOD, PERFORMANCE, SLEEP AND SLEEPINESS IN A LABORATORY STUDY WITH NO SLEEP DEPRIVATION?

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There are relatively few studies examining changes in waking function in a laboratory environment with no sleep deprivation and mood has been largely overlooked in this context. Understanding changes that occur in the laboratory with no sleep deprivation will allow a clearer understanding of the impact of both the laboratory environment and sleep loss on mood and other aspects of waking function. Thus, the present study examined changes in mood, performance, sleep and sleepiness during extended time in the laboratory with no sleep deprivation. Nineteen healthy, young adults (10M, 9F; 22 y ± 4.2 y) were given nine consecutive 9 h sleep opportunities (2300–0800). Every two hours during wake, participants completed the Mood Scale II, a 10-minute Psychomotor Vigilance Task and measures of sleepiness and fatigue. Sleep was monitored using a five-channel electroencephalographic montage. Findings revealed significant negative mood change, performance impairment, reduced total sleep time and sleep efficiency (all $p < 0.05$). These findings suggest that the laboratory environment or procedural factors may impair mood, performance and sleep in research participants. In turn, these findings have implications for the way we interpret impairments in mood, performance and sleep observed in laboratory environments.

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DOES MOOD PLAY A ROLE IN FOOD CHOICE WHEN IS SLEEP RESTRICTED?

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Introduction: Previous research suggests severe sleep restriction (SR) increases snacking behaviour and in particular a preference for sweet snacks. However, motivation for this behaviour is not yet understood. SR is associated with an increase in negative mood states such as depression and negative mood states have been shown to be a primary motivator of poor food choice. The aim of this study is to determine whether mood plays a role in food choice during a week of severe sleep restriction.
Methods: Twelve healthy males (mean ± SD, age: 24.6 ± 3.1 years; BMI: 22.9 ± 1.7 kg/m^2) participated in one of two conditions. Each condition included three adaptation days and a baseline day [8 h Time in Bed (TIB)]. Participants then either completed a SR condition consisting of seven experimental nights of 4 h TIB or a control condition consisting of seven experimental nights of 8 h TIB. Mood and food choice were assessed five times each experimental day. Mood was measured using Profile of Mood States. Food choice was assessed using a computerised forced choice task consisting of 54 pairs of food images. Participants were asked to choose which food they would 'rather eat right now' from four categories (high-fat sweet, low-fat sweet, high-fat savoury, low-fat savoury).
Results: Contrary to expectation, depressive mood did not appear to follow the same trend as choice of high-fat sweet foods over the study period. In the SR condition, depressive mood peaked on experimental day 3 (72% increase compared to baseline) and then steadily decreased. However, choice for high-fat sweet food did not increase until experimental day 7 (91% increase compared to baseline). In the control condition, depressive mood decreased by 79% (compared to baseline) on experimental day 3 and choice for high-fat sweet food peaked on experimental day 7 (23% increase compared to baseline).
Discussion: These analyses suggest that depressive mood may not play a role in food choice under conditions of severe sleep restriction. In further analyses, we will examine the influence of other mood states on food choice (e.g. fatigue, vigour) as well as the influence of eating style (e.g. restrained and emotional eating styles).

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ELECTROENCEPHALOGRAM MARKERS OF SLEEP PROPENSITY IN OBSTRUCTIVE SLEEP APNEA PATIENTS CORRELATE WITH DRIVING PERFORMANCE DURING EXTENDED WAKEFULNESS

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Introduction: Obstructive sleep apnea (OSA) patients often experience inappropriate sleepiness and neurobehavioural impairment, and have an increased risk of motor vehicle crashes. It is important to identify at-risk patients but no robust biomarkers currently exist. We investigated the relationship between electroencephalogram (EEG) markers of sleep propensity and driving impairment in OSA patients during baseline and recovery sleep, and 40 h of wakefulness. We hypothesised that a greater sleep propensity at recovery would be associated with worse driving performance in the early morning hours, a period when vulnerability to sleep loss is greatest.
Methods: Participants completed a 3-day/night protocol with a baseline night of polysomnography – 8 h time in bed (TIB), followed by 40 h of extended wakefulness, and a recovery night (8 h TIB). A driving simulator task (AusEd) was performed every 2 h during wake. Sleep

EEG (Cz/A1) during baseline and recovery nights was analysed using power spectral analysis following artefact exclusion. We calculated the change in slow wave activity (SWA, 0.5–4 Hz) during the recovery night relative to baseline; and in driving performance (steering deviation) during the circadian night/early hours (2 am–8 am, after 20–26 h time awake) relative to baseline (10 am, after 4 h time awake). We then assessed the relationship between SWA and performance using Pearson's correlation coefficient.

Results: Data from 6 OSA patients were included in this preliminary analysis (age 46 ± 8 yrs, BMI 31 ± 5 kg/m^2, apnea hypopnea index 44 ± 19/h, ESS 12 ± 5). An increase in SWA (average absolute delta power) during slow wave sleep at recovery relative to baseline positively correlated with the decline in driving performance after 26 h awake (AusEd steering deviation), $r = 0.918$ $p = 0.01$.

Discussion: These preliminary but novel findings suggest that EEG markers of sleep propensity following extended wakefulness are associated with driving performance decline during extended wakefulness in OSA patients. EEG biomarkers may help identify those at increased risk of vigilance failure.

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DELAYED CIRCADIAN RHYTHMS IN YOUNG PERSONS WITH UNIPOLAR OR BIPOLAR AFFECTIVE DISORDERS

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Circadian disturbances may play a key role in the pathogenesis of some forms of mood disorders. Despite marked changes in circadian rhythms during the normal course of adolescence and young adulthood, less is known about changes in the sleep-wake cycle and endogenous circadian rhythms in young persons with mood disorders.

Seventy-five young participants with mood disorders (unipolar: n = 46, 20.1 ± 0.7 y.o.; bipolar I or II: n = 29, 23.2 ± 4.3) and 20 healthy participants (24.8 ± 2.5 y.o.) underwent actigraphy during a depressive phase over seven consecutive days and nights. Sleep phase delay was defined as mean sleep onset ≥1:30 am and/or sleep offset ≥10:00 am. In a subgroup of 17 participants with unipolar depression and 10 participants with bipolar depression, dim light melatonin onset (DLMO) was measured using salivary samples collected every 30 minutes starting 6 hours before habitual sleep onset.

A delayed sleep phase was found in 62% of participants with bipolar disorders when depressed, compared with 30% of those with unipolar depression ($\chi^2 = 6.0$, $p = 0.01$) and 10% of control participants ($\chi^2 = 11.2$, $p < 0.01$). Sleep offset times were significantly later in subjects with mood disorders compared to the control group, and later in those with bipolar as compared with unipolar disorders (all $p \leq 0.04$). Compared to previously published values, DLMO occurred on average 1h01 later in the unipolar group and 2h30 later in the bipolar group. DLMO was significantly later in patients with bipolar disorders compared to those with unipolar depression ($t = -2.04$, $p = 0.05$).

Young patients with mood disorders, especially those with bipolar disorders, are particularly likely to have delayed endogenous circadian rhythms and sleep-wake cycle. While poor sleep may be seen as a hallmark of major depression, circadian phase delay may be more strongly associated with bipolar disorders. Therapies focused on advancing the biological clock may be of specific benefit to young patients with affective disorders, and particularly for those with bipolar disorders.

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CIRCADIAN RHYTHMS OF CORE BODY TEMPERATURE AND MELATONIN IN PERSONS WITH DELAYED SLEEP PHASE DISORDER

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Introduction: Previous investigations of DSPD have typically found a delay in circadian rhythm phase markers and assumed that to be its aetiology. Since treatment of Delayed Sleep Phase Disorder (DSPD) to normalise circadian phase has been problematic, the aim of this study was to investigate other underlying causes. While it was suggested that DSPD might be the result of an unusually long period length (tau), until recently this notion has not been empirically researched. In 2007, Campbell and Murphy pioneered a free running study to measure circadian tau. With a limited sample, they measured a longer circadian core temperature tau in one person with DSPD (25.4 h) compared to three healthy sleepers (24.4 h). These findings were further supported in our 2011 ultradian study of circadian taus of 6 participants with DSPD (25.1 h) and 7 good sleepers (24.3 h). The results gave further evidence of significantly longer endogenous temperature rhythm taus in individuals with DSPD.

Method: The ultradian method with alternating 20-minute sleep opportunities and 40-minutes of enforced wakefulness across an 80-hour weekend protocol was utilised in a sample of 12 good sleepers and 12 DSPD. As well as core body temperature, dim light melatonin onset (DLMO) measures were studied to further investigate the underlying circadian system of DSPD.

Results and Discussion: It is expected that melatonin and temperature rhythms will show consistently longer taus in people with DSPD compared to good sleepers. The results of these measures will be discussed and the findings will be applied to devising optimum intervention options for treatment of DSPD.

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SLEEP, CIRCADIAN RHYTHMICITY AND PSYCHOLOGICAL HEALTH DURING THE ANTARCTIC WINTER

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Ocular light exposure is the primary environmental time cue for synchronising the circadian pacemaker, including sleep-wake cycles, alertness and performance patterns and many other hormonal and metabolic rhythms. Inappropriate or absent exposure to a 24-h light-dark cycle causes misalignment of the circadian pacemaker, resulting in sleep disturbance, impaired performance and disrupted metabolic and endocrine systems. The Antarctic winter is an unusual light environment where individuals receive minimal natural sunlight for long durations

that may present considerable challenges to the circadian system without structured imposed light-dark cycles.

The aim of this study is to assess sleep, circadian phase, cognitive functioning and psychological health in expeditioners over-wintering in Antarctica. Thirty-one expeditioners (5F, aged 44.58 ± 11.45 years) stationed at three Australian Antarctic bases (Davis, Mawson and Casey) completed data collection during a six-month winter season (March to September 2011). Participants completed daily sleep diaries and a subset wore wrist activity monitors continuously for up to six months. Once each month participants completed numerous computer-based performance tests and questionnaires examining psychological health and wellbeing. Expeditioners also completed monthly 48-hour urine collection for assessment of the urinary melatonin metabolite 6-sulphatoxymelatonin, considered a reliable marker of circadian phase.

The study will provide data necessary to assess the degree of sleep loss and circadian desynchrony experienced during an Antarctic winter and to quantify the contribution of sleep loss and circadian deficiency on cognitive and psychological impairment. These data will inform the development of an integrated, comprehensive sleep and circadian intervention program to monitor and improve health, safety and psychology during long-duration expeditions.

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A COMPARISON OF DIAGNOSTIC OUTCOMES (DO) BETWEEN AMBULATORY TYPE 2 POLYSOMNOGRAPHY (PSG) SLEEP STUDIES AND GOLD STANDARD ATTENDED LABORATORY TYPE 1 PSG SLEEP STUDIES IN THE INVESTIGATION OF OBSTRUCTIVE SLEEP APNOEA (OSA) IN PAEDIATRICS.

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Introduction: Unattended type 2 PSG is a potential alternative to gold standard type 1 PSG.
Hypothesis: That unattended ambulatory type 2 PSG will provide similar DO to gold standard type 1 PSG.
Aim: to compare type 2 PSG to the type 1 gold standard PSG both as simultaneous studies and separate studies.
Method: Equipment: Gold standard type 1 PSG ('E' Series and PSG 3); ambulatory type 2 PSG (Somté PSG) both devices manufactured by Compumedics Melbourne Australia.
Group 1: 81 children simultaneously had ambulatory type 2 PSG and attended type 1 PSG. Ambulatory sleep study parents were trained to check the leads overnight. This checking was extended to the overnight sleep scientists who checked leads periodically and replaced obviously detached leads in the ambulatory study during the laboratory visit.
Group 2: 48 children separately had ambulatory type 2 PSG and attended type 1 PSG. A hospital in the home nurse or sleep scientist visited the home to set the child up for a type 2 PSG. Within 2 weeks the study participant was also set up for a laboratory type 1 PSG.
Population: Age 4–17 years; no co-morbidities; referred for OSA investigation. Consecutive suitable subjects identified by sleep specialist at clinic or from referral.
Analysis: performed in a blinded fashion at different times and orders, by the same scientist.
Diagnosis: In a blinded fashion the duty sleep physician diagnosed the study for OSA based on clinical information, raw study data and scientist analysis from either the type 1 PSG or type 2 PSG. Studies were diagnosed as normal; mild; moderate; or severe the results were then compared between the study pairs.
Results: In group 1: 96.2% and in group 2: 98% study success rate. Comparing ambulatory to gold standard for DO: Group 1) 89% of type 2 PSG matched the gold standard; Group 2) 94%. of type 2 PSG matched the gold standard.

False negatives were diagnosed in 2.5% of type 2 PSG compared to the gold standard; False positives were diagnosed in 7% of type 2 PSG compared to the gold standard.
Discussion: The results support the use of Type 2 PSG when investigating OSA in specified paediatric populations when performed utilising appropriate staff, patient, study protocol and equipment guidelines. Type 2 PSG can enable diversification of diagnostic pathways to provide a more holistic and timely service.

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SURGICAL VERSUS CONVENTIONAL THERAPY FOR WEIGHT LOSS TREATMENT OF OBSTRUCTIVE SLEEP APNEA: A RANDOMIZED CONTROLLED TRIAL

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Introduction: Obstructive sleep apnea (OSA) is strongly related to obesity and weight loss is advised. The aim of this trial was to determine whether surgically induced weight loss is more effective than conventional weight loss therapy for the management of OSA.
Method: A 2-year randomized trial was conducted between September 2006 and March 2011. Sixty participants (BMI > 35 and < 55 kg/m^2) with recently diagnosed (<6 months) OSA with an apnea/hypopnea index (AHI) of ≥20/hour and recommended CPAP were randomized to a conventional weight loss program or bariatric surgery (laparoscopic adjustable gastric band). The primary outcome was baseline to 2-year change in AHI on diagnostic polysomnography. Secondary outcomes were changes in weight, CPAP adherence, sleepiness, exercise capacity, quality of life and functional status. Analysis was intention to treat.
Results: Conventional and surgical groups lost (mean ± SEM) 4.2 ± 2.0 and 27.8 ± 3.5 kg respectively ($P < 0.001$). The AHI in the conventional group fell by 12.8 ± 5.0/hr (13.5 ± 9.5%), $p = 0.02$, and by 21.9 ± 5.4/hr (31.4% ± 9.2%), $p < 0.001$ in the surgical group (between group difference, $p = 0.22$). The relationship between change in weight and AHI was significant, but non-linear, with modest weight loss providing much of the benefit. CPAP adherence was no different between

groups. The surgical group had greater improvements in daytime sleepiness, exercise capacity, and quality of life.
Conclusion: The response of OSA to weight loss is variable, non-linear and incomplete. While weight loss is advisable for obese patients with OSA, remission of OSA with weight loss is unusual and the majority will require ongoing treatment with CPAP.

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HYPOGLOSSAL NERVE STIMULATION FOR THE TREATMENT OF OBSTRUCTIVE SLEEP APNOEA: POLYSOMNOGRAPHIC AND SYMPTOMATIC RESPONSES AFTER 12 MONTHS OF TREATMENT

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Introduction: Reduced upper airway muscle activity during sleep contributes to obstructive sleep apnoea (OSA) pathogenesis. Hypoglossal nerve (HGN) stimulation has previously shown promise in reducing OSA severity and symptoms. This study evaluated a novel HGN stimulation (HGNS®; Apnex Medical, Inc.) system for the treatment of OSA.
Objective: To evaluate the safety and effectiveness of HGN stimulation therapy for one year in participants intolerant of continuous positive airways pressure (CPAP).
Methods: Thirty-two subjects (66% male, mean age 52.8 ± 9.6 years) with moderate to severe OSA (AHI 20–80) underwent surgical implantation of the HGNS system, which stimulates the hypoglossal nerve at the onset of inspiration during sleep. Measured outcomes were AHI (in lab polysomnogram), subjective sleepiness (ESS), sleep-related quality of life (FOSQ, SAQLI), sleep quality (PSQI) and mood (BDI).
Results: With HGNS therapy, there was a significant improvement in sleep disordered breathing (AHI, arousal index and oxygen desaturation, ODI4%), subjective sleepiness, quality of life, subjective sleep quality and mood which were maintained at 12 months.

Measure	Baseline	6 months	12 months
AHI	44.7 ± 17.7	21.3 ± 18.0*	20.8 ± 16.3*
ODI4%	20.4 ± 17.2	11.1 ± 17.6*	12.0 ± 14.3
Arousal Index	43.8 ± 17.7	24.7 ± 13.5*	25.4 ± 11.1*
ESS	12.0 ± 4.6	8.5 ± 3.8*	7.5 ± 3.6*
FOSQ – Total	14.3 ± 2.0	16.6 ± 2.4*	17.2 ± 2.0*
SAQLI	3.2 ± 1.1	4.8 ± 1.4*	5.0 ± 1.1*
PSQI	10.5 ± 3.0	8.5 ± 4.1*	8.0 ± 4.4*
BDI	15.3 ± 9.1	9.0 ± 7.8*	8.9 ± 8.0*

All data are mean ± SD. *$p < 0.05$ compared to baseline.

Conclusions: With HGNS therapy, there was a significant improvement in sleep-disordered breathing and symptoms. These data suggest that HGNS therapy may be a viable alternative for treating OSA in patients who do not tolerate CPAP.

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IMPROVED HYPERCAPNIA INTERCORRELATED WITH REDUCED DELTA ACTIVITY DURING SLEEP AND IMPROVED DAYTIME SLEEPINESS IN RESPIRATORY FAILURE PATIENTS

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Introduction: Previously we have demonstrated that increased hypercapnia is positively associated with increased slow wave sleep in respiratory failure patients. We hypothesize that by improving hypercapnia in respiratory failure patients, we will reduce delta sleep, and improve daytime sleepiness.
Methods: We performed overnight PSGs on 55 hypercapnic respiratory failure patients before and after (~3 months) CPAP/BiPAP treatment. We assessed awake ABG as well as Epworth Sleepiness Scale (ESS) in the afternoon of each sleep study. Quantitative EEG spectral analyses were performed.
Results: Of the 55 patients tested, we obtained satisfactory data for analysis from 41 patients (30M, 11F). 30 of the 41 patients had obesity hypoventilation syndrome and other 11 had overlap syndrome. After the CPAP/BiPAP treatment, awake pCO_2 dropped from 54.7 ± 8.6 at baseline, to 44.7 ± 4.8 (mean ± SD) mmHg, and ESS dropped from 14 ± 5 to 5 ± 4. The ESS improvement positively correlated with the reduction of pCO_2 ($r = 0.42$, $p = 0.007$). In addition, as shown in the Table below, both the reduction of pCO_2 and ESS positively correlated with the decrease of delta power during both sleep and awake time of PSG. (change = Baseline – Intervention).

	pCO_2 change		ESS change	
Brain wave change	Pearson's r	p	Spearman rho	p
%Delta change in all PSG	0.367	0.018	0.327	0.037
%Alpha change in all PSG	–0.356	0.023	–0.332	0.034
D/A ratio change in all PSG	0.516	0.001	0.310	0.049
%Delta change in awake PSG	0.467	0.002	0.363	0.020
%Alpha change in awake PSG	–0.514	0.001	–0.388	0.012
D/A ratio change in awake PSG	0.432	0.005	0.403	0.009

Discussion: Against current understanding of delta sleep, our interventional study has for the first time shown that reduced hypercapnia intercorrelated with both reduced EEG delta activity during sleep and improved daytime sleepiness in respiratory failure patients.

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COST-EFFECTIVENESS ANALYSIS OF A SIMPLIFIED MODEL OF CARE FOR OBSTRUCTIVE SLEEP APNEA IN GENERAL PRACTICE

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Introduction: In order to improve patient access to sleep service provision, there has been increasing focus on development of more cost-effective, community-based models of care for the diagnosis and management of obstructive sleep apnea (OSA). In this randomised controlled study, we evaluated the cost-effectiveness of a simplified model of care for OSA in primary care versus the usual standard care in a specialist sleep centre.

Methods: Patients with symptomatic, moderate-to-severe OSA were identified by general practitioners (GPs) using a 4-item screening tool, the Epworth sleepiness scale (ESS) and home oximetry (ApneaLink, ResMed). Eligible patients were randomised into either: (1) general practice-based care, with management led by their GP and a community-based nurse, or (2) usual care in a specialist sleep centre, involving sleep physician management and laboratory-based testing. Within-study resource use and associated costs were collected during the 6 month follow-up period, including nursing time, travel costs, inpatient hospital admissions, GP and specialist visits, diagnostic services and pharmaceutical costs. Bootstrapping of patient data associated with their costs and outcomes (i.e. change in ESS) was conducted to assess within-study incremental cost effectiveness and non-inferiority of primary care versus specialist management.

Results: 155 patients were randomised into the study. The average cost of primary care management was AUD$2610, compared to AUD$4767 in the specialist arm. There was a statistically significant cost saving of AUD$2157 (95% CI: $1293 to $3114) per patient in the primary care arm within study with 100% chance of cost saving and a non-significant, minor reduction in the mean change in ESS score of 0.4 per patient (95% CI: −1.1 to 1.7) with 97.2% chance of treatment being non-inferior at the pre-specified non-inferiority margin of 2.0.

Discussion: Management of OSA in primary care using a simplified, ambulatory approach which utilises the skills of appropriately trained GPs and community-based nurses is associated with significant within-study costs savings and produces clinical outcomes which are not inferior to usual management in a specialist sleep centre.

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HIGH PREVALENCE OF UNDIAGNOSED OSA IN A COMMUNITY SAMPLE OF MEN AGED 40 YEARS AND OVER

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Introduction: The current prevalence of OSA in the community is unknown. With the large increase in obesity over the past 20 years it is likely OSA has also increased but there are no recent population data reporting current prevalence in Australia.

Methods: We determined the prevalence and severity of sleep disordered breathing and related co-morbidities in a comprehensively characterized representative population-based cohort of men aged over 40 yrs (MAILES) (n = 1869). In 2011–12, full in-home unattended polysomnography (Embletta X100) were done in 851 randomly selected men from the cohort who did not have a previous diagnosis of OSA and were scored by a single experienced scorer according to current AASM (alternate) criteria.

Results: Among all MAILES participants, n = 184 (11.3%) self-reported a previous diagnosis of OSA on a sleep study [mean age: 62.0 (sd 10.1), prevalence of diabetes: 24%, metabolic syndrome: 63%, hypertension: 61%, and abdominal obesity: 66%]. Sleep study participants (no prior diagnosis of OSA) did not differ from the rest of the cohort in anthropometry, co-morbidities or socio-economic status. Mean age was 59.6 (sd 10.8) years. Among the sleep study participants, n = 451 (53%) had an AHI ≥ 10; AHI 20–29, and AHI ≥ 30 were demonstrated in 14.0% (n = 119) and 12.3% (n = 105) respectively. OSA prevalence increased significantly with age (<50 yrs 41.2%, >70 yrs 63.2%), and was significantly more likely in those with financial stress, lower incomes, and perceived dissatisfaction at work. Among those with OSA (AHI ≥ 10), n = 198 (51%) had a score on the Pittsburgh Sleep Questionnaire >5, and n = 83 (9.8%) had an Epworth scale score ≥10. Those with previously undiagnosed OSA were significantly more likely to have diabetes (age adjusted OR 1.8, 95% CI 1.1, 2.7), metabolic syndrome (OR 1.9, 95% CI 1.4, 2.6), depression (OR 2.2, 95% CI 1.4, 3.3), hypertension (OR 1.9, 95% CI 1.4, 2.5), waist-to-hip ratio >1 (OR 1.5, 95% CI 1.1, 2.0).

Discussion: OSA is highly prevalent in men aged over 40 years, with most being undiagnosed. Men with undiagnosed OSA have concurrent metabolic conditions similar to those expected in OSA. The burden of undiagnosed OSA is substantial and demands innovative methods to extend screening and diagnosis in the community.

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NON-INVASIVE VENTILATION IN CHILDREN WITH SEVERE KYPHO/SCOLIOSIS

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Study Design: Retrospective chart review.
Objectives: Assess outcomes of early non-invasive ventilation (NIV) in children with severe restrictive lung disease (FVC < 40% predicted), who underwent corrective spinal surgery for severe scoliosis on post-operative pulmonary complications and duration of post-operative PICU stay.
Background: Severe thoracic kypho/scoliosis may lead to severe restrictive lung disease and respiratory failure. Few studies evaluated the use of NIV to reduce or prevent early post-operative pulmonary complications, or length of post-operative PICU or hospitalization.
Methods: Retrospective chart review on 133 patients with kypho/scoliosis who underwent spinal surgery from January 2009 to January 2012.
Results: Mean age at operation 11.4 (range 2–19) years, (90 Female). Scoliosis types: Idiopathic 48 (36.09%), secondary to neuromuscular disease 39 (29.3%), Congenital 12 (9%), syndrome 19 (14.28%) and kyphoscoliosis 15 (11.28%). All underwent scoliosis repair. Surgery included posterior spinal fusion 117 (88%), anterior spinal fusion 5 (3.76%), anterior and posterior fusion 7 (5.26%), and insertion of growing rods 4 (3%) and there were no deaths. Analysis included Pre-operative Pulmonary Function Tests (PFT) with severity of restrictive lung disease categorised according to % predicted as mild (FVC > 60% predicted) n = 63 (47.37%), moderate (FVC > 40%, <60%) n = 26 (19.55%) and severe (FVC < 40%) n = 10 (7.52%). The 34 (25.56%) unable to perform PFTs had overnight SaO2/CO2 screening test or PSG plus venous blood gas. Post–operative pulmonary complications occurred in 22 (16.54%) and included pneumonia n = 3 (2.25%), pleural effusion n = 6 (4.5%), pneumonia + pleural effusion n = 3 (2.25%), pneumothorax n = 2 (1.5%) and hypoventilation n = 8 (6%). Pre-operative use of NIV eliminated post-operative pulmonary complications and requirement for post-operative intubation. Average PICU stay was 1.2 days with pre-operative NIV compared to 2.75 days for those without.
Conclusion: Use of pre-operative NIV reduced or eliminated post-operative pulmonary complications, need for mechanical ventilation and duration of PICU stay in patients with severe restrictive lung disease undergoing spinal surgery.

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A CROSS-CULTURAL COMPARISON OF SLEEP DURATION BETWEEN U.S. AND AUSTRALIAN ADOLESCENTS: THE EFFECT OF SCHOOL START TIME, PARENT-SET BEDTIMES, AND EXTRA-CURRICULAR LOAD

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Study Objective: To determine whether sleep duration on school nights differs between adolescents in Australia and the U.S. and, if so, whether this difference is explained by cultural differences in school start time, parental involvement in setting bedtimes and extra-curricular commitments.
Methods: Participants were 385 adolescents aged 13–18 years (M = 15.57, SD = 0.95; 60% male) from Australia and 302 adolescents aged 13–19 years (M = 16.03, SD = 1.19; 35% male) from the United States. Adolescents completed the School Sleep Habits Survey during class time, followed by a Sleep Diary, wrist actigraphy and logged phone calls to the sleep laboratory at bedtime and wake time for 7 consecutive days.
Results: U.S. teens woke significantly earlier on school mornings than Australian teens and obtained significantly less sleep. After controlling for age and sex, Australian adolescents averaged 47 minutes more sleep per school night than those in the U.S. Australian adolescents were more likely to have a parent-set bedtime (17.5% vs 6.8%), have a later school start time (8:32 am vs 7:45 am) and spend less time per day on extra-curricular commitments (1 h 37 m vs 2 h 41 m) than their U.S. peers. In regard to specific extra-curricular activities, Australian teens spent significantly less time per day on homework (50 m vs 1 h 18 m), part-time paid work (18 m vs 40 m) and other extra-curricular activities such as volunteering, band, or youth groups (6 m vs 18 m) than U.S. adolescents, but spent an equivalent time on sport participation (27 m vs 26 m). The mediating factors of parent-set bedtimes, later school start times, and less time spent on extra-curricular activities were significantly associated with more total sleep.
Conclusions: The present study highlights the importance of a cross-cultural, ecological approach to examine factors that may occur relatively uniformly within cultures. In particular, the impact of early school start times, lack of parental limit setting around bedtimes and extra-curricular load in limiting adolescent sleep. The results indicate that, in addition to biological factors, extrinsic cultural factors are important determinants of adolescent sleep. Indeed, these modifiable, extrinsic factors may moderate the effect of biological changes to teen sleep.

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THE EFFECT OF DEPRESSION ON CARDIOVASCULAR FUNCTIONING DURING SLEEP IN ADOLESCENT GIRLS

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Introduction: Depression is an established independent risk factor for cardiovascular disease in adults. Recent literature suggests preclinical signs of cardiovascular risk are also present in depressed adolescents. No study has examined the effect of depression on cardiovascular factors during sleep in adolescents. The aim of this study was to examine the cardiovascular health of depressed versus healthy adolescents during wakefulness and sleep through measures of autonomic activity (heart rate variability) and continuous blood pressure.
Method: Twenty girls (13–18 yrs; 9 clinically depressed, 11 control) recruited through Victorian high schools took part in a clinical interview followed by an overnight assessment in a sleep laboratory. A whole-night polysomnography was conducted with continuous beat-to-beat finger arterial blood pressure (BP) and heart rate variability (HRV) monitored via Portapres and ECG, respectively. Data were analysed in 2-minute epochs of stable sleep averaged within sleep stages. At this time 10 (4 depressed, 6 control) participant's BP and all participant's HRV data have been analysed.
Results: A 2 (depressed, control) × 4 (Wake, NREM1&2, SWS, REM) repeated measures ANOVA revealed a significant main effect of sleep stage but no significant group differences in HRV measures (high frequency power, total power, low frequency/high frequency ratio). Blood pressure analyses also revealed a significant main effect of sleep stage, where BPdiastolic and BPsystolic decreased from Wake to stable NREM and increased during REM. A significant main effect for group was observed in average BP (p = 0.011), BPdiastolic (p = 0.028) and BPsystolic (p = 0.004), with depressed girls showing consistently higher BP (eg. BPaverage: *M*.Depressed = 52.3 ± 2.24, *M*.Control = 64 ± 2.7). No group*stage interactions were found to be significant.
Discussion: Clinically depressed adolescent girls were found to have significantly higher systolic, diastolic and average BP during wake and sleep compared to controls. This suggests that depression has a significant chronic effect on the cardiovascular system in adolescents, which may increase risk for future cardiovascular problems such as hypertension.

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CHILDREN WITH OBSTRUCTIVE SLEEP APNOEA HAVE SIGNIFICANTLY DAMPENED BAROREFLEX RESPONSES TO CHANGES IN BLOOD PRESSURE

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Introduction: The arterial baroreflex is a homeostatic control mechanism for blood pressure (BP). Baroreflex sensitivity (BRS) is a measure of baroreflex function. Activation of baroreceptors via a surge in BP leads to increased vagal, and decreased sympathetic activity. Conversely, a decrease in BP leads to vagal inhibition and increased sympathetic activity. The pathogenesis of hypertension in adults with obstructive sleep apnoea (OSA) has been associated with low BRS, suggesting that low BRS may be the harbinger of the circulatory consequences of OSA. However, limited research has been performed investigating BRS in primary school aged children with OSA, even though these children are known to have elevated BP[1].
Methods: 105 children (7–12 y) referred for assessment of OSA and 36 non-snoring controls were studied. Routine overnight polysomnography was performed with continuous BP monitoring. Subjects were assigned to diagnostic groups according to their obstructive apnoea hypopnoea index (OAHI); primary snoring (PS, OAHI ≤ 1 event/h), mild obstructive sleep apnoea (OSA, OAHI > 1–5) and moderate/severe OSA (MS, OAHI > 5). 39 ± 2, 3 min epochs per subject were analysed. BRS was calculated by cross spectral analysis in the low frequency range (0.04–0.15 Hz). BRS was compared between SDB severity groups and sleep states (NREM1/2, SWS, REM) using 2-way ANOVA.
Results: There was a significant effect of SDB severity on BRS ($p < 0.001$). Children with Mild or MS OSA had significantly lower BRS compared with the Control and PS groups. There was no effect of sleep state ($p = 0.2$) or interaction ($p = 0.9$).
Conclusion: Our data demonstrating reduced BRS in children with Mild and MS OSA which is not dependant on sleep state, are similar to that in adults. These findings suggest that children with OSA, who are known to have elevated BP, have inhibited vagal and sympathetic responses to BP changes. Although not clinically hypertensive, these children display reduced autonomic regulation. Longitudinal studies are required to ascertain if the dampening of the normal baroreflex response will lead to hypertension in these children.

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HOW DOES DUMMY SUCKING PROTECT BABIES FROM THE SUDDEN INFANT DEATH SYNDROME?

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Background: Epidemiological studies have consistently shown that dummy sucking is a protective factor for the Sudden Infant Death Syndrome (SIDS). However, the mechanism by which dummy sucking acts is unknown. It is thought that impaired cardiovascular control accompanied with an uncompensated hypotension may play a major role in the underlying mechanism of SIDS. In support of this hypothesis, major risk SIDS risk factors such as prone sleeping, are associated with lowered blood pressure. Accordingly, we assessed the effects of dummy sucking on blood pressure and heart rate during sleep within the first 6 months of life. We hypothesised that in order to be protective dummy sucking would increase blood pressure and heart rate and this would be most marked in the prone position.
Methods: Term infants were studied longitudinally at 2–4 weeks, 2–3 months and 5–6 months of age using daytime polysomnography. Infants were divided into those who regularly used a dummy (n = 10 at study 1; n = 19 at study 2; n = 14 at study 3) and those who did not (n = 17 at study 1; n = 16 at study 2; n = 17 at study 3). Heart rate and systolic blood pressure were measured continuously in 2 min epochs during both quiet sleep (QS) and active sleep (AS) in the supine and prone sleeping positions. Only periods of non-sucking were analysed.
Results: Systolic blood pressure was higher (10–22 mmHg) in those infants who sucked on a dummy compared to those infants who did not at 2–4 weeks during QS-prone ($p < 0.05$) and AS-supine ($p < 0.05$) and at 5–6 months during AS-supine ($p < 0.05$). There was no effect of dummy sucking on heart rate at any of the ages studied.
Conclusions: This study has identified that dummy sucking increases blood pressure during sleep. A higher baseline blood pressure in infants who routinely use a dummy may indicate increased sympathetic tone of the peripheral vasculature which may serve as a protective mechanism against possible hypotension during sleep leading to SIDS, however further analysis is required.

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THE PRONE SLEEPING POSITION MAY ALTER BOTH SYSTEMIC AND CEREBRAL VASCULAR CONTROL IN PRETERM INFANTS

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Background: Preterm infants are known to be at significantly increased risk of the Sudden Infant Death Syndrome (SIDS). The prone sleeping position is a major risk factor for SIDS and it has been shown in term infants to alter systemic and cerebral vascular control, with the effect being most prominent at 2–3 months of age when the risk of SIDS is greatest. Currently, there has been little investigation of the effects of the prone sleeping position on cerebral vascular control in preterm infants; thus we aimed to determine the effect of sleep position on cerebral vascular control in preterm infants at the age when SIDS risk is highest.
Methods: 16 healthy preterm infants with a mean gestational age of 31.2 ± 0.6 weeks (range 27–36 weeks) were recruited and underwent daytime polysomnography at 2–3 months corrected age. Continuous mean arterial pressure (MAP) was measured using a Finometer™ cuff (Finometer Medical Systems, Amsterdam, The Netherlands) and cerebral tissue oxygenation index (TOI) was measured using a NIRO-200 spectrophotometer (Hamamatsu Photonics KK, Tokyo, Japan). Cardiovascular challenges, in the form of 15° head-up tilts (HUT), were induced in both sleep states, active sleep (AS) and quiet sleep (QS), and in both prone and supine sleep positions. Statistically significant changes from baseline were determined using one-way RM ANOVA within four phases; (baseline: beats 1–30; phase 2: beats 31–60; phase 3: beats 61–90; phase 4: beats 91–120) with HUT performed the baseline phase.
Results: In the supine position, cerebral oxygenation did not change significantly from baseline for the duration of the HUT response in either QS or AS. However, in the prone position, cerebral oxygenation increased above baseline following the HUT reaching significance in phase 2 in QS and phases 2, 3 and 4 in AS. Furthermore, in the supine position MAP did not change significantly from baseline for the duration of the HUT response in either QS or AS. In contrast, in the prone position, MAP increased significantly from baseline in phase 2 in QS and in phases 2, 3 and 4 in AS.
Conclusion: In the prone position, cerebral oxygenation increases following a HUT which may reflect impaired autoregulation in the presence of rising MAP. Our results suggest that both systemic and cerebral vascular controls are altered in the prone sleeping position in preterm infants which may explain their increased risk for SIDS.

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ESTIMATING VENTILATORY INSTABILITY IN OBSTRUCTIVE SLEEP APNOEA FROM ROUTINE POLYSOMNOGRAPHY: A VALIDATION USING ACETAZOLAMIDE

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Introduction: Ventilatory instability (high loop gain, LG) is an important physiological trait contributing to obstructive sleep apnoea (OSA). However, existing methods of estimating LG in OSA require labour-intensive physiological overnight studies, and as such are not suitable for a clinical use. Here we present a novel means to estimate LG using routine polysomnography and evaluate its performance in comparison to a published method using 3 minute 'drops' in continuous positive airway pressure (CPAP) in a small group of OSA patients treated with acetazolamide (ACZ).
Method: In our previous study, 12 participants with OSA (mean AHI = 47 events/hr; range 17–84) underwent polysomnography at baseline and following 1 week administration of ACZ (500 mg, twice daily). Here, we estimated LG during both nights using 10 min windows of supine non-REM data with ≥2 obstructive events. The nasal pressure signal (square-root, integrated) provided a breath-by-breath surrogate

of minute ventilation. A simple chemoreflex model (gain, time constant, delay) was fit to ventilation time series using an autoregressive modelling technique to yield a continuous measure of ventilatory drive; the fit excluded breaths during obstructive events (since ventilation < ventilatory drive), and the ventilatory response to EEG arousal was incorporated as an independent contributor to ventilation. To estimate stability, LG was calculated at the natural cycling frequency (LG_n), and also at a cycling period of 60 s (LG_{60}) for comparison with LG measured using CPAP drops.
Results: As expected, LG_{60} was reduced with ACZ (0.60 ± 0.05 vs. 0.44 ± 0.08, baseline vs. ACZ, $p < 0.05$) matching our published reduction in dynamic LG associated with ACZ (0.60 ± 0.1 vs. 0.36 ± 0.1, baseline vs. ACZ, $p < 0.05$) calculated using the CPAP drop method. Surprisingly, LG_n at baseline was lower in the 6 responders to ACZ (>50% reduction in AHI) than in the 6 non-responders (0.42 ± 0.03 vs. 0.59 ± 0.03, $p < 0.005$).
Discussion: Our novel clinically-applicable method effectively estimated LG in OSA and detected its reduction with ACZ treatment. Intriguingly, our data suggest that those with the lowest LG at baseline are most likely to respond to ACZ. Our approach provides a promising means for estimating physiological traits causing OSA and guiding treatment using routine clinical recordings.

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POSITIONAL CHANGES IN LUNG VOLUME AND AIRWAY SHAPE IN SUPINE DEPENDENT VERSUS RAPID EYE MOVEMENT BASED OBSTRUCTIVE SLEEP APNOEA

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Introduction: Multiple factors have been implicated in the generation of upper airway obstruction including lung volume and airway size and shape. It is not known, however, how these variables are involved in the generation of obstruction in given phenotypes of obstructive sleep apnoea (OSA).
Method: We selected patients with rapid eye movement (REM) and supine based OSA and examined their upper airway with a 320-slice CT scan in the supine and lateral position to obtain cross-sectional area (CSA) and anterior-posterior to lateral (APL) ratio. Lung volumes were also measured seated, supine and lateral using an oxygen wash-in/wash-out technique while patients were awake. Demographic and anthropomorphic measurements were also recorded.
Results: Lung Volume (±standard deviation [SD]):

REM OSA	Seated (L)	Lateral (L)	Supine (L)	ΔLateral to Supine (%)
N = 5	2.12 ± 0.6	2.07 ± 0.5	2.15 ± 0.6	+2.9 ± 9.0
Supine OSA	Seated	Lateral	Supine	ΔLateral to Supine (%)
N = 5	2.75 ± 1.2	2.93 ± 1.4	2.2 ± 1.1	−18.5 ± 6.8
P Value	NS (0.3)	NS (0.23)	NS (0.9)	0.003

Airway Shape (±SD):

	Lateral		Supine		P value	
	CSA (mm^2)	APL Ratio	CSA (mm^2)	APL Ratio	CSA	APL R.
REM OSA	66 ± 35	0.4 ± 0.2	66 ± 31	0.3 ± 0.2	NS (0.9)	NS (0.4)
Supine OSA	**142 ± 80**	0.6 ± 0.1	**99 ± 14**	0.5 ± 0.2	**0.0006**	NS (0.6)
P Value	NS (0.14)	NS (0.19)	NS (0.15)	NS (0.13)		

Discussion: Lung volume and airway size change dramatically from the lateral position to the supine position in patients with supine related OSA, when compared with patients who have REM based OSA which is not position dependent. We speculate that a major factor in the development of OSA when adopting the supine position results from loss of lung volume and a consequent loss of tracheal traction.

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MEASUREMENT OF VENTILATORY INSTABILITY PREDICTS THE INSPIRED CO_2 LEVEL REQUIRED FOR STABLE BREATHING IN HEART FAILURE

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Introduction: Inspired PCO_2 (P_ICO_2) can be effective at terminating Cheyne-Stokes respiration (CSR) in heart-failure, although the precise mechanism is unclear. The common view is that P_ICO_2 resolves CSR by raising arterial PCO_2 away from the apneic threshold, yet this mechanism does not explain the cessation of fluctuations in ventilation and CO_2. Control theory suggests that raising P_ICO_2 lowers 'loop gain' (LG) by bringing the inspired PCO_2 towards the alveolar level ($P_{ET}CO_2$), rendering ventilation ineffective at inducing fluctuations in arterial PCO_2 (i.e. lowering plant gain). Since LG falls proportionally to the narrowing of the end-tidal-inspired PCO_2 difference ($P_{ET}CO_2$–P_ICO_2), if $P_{ET}CO_2$–P_ICO_2 is lowered sufficiently, LG will fall below 1.0 and stabilize breathing. We tested the hypothesis that CO_2 resolves CSR when LG after the intervention is predicted to be below 1.0. The predicted LG ($LG_{predicted}$) was estimated from baseline LG ($LG_{baseline}$; see Methods) and the expected effect on plant gain where $LG_{predicted} = LG_{baseline} \times [(P_{ET}CO_{2,intervention} - P_ICO_2)/P_{ET}CO_{2,baseline}]$.
Methods: 7 subjects with symptomatic heart-failure and CSR underwent overnight polysomnography with measurement of ventilation and $P_{ET}CO_2$. During established CSR, inspired gas was switched from room air to 1%, 2%, or 3% CO_2 to assess whether CSR stabilized or persisted. $LG_{baseline}$ was measured from the duty-ratio (DR) of CSR in the 3–5 cycles preceding the intervention ($LG = 2\pi/[2\pi DR - \sin 2\pi DR]$).
Results: Amongst 78 interventions, $LG_{predicted} > 1$ led to CSR persistence on 17/18 occasions, $0.8 < LG_{predicted} < 1$ preceded an uncertain outcome, and $LG_{predicted} < 0.8$ led to CSR resolution on 29/31 occasions. LG prior to 1% CO_2 and 2% CO_2 was greater prior to failed versus successful

interventions (p = 0.02 and p = 0.04 respectively); 3% CO_2 consistently suppressed CSR in all subjects. Logistic regression demonstrated that both CO_2 level and $LG_{baseline}$, but not subject, were significant predictors of CSR resolution.
Discussion: Loop gain measurement coupled with control theory predicts the resolution of CSR with inspired CO_2, consistent with our view that reduced plant gain is a key mechanism by which inspired CO_2 resolves CSR. For effective resolution of CSR, we recommend designing interventions that target a reduction in loop gain to below 0.8.

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EFFECTS OF CHRONIC HYPOXIA ON RESPIRATORY MUSCLE FORM AND FUNCTION DURING EARLY DEVELOPMENT IN THE RAT

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Chronic hypoxia (CH) is a dominant feature of respiratory disease including various forms of sleep-disordered breathing. The respiratory muscles face considerable challenges during CH in that they must increase their workload despite a reduction in oxygen availability. This study aimed to investigate the effects of CH on respiratory muscle form and function during development. Wistar rats were exposed to 1 week of hypobaric hypoxia (450 mmHg) or normoxia at various time-points during development (postnatal day (P)1–P31). Sternohyoid and diaphragm muscle contractile and endurance properties were assessed *in vitro*. Muscle succinate dehydrogenase (SDH) activity, myosin heavy chain (MHC) isoform composition and fibre cross-sectional area were determined. The putative role of reactive oxygen species in CH-induced muscle remodelling was assessed. CH significantly increased sternohyoid muscle force and fatigue in early but not late development – effects that persisted for several days after return to normoxia. (e.g. early hypoxia peak force 4.6 ± 1. vs. 8.2 ± 1.2 N/cm^2; fatigue index 83.2 ± 7 vs. 58.5 ± 8%; control (n = 6) vs. CH (n = 8), P < 0.05 and late hypoxia peak force, 8.2 ± 1.3 vs. 10.6 ± 1.6 N/cm^2; fatigue index, 36 ± 5 vs. 38 ± 3%; control (n = 8) vs. CH (n = 6)) CH-induced functional plasticity in the sternohyoid muscle was not attributable to MHC fibre type transitions (areal density of MHC slow 7 ± 1 vs. 10 ± 2%; MHC 2a 27 ± 2 vs. 32 ± 3%; MHC 2b 41 ± 2 vs. 36 ± 2%; control (n = 9) vs. CH (n = 6)) or a decrease in oxidative capacity. Chronic supplementation with the superoxide scavenger – Tempol (100 mg/kg p.o.) did not prevent CH-induced increases in sternohyoid muscle force or fatigue, suggesting that mechanisms unrelated to oxidative stress underpin CH-induced adaptation in respiratory muscle. CH increased force in the diaphragm muscle only when exposed to hypoxia in the first week of life (peak force 8.3 ± 0.8 vs. 13.5 ± 0.9 N/cm^2, control (n = 6) vs. CH (7), P < 0.05). We conclude that there are critical periods in early development for CH-induced respiratory muscle adaptation. CH-induced 'conditioning' of muscle may persist into later life. Airway muscle remodelling may have consequences for the control of airway calibre *in vivo*.

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THE EFFECT OF INTERMITTENT HYPERCAPNIC HYPOXIA ON LOOP GAIN IN HEALTHY MALES

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Introduction: Respiratory control instability, or high loop gain (LG), is thought to contribute to OSA pathophysiology by promoting cyclic breathing. High loop gain in OSA is likely partly a feature of low lung volume, but OSA patients also show evidence of increased controller gain which normalises with CPAP treatment, suggesting OSA effects on respiratory control that are not an inherent or underlying trait. Intermittent hypercapnic hypoxia (IHH) induces neuroplastic changes which alter chemoreflex control and could contribute to increased controller gain in OSA. The aim of this study was to determine if acute IHH during wakefulness augments respiratory LG.
Methods: To date 14 healthy (BMI ≤ 25, FVC and FEV1 ≥ 80%, non asthmatic), non-snoring, non-smoking males aged 18–65 have been recruited, with analysis completed in 7. Pseudorandom binary stimulation of breathing using carbon dioxide (4% CO_2) was used to determine overall LG and controller gain before and after acute exposure to IHH. IHH consisted of 24 × 30 s episodes of 3% CO_2, 3% O_2 (adjusted as required to prevent oxygen desaturation below 80%) separated by 2 minutes breathing room air. Intermittent medical air on a separate day in random order and with participants blinded to condition served as a control. Breath-by-breath inspiratory CO_2, expiratory CO_2 and inspiratory ventilation were used to assess LG using the method of Khoo. Effects of gas condition and time on overall LG and controller gain were examined using linear mixed effects model analysis.
Results: There were no significant gas condition, time or interaction effects on overall LG. However, there was a trend towards elevated controller gain following IHH compared to control (mean ± SEM change from baseline IHH 0.248 ± 0.126 vs –0.050 ± 0.079, interaction P = 0.084).
Discussion: These preliminary data are inconclusive and the study is ongoing, but early data indicate that controller gain may be increased by IHH.

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THE EFFECT OF CONTINUOUS POSITIVE AIRWAY PRESSURE ON THE ABNORMAL REFLEX INHIBITION TO INSPIRATORY LOADING IN OBSTRUCTIVE SLEEP APNOEA

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Introduction: In obstructive sleep apnoea (OSA), the short-latency inhibitory reflex response to transient occlusion of inspiratory airflow is prolonged in inspiratory pump muscles in proportion to the severity of the OSA. The mechanism of this abnormal prolongation may relate to conditioning by chronic alteration of proprioceptive afferent activity or changes in afferent traffic or central processing due to OSA-mediated inflammation. Continuous positive airway pressure (CPAP) therapy prevents upper airway obstruction and reverses inflammation and therefore may normalise the reflex abnormality. If so, measurement of

the inhibitory response (IR) might prove useful in the monitoring of OSA therapy.
Methods: Thirty-four patients with OSA were recruited for the study and underwent reflex measurement before CPAP therapy. Thirteen of these patients were restudied after CPAP therapy (mean usage 19 months, range 4–41 months). Reflexes were measured with surface electrodes placed bilaterally over the scalene muscles (obligatory inspiratory pump muscles).
Results: CPAP did not normalise the reflex duration (105 ± 3.2 ms pre-treatment vs 102 ± 2.6 ms post-treatment, $p = 0.77$). There was no association of age, height, weight, gender, peak mouth pressure during occlusion (Pm peak), apnoea hypopnoea index (AHI), oxygen desaturation index, minimum arterial haemoglobin saturation, mean sleep arterial haemoglobin saturation or sleepiness with CPAP adherence. Of these variables, Pm peak magnitude was negatively associated with the onset, peak and offset latencies of the IR and the peak latency of the ER. Height and sleepiness were positively associated with the IR onset latency.
Discussion: The absence of a treatment response suggests that the prolongation of this reflex, whether due to chronic loading or inflammation, reflects durable alterations in the reflex pathway.

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SHOULD WE BE WORRIED ABOUT SNORING IN INFANCY?

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The cognitive impact of sleep disordered breathing (SDB) in school-aged children is well documented. However, whether SDB in infancy has similar detrimental effects is unknown. The long-term impact of any cognitive insult during infancy is potentially greater than for older children given the rapid neural development and sensitive period of cognitive development that occurs during the first few years of life. It is therefore important to carefully characterise the impact of SDB during infancy in order to implement best treatment practise.

A recent study by our group surveyed 457 term infants (aged 1–13.9 weeks) regarding sleep, respiratory problems and sleep disordered breathing symptoms specifically, and then followed up a subgroup of these children evaluating cognitive, developmental and sleep parameters at 6 months (16 snorers and 88 never-snorers) and 12 months (13 snorers and 78 never-snorers) post-baseline.

Consistent with reports from older children, habitual snoring was reported in 9% of infants surveyed. Habitual snoring was associated with formula feeding, parental concern, and restless sleeping. At 6 months chronic habitual snorers showed reduced cognitive development and snoring frequency was significantly correlated with cognitive performance. The reduction in cognitive performance persisted at 12 months in those infants who continued to habitually snore. Additionally, habitually snoring infants had more restless sleep, shorter sleep duration and were predominantly male.

Our findings are consistent with the limited data available in preschool children regarding the impact of SDB on cognitive development, and demonstrate that there is cause for concern about the long-term developmental damage unresolved snoring and more severe SDB possibly causes during infancy.

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COGNITIVE PERFORMANCE AND BEHAVIOUR IN SNORING CHILDREN

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Neurocognitive and behavioural problems are increasingly documented in children with sleep breathing disorder (SDB) but it is unclear at what level of SDB severity such morbidity occurs. Some 12 years ago our group reported that children with relatively mild SDB had significant decrements in cognition. Since then there has been a general consensus that SDB is associated with deficits in intelligence, attention and executive function and less commonly in memory, visual – spatial ability, language skills and sensorimotor function. Behavioural issues are also common and include somatic complaints, depression, anxiety and social problems while hyperactivity, aggression and oppositional behaviour are often reported. Despite an intense research focus on this area over the last decade the accepted view is that there does not seem to be a clear dose response and to compound things further, some studies have found that snoring in a community sample of children is not associated with the neurocognitive deficits that are found in clinical populations. To further compound clarity, most studies have found that the correlation of cognitive and behavioural deficits with polysomnography data to be less than compelling. In addition our knowledge as to whether treatment of SDB reverses these cognitive and behavioural is incomplete and some have argued that if cognitive deficits do persist post treatment (adenotonsillectomy) this is likely to be the result of incomplete resolution of the upper airway obstruction. Our group has closely studied a group of children with SDB pre and 6 and 48 months post surgery and compared them with matched controls. At six months post surgery post surgery cognitive deficits were not significantly improved. However the 48 month results are more encouraging and these will be discussed.

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WHAT DIFFERENCE DO A FEW YEARS MAKE? LONG TERM IMPACT OF RESOLUTION OF SLEEP DISORDERED BREATHING ON NEUROCOGNITION AND BEHAVIOUR IN CHILDREN

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Sleep disordered breathing (SDB) is common in children and ranges from primary snoring (PS), without gas exchange abnormalities or increased arousal, to obstructive sleep apnoea (OSA), characterised by obstructive apnoeas, intermittent hypoxia, hypercapnia and repeated arousals. The detrimental neurocognitive and behavioural consequences of SDB in children are well documented and it is now understood that deficits occur regardless of severity. The most common treatment for OSA is adenoidtonsillectomy (A&T), however children with PS or mild OSA often go untreated. Studies examining the impact of A&T on neurocognition and behaviour over the short term have produced mixed results. Most commonly, although not consistently, behaviour is seen to improve with treatment, however neurocognition remains impaired when compared to controls. Whether these deficits improve, remain or continue to decline over the long term is still unknown. It is

also unknown whether the long-term trajectory of daytime functioning is dependent on the age at which the OSA is treated. There is also limited knowledge about the natural history of SDB symptomology, neurocognition and behaviour in children with PS or mild OSA who do not get treated. Do their symptoms naturally improve with age and with it daytime functioning? Or do symptoms persist and the observed deficits increase? This presentation will review the current literature on the longitudinal implications of OSA treatment on neurocognition and behaviour and present new data from a four-year follow-up study of two cohorts of children: pre-school and school-aged. In particular, this presentation will highlight the neurocognitive and behavioural domains most at risk of impairment and most receptive to recovery and whether that be spontaneous recovery or as a result of treatment. Finally the clinical implications of these results for treatment management will be discussed.

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CARDIOVASCULAR EFFECTS OF SLEEP DISORDERED BREATHING IN CHILDREN – IS IT A MATTER OF TIME?

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Sleep disordered breathing (SDB) is extremely common in children with up to 35% of children reported to snore; this equates to over 1 million Australian children. Symptoms of SDB form a continuum of severity ranging from primary snoring (PS) through to obstructive sleep apnoea (OSA). PS, at the milder end of the spectrum, refers to children who snore but who do not have associated gas exchange abnormalities nor sleep disturbance as detected by conventional polysomnography (PSG). OSA is at the severe end of the SDB spectrum, and is characterised by snoring, apnoea, intermittent hypoxia, hypercarbia and repeated arousals and sleep disruption.

In children the majority of SDB is associated with adenotonsillar hypertrophy so that most children with more severe symptoms are treated surgically with adenotonsillectomy. The peak age for snoring is in the preschool years but there have been very limited studies in this age group, with most studies being conducted in older children. In adults SDB is independently associated with hypertension and an increased risk for cardiovascular disease and stroke. In school aged children studies have now identified that even PS is associated with elevated blood pressure and heart rate[1,2]. Recent studies in pre-school children suggest that the effects on the cardiovascular system are not as severe as that identified in older children. These findings suggest that this may be a window of opportunity to treat children at a younger age and with milder disease before the adverse effects of SDB impact the developing cardiovascular system.

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THE DEFINITION AND MEASUREMENT OF SLEEPINESS

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The concept of sleepiness is central to clinical practice and research in sleep medicine. Various objective and subjective methods are currently used for its measurement, but there has been surprisingly little discussion about the nature and definition of sleepiness. That is the topic of this presentation. In fact, sleepiness is not a unitary concept. By its traditional meaning, the term sleepiness is synonymous with drowsiness, the transitional state between alert wakefulness and sleep. That is what the Karolinska Sleepiness Scale (KSS) purportedly measures – a person's state of alertness/drowsiness at the time, reported subjectively. However, in recent years, sleepiness has also come to mean sleep propensity – the likelihood (in the sense of either probability or speed) of falling asleep. That is what the MSLT measures objectively under one particular set of circumstances, and what the MWT measures under a different set of circumstances. It is also what the Epworth Sleepiness Scale (ESS) measures subjectively under eight different circumstances. However, all these methods provide measurements that are only moderately correlated. The relationships between different situational sleep propensities suggest that all measurements of sleep propensity are partly situation-specific. That is, measurements of sleepiness in one situation cannot be relied upon as an accurate predictor of the same person's sleepiness in different situations. This problem arises because a person's posture, as well as their levels of physical and mental activity at the time, (the integrated effects of which I have called Process-A), have a marked effect on their sleep propensity. This is addition to the effects of Process-S and Process-C, as previously described in models of sleep and wakefulness, which must now be reconsidered.

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VIDEO-ENDOSCOPIC ANALYSIS OF THE AIRWAY IN ADULT OSA

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This presentation will discuss the static and dynamic quantitative assessment of the anatomy of the upper airway. These measurements can be utilised as assessment of OSA in adults, as well as in pre and post-operative evaluation. Detailed analysis of measurements made in both supine and erect positions, and with modified airway manoeuvres will be explained. Some measurements correlate well with polysomnographic indices and represent a potential utility in future diagnostics for OSA.

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THE NOSE IN OSA: A SURGICAL PERSPECTIVE

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This lecture serves to discuss the disconnect between the philosophy and the literature in adult OSA. The principles behind pre-phase nasal surgery will be discussed, with emphasis on treating the nose in order to facilitate subsequent treatment for OSA. An ENT surgical perspective on the role of medical, surgical, and immunological treatments for nasal pathology in OSA with be presented.

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PRE-PHASE NASAL SURGERY: STRUCTURAL AND DYNAMIC CONSIDERATIONS

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Dynamic abnormalities of the nasal valve have been traditionally poorly taught and understood. Surgical focus on structural abnormalities leave dynamic problems untreated resulting in some adult OSA patients having persistent increased nasal resistance, reducing effectiveness and tolerance of device use. The talk will focus on practical demonstration of dynamic abnormalities with photographs and videos of nasal valve collapse and methods of correcting this problem.

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REVIEWING THE EVIDENCE FOR SURGERY IN ADULT OSA: WHAT ARE THE POSITIVES?

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This presentation will focus on the positive surgical contribution to the adult OSA literature. Recent Australian contributions will be discussed, including current deficiencies and potential future research targets.

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PCRIT: THE PROS AND CONS

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Obstructive sleep apnoea (OSA) is characterised by increased pharyngeal collapsibility during sleep. Quantification of pharyngeal collapsibility is important in elucidating OSA pathogenesis, determining severity and evaluating changes with time or treatment. Clinically, OSA severity is defined by the apnoea hypopnoea index (AHI). However passive pharyngeal critical pressure (Pcrit), the pressure at which a hypotonic airway collapses and airflow ceases, is thought to provide a more specific measurement of airway collapsibility and is widely used in research settings. The Pcrit technique involves performing brief pressure drops from an applied nasal pressure sufficient to maintain airway patency and suppress airway neuromuscular reflexes to various levels associated with flow limitation. Examination of the pressure-flow relationships and extrapolation to zero flow reveals the pressure at which airflow would cease (Pcrit). A typical measurement can be performed in less than 2 minutes, significantly less time than the time required to obtain a meaningful AHI.

Despite the relative rapidity of obtaining a single Pcrit value, it describes collapsibility under circumscribed conditions and using one number from an entire night is likely to provide an imperfect representation of an individual's propensity for airway collapse which varies with changes in posture and sleep state. After performing multiple measurements in the same individuals across a night, incorporating sleep stage and body posture changes, we have recently calculated the coefficient of repeatability of the passive Pcrit measurement to be 4.1 cmH_2O. This substantial variability suggests that unless a difference of greater than 4.1 cmH_2O is identified, two measures of passive Pcrit cannot be considered significantly different.

In addition to state and body posture changes, it is likely that the variability in Pcrit across a night arises from factors such as head/neck posture, degree of mouth opening, saliva production and variations in fluid distribution and lung volume, all of which are known to influence airway collapsibility. Related to this, it is important to note that the Pcrit measurement technique itself is associated with changes in lung volume which may confound the measurement.

An alternate method for assessing airway collapsibility is the Pclose technique which although does not inhibit neuromuscular activation, does allow for control of lung volume. The technique involves abruptly occluding nasal airflow to precipitate a negative pressure stimulated airway occlusion. Identifying the point at which the pressures up- and down-stream to the occlusion diverge elucidates the collapsing pressure, which can typically be identified within 5 breaths. Our recent comparison of measures of Pclose and Pcrit within 15 sleeping individuals has revealed a difference of 1.1 cmH_2O suggesting that Pclose could be used as a surrogate for Pcrit. Its simplicity and ease of measurement suggests it may be a useful clinical tool. It appears minimally disruptive to sleep, a further advantage for clinical use.

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AROUSALS FROM SLEEP: HOW SHOULD THEY BE MEASURED AND WHY?

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In 1992 the American Sleep Disorders Association (ASDA) and Sleep Research Society published a set of guidelines to standardise the scoring of arousals from sleep on polysomnography. While these guidelines have been extremely useful in making clinical laboratory reports and research studies comparable, they have led to the general notion in the field that arousal is an all or nothing event and any EEG/physiological changes that do not meet the stated ASDA criteria are not 'true' arousals. This concept has been re-enforced by the current neuro-anatomical model of the sleep-wake system as a flip-flop switch with two mutually exclusive states of wake or sleep.

However, since publication of the 1992 standards, there has been considerable research conducted regarding the EEG and physiologic changes that occur in response to arousing stimuli in healthy normal volunteers and in disease states such as Obstructive Sleep Apnea. This research has suggested that many forms of arousal that are more subtle

than the ASDA criteria likely exist (so called autonomic arousal, subcortical arousal, micro arousal etc).

In this talk, the original ASDA recommendations and some of the more recent literature regarding this topic will be reviewed. In addition, a model of arousal responses being a continuum will be presented.

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COMPLEXITY OF THE UPPER AIRWAY MUSCLES

DANNY ECKERT[1,2]
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The upper airway is comprised of over 25 muscles. Coordinated activation and relaxation enables the upper airway to rapidly change its shape and size to facilitate speech, swallowing of food, and breathing. However, reliance on muscles also renders the upper airway vulnerable to collapse during sleep in susceptible individuals.

Surface and intramuscular electromyographic (EMG) recordings of upper airway muscles have provided insight into upper airway neural control across sleep states and to a variety of respiratory stimuli (e.g. hypoxia, hypercapnia, and negative pressure). Genioglossus, the largest upper airway dilator, has been the most extensively studied muscle. During wakefulness, genioglossus activity is increased in obstructive sleep apnoea (OSA) patients versus controls during quiet breathing as measured using multiunit EMG recordings. Historically, this has been attributed to a neurocompensatory effect via increased reflex activation to an anatomically narrow upper airway. However, recent single motor unit studies suggest that neurogenic processes may also be involved. While there is mounting evidence for neurogenic remodelling of the upper airway muscles in OSA, it remains controversial as to whether or not these changes affect upper airway muscle function and OSA disease progression. The presence of six different patterns of genioglossus single motor unit activity highlights the complexity of its neural control. Surprisingly, tensor palatini, an upper airway dilator muscle that typically shows a constant (tonic) level of multiunit EMG activation during quiet breathing, also displays multiple single motor unit firing patterns, albeit in different proportions to genioglossus. Detailed upper airway reflex studies indicate both excitatory and state-dependent inhibitory components to the genioglossus negative pressure reflex. How the various upper airway muscles actually move to dilate or maintain a patent upper airway (or fail to do so in OSA) in response to varying levels of neural drive remains largely unknown. However, recently developed techniques to measure upper airway muscle movement such as MRI tagging have provided important new insight. In summary, this presentation covers the complexity of upper airway and its neural control, describes several key measurement techniques, and highlights some of the on-going controversies in upper airway muscle physiology.

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LONG TERM MONITORING OF CPAP USAGE – TECHNOLOGY UPDATES

ANGELA CAMPBELL
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The use of CPAP is now common place for the treatment of moderate to severe OSA. A lot of effort is put into starting patients on treatment, close initial follow up to encourage compliance and trouble shooting of side effects. Following successful initiation of CPAP many patients are often then 'left to their own devices' to maintain use of their device. Research shows that a significant number reduce or stop their use of the CPAP over the next 12 months.

The ability to physically see patients on an annual basis to check machine effectiveness and troubleshoot further issues is limited by staff and hospital time. The use of technology to remotely monitor patients is an option which is potentially time saving and would allow the sleep service and patient to ensure sleep quality and treatment efficacy is always at its optimum.

A number of new technologies have been adopted by CPAP manufacturers recently allowing both the patient and sleep service to monitor treatment effectiveness on an ongoing basis without the need to see the patient/device.

This talk will focus on some of these new technologies including: ResMed's EasyCare Online, Philips Respironics' EncoreAnywhere, Fisher & Paykel InfoGSM Compliance management solution and CPA-Paide an iPhone app for CPAP users.

The use of remote technologies also brings some issues for consideration with regards to the use of 'big brother technology'. This was an issue many patients in recent focus groups felt uncomfortable with, ramifications of this technology will be discussed with reference to insurance and licensing.

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SLEEP SERVICES IN AN ABORIGINAL COMMUNITY SETTING

SAMANTHA WINDLER
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The Royal Darwin Hospital (RDH) Sleep Studies Unit does not have a dedicated sleep laboratory for performing polysomnograms (PSGs) and thus fulfils the bulk of requests through unattended home-based studies. One of the challenges facing the unit is performing PSGs on Aboriginal and Torres Strait Islander (ATSI) people who live in remote communities. To address this issue, we have been trialling two separate approaches in service delivery which differ from the traditional laboratory setting. The first approach involves bringing the patient to Darwin to stay in hostel accommodation to undergo PSG, attend a physician review and initiate CPAP therapy, if warranted. This approach has the advantage that it allows extra time for CPAP initiation and troubleshooting, if required. Disadvantages involve the cost of the patient's travel and accommodation, extensive liaison between hospital, clinic, accommodation and travel agency staff, and ultimately, it requires the cooperation of the patient who may hesitate to travel independently for medical investigations which seem unnecessary or intimidating to him or her. The second approach involves coordinating with the hospital's existing Respiratory Outreach schedule and performing PSGs in the patient's own community. While this approach involves a cost associated with the sleep technologist's travel it requires less interaction with fewer agencies thus reducing the likelihood of breakdowns in communication and DNAs. Patients are more likely to consent to PSG as travel is not required. Furthermore, remote visits allow the respiratory team to educate family, community members and clinic staff on sleep disorders and CPAP therapy, as well as the patient. Limitations to this approach are largely associated with time constraints, i.e. if the PSG fails it is unlikely to be repeated on that visit; if the patient requires CPAP therapy, only a brief initiation can occur before the team travel back to Darwin. While each approach to PSG delivery for ATSI patients has its advantages and limitations, it is difficult to predict which approach will yield better outcomes for individual patients. Factors such as age, gender, previous exposure to the healthcare system and health 'literacy' all impact whether a patient will consent to PSG and tolerate the study

long enough to produce meaningful results. Future research aimed at predicting the likelihood of ATSI patients successfully undergoing PSG should investigate these variables.

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THE TECHNICAL AND CULTURAL ISSUES OF HOME MONITORING TO EVALUATE A MĀORI INFANT SLEEP DEVICE

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SIDS remains a significant issue for New Zealand as it accounts for approximately 50 infant deaths each year. The rate of SIDS for Māori babies is 5 times that of non-Māori, non-Pacific babies in NZ. Bedsharing and maternal smoking rates are high among Māori and this combination likely account for many of the deaths. The aim of this study is to evaluate a Māori initiative – the wahakura (woven flax bassinet) – as a possible safer sleep option for high risk families wanting to bedshare. Participants are recruited from midwifery practices that support mainly Māori families from low socio-economic areas. Recruitment is a particular challenge in these hard to reach communities. Participants are randomized to either receive a wahakura or a bassinet prior to the birth of their baby and asked to use this until the infant is 6 months of age. Questionnaires are administered antenatally and at 1, 3 and 6 months regarding infant sleep, childcare practices and maternal well-being. A sleep study with videosomnography, oximetry and temperature measures is carried out in the home at 1 month of age. Our previous research has identified the importance of studying sleep practices in the home to capture usual practices. Home monitoring requires flexibility from the researcher, reliable equipment and cooperation from the parents. While this is not a standardised environment it is more realistic for evaluating risks and benefits of a home sleep practice. To date 100 plus families/240 required have consented to participate and data collection is ongoing. This presentation will focus on recruitment related to this cultural group and on the specific challenges and advantages of sleep monitoring in the home.

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ACTIGRAPHY IN INFANTS AND CHILDREN: ACCURACY AND ALGORITHMS

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Over the last 20 years, actigraphy as an objective measure of sleep in children has gained popularity, particularly as a research tool. Unlike polysomnography (PSG), no published guidelines for actigraphy exist on identification of sleep and wake within the paediatric age group, despite calls for standard recommendations to be made[1]. The scoring rules vary greatly and although sensitivity (sleep agreement with PSG) is often high, this is at the expense of specificity (wake agreement). Accurate algorithm sleep-wake output requires prior data entry from daily logs of sleep–wake periods and artefact-related information (e.g. non-wear time). For infants and young children, 24-hour information is desirable meaning significant parent co-operation is required. Some software programs provide automatic scoring accepting a minimum of 30 minutes of sleep to calculate sleep-wake summary parameters. This limits accuracy around fragmented daytime sleep being included into a 24-hour sleep summary. Whether or not scoring criteria for daytime naps should be different from nighttime sleep remains an unexplored area. Algorithms used are often brand-specific. Actigraphs have movement detectors (e.g. accelerometers) that vary in both hardware and software and few brands include age-specific scoring criteria. With the exception of the Sadeh algorithm[2] and that derived from Lotjonen et al.[3], most actigraphy algorithms use a combination of a scaling factor and epoch weightings to produce an output that is compared against a fixed threshold. These algorithms act as basic filters to reduce signal/data 'noise' and give more accurate sleep-wake indication. The algorithms have been validated against PSG for a single (or limited) device/placement combination and therefore using the algorithms with different device/placement arrangements could produce inaccurate results. We have begun to explore a new algorithm (Count-scaled algorithm) developed within our laboratory and designed to overcome some of these device-specific aspects[4]. The uniqueness of the Count-scaled algorithm is in the pre-scaling of the accelerometer count data to produce an algorithm input unaffected by the magnitude of the count signal. This means the algorithm could be applied to other devices where count outputs differ, either from different sensor sensitivities, or different placement on the body aligned to movement that can reduce or increase the number of counts per epoch.

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MEASURING SLEEP IN FLIGHT: ISSUES ASSOCIATED WITH THE USE OF ACTIGRAPHY

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In some industries individuals have the opportunity to sleep while at work. This may be due to the timing and length of work periods, and the safety critical nature of the work being undertaken. Measuring the duration and quality of this sleep accurately can be important in answering a specific research question and/or as a key measure in an organisation's Fatigue Risk Management System (FRMS). An FRMS is a data driven approach that allows the assessment and management of the risks associated with fatigue. Aviation is an example of an industry where sleep at work may occur and also an environment in which FRMSs are being utilised. Measuring the sleep of flight crew can be difficult as they frequently have irregular and extended hours of work, sometimes crossing multiple time zones, with sleep at irregular times and in various locations, including on the flight deck, in a cabin seat, in an aircraft bunk, or in a layover hotel. Such an environment makes the use of polysomnography particularly challenging and costly. Actigraphy is an alternative means of estimating sleep duration and quality that is non-invasive, easy to use, and low-cost, so it has become widely

used for monitoring sleep over extended periods and in challenging field settings. However, there are a number of important considerations when collecting and analyzing this data. The use of clear, consistent instructions to participants and the choice of an appropriate time base, such as Greenwich Mean Time when participants cross multiple time zones, can improve the quality of the data collected. To allow the timing and duration of sleep periods to be accurately determined, multiple pieces of information should be utilized. In the analysis software, a change in activity can be aligned with event marker data and sleep diary entries to provide confidence in the identification of sleep periods. The population being studied may also require alteration of the sensitivity setting of the analysis software, although for healthy adult populations default settings are often appropriate. It has also been demonstrated that although actigraphically determined mean total sleep time for group data relates closely to polysomnographic measures, there is wide variation in accuracy for individuals. Furthermore, actigraphic estimates of sleep quality and sleep onset latency are less reliable. These considerations should be taken into account when using this method for recording sleep.

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EFFECTS OF TONSILLECTOMY ON SLEEP STUDY PARAMETERS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA

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Objectives: To evaluate the efficacy of tonsillectomy in reduction of Respiratory Disturbance Index (RDI) and other sleep study parameters in patients with Obstructive Sleep Apnoea (OSA).
Methods: This is a prospective case series involving 34 adults with OSA and Friedman[1] grade 3 or 4 tonsils. All 34 patients were treated with tonsillectomy as the only treatment for OSA from 2007 to 2011. Pre- and postoperative polysomnography were performed in all these patients.
Results: Prior to tonsillectomy, 21 patients had severe OSA, 9 patients had moderate OSA and 4 had mild OSA. Surgical response rate (classically defined as 50% or more reduction in RDI and a postoperative AHI of less than 20[2]) was 71.4% among patients with severe OSA, 77.7% among patients with moderate OSA and 75% in patients with mild OSA. Among all the 34 patients, there was a reduction of 24.6 ($p = 0.000$) in the RDI pre- and postoperatively. In our sub-analysis, we arbitrarily divided the patients into 3 groups, patients with RDI less than 30, patients with RDI between 30 to 60 and patients with RDI above 60. It showed that in the patient group with RDI greater than 60, an average reduction of RDI by 29.9 ($P = 0.015$) was achieved and was the greatest reduction in RDI compared to the two other groups.
Conclusion: Results from the study shows that tonsillectomy alone may be considered as an effective first line surgical procedure in the treatment of OSA. Patients with Friedman grade 3 or 4 tonsils may be considered for isolated tonsillectomy as the only surgical procedure without the need for palatal or tongue base procedures.

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UTILITY OF A SLEEP MULTIDISCIPLINARY TEAM MEETING: CLINICIAN AND PATIENT BASED EVALUATION

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Aim: To evaluate patient and clinician assessment of the value of a sleep multidisciplinary team meeting.
Methods: A prospectively collected 18-item questionnaire for patients and 7-item questionnaire for clinicians attending a sleep MDT was performed, at the monthly meeting, for 4 consecutive months. Patients and clinicians were given an internally validated questionnaire to fill out before and after the MDT. All patients attended a consultation with members of the MDT present. Results were analysed by an independent reviewer blinded to the patients condition and the discussion.
Results: Across the range of questions provided, both patients and clinicians had a beneficial experience with the MDT interaction. This resulted in improved understanding of the relevant condition, treatment options and the long term follow up required in its management. Several patients had alterations in their initially proposed management following a consensus discussion.
Conclusion: Sleep MDTs are of benefit to both patients and clinicians in improving understanding of contemporary management pathways for obstructive sleep apnoea.

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ASSESSMENT OF THE PERFORMANCE OF NASAL PILLOWS AT HIGH CPAP PRESSURES

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Introduction: Mask selection is likely to affect a patient's experience with CPAP therapy and compliance. Nasal pillows have less contact with the face compared to nasal masks and might have beneficial effects on minimising adverse effects such as claustrophobia, pressure sores and air leak into the eyes. Nasal pillows, however, are infrequently used at high CPAP pressures. The current literature on different interfaces is scarce and the performance of nasal pillows at higher pressures has not been systematically evaluated. The aim of this study was to examine the performance of nasal pillows at pressures ≥12 cm H_2O compared with the patient's current nasal mask.
Methods: 20 subjects with OSA, established on CPAP therapy (≥6 months) were recruited into this study (CPAP pressure ≥12 cm H_2O; naive to nasal pillows). Participants were randomised to nasal pillows (Swift FX) and current nasal mask for 7 consecutive nights each in a prospective cross-over trial. Participants used the S9 AutoSet with their prescribed therapy settings. Objective device data and subjective feedback were collected.
Results: 19 subjects (14 males, 5 females; pressure range 12–19 cm H_2O; 68.4% humidification use) completed the trial. There were no statistical differences in objective device data. Means (±SD) for nasal pillows vs.

nasal masks were as follows: Daily Usage 7.32 ± 1.42 vs. 7.18 ± 1.40 (hours/night); 95%ile Leak 29.75 ± 13.71 vs. 29.33 ± 18.05 (L/min); AHI 2.02 ± 1.28 vs. 1.76 ± 1.16, respectively (all p-values >0.05). There were no statistical differences between the nasal pillows and nasal masks for subjective ratings of comfort, seal, stability, red marks, feeling of pressure, dry mouth/throat, nasal symptoms, breathing comfort, jetting, eye irritation, sleep quality and overall performance (all p-values >0.05). The nasal pillows were rated to be significantly less obtrusive (p = 0.005) and claustrophobic (p = 0.018). 47.4% preferred nasal pillows, 47.4% preferred nasal masks and 5.3% participant found no difference between nasal pillows and nasal masks.
Discussion: Objective measures showed that the nasal pillows are as efficacious as nasal masks at CPAP pressures ≥12 cm H_2O. Subjective feedback shows nasal pillows are a suitable option for patients at higher CPAP pressures.

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INTERACTIVE EFFECTS OF MANDIBULAR ADVANCEMENT AND CAUDAL TRACHEAL DISPLACEMENT ON UPPER AIRWAY LUMEN GEOMETRY: STUDIES IN AN ANAESTHETISED RABBIT MODEL

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Mandibular advancement (MA) devices are widely used to treat obstructive sleep apnoea (OSA) but are only partially effective in many patients. Since lung volume related caudal tracheal displacement (TD) is a known influence on upper airway (UA) function, we hypothesised that MA effects on UA patency may be modulated by the prevailing level of TD.
Methods: We studied 9 supine, anaesthetised (ketamine/xylazine), adult, male, New Zealand White rabbits. The cervical trachea was surgically exposed and severed between the 3rd/4th cartilaginous rings, then re-extended to pre-transection position (TD = 0 mm). Computed tomography was used to obtain axial images of the entire UA lumen (nasal choanae to glottis) at MA of 0, 2.2 and 4.5 mm (applied via a specially designed device), each with 0 to 7.5 mm graded TD (applied directly to cranial tracheal segment). We measured percent change (from MA and TD = 0 mm) in UA luminal cross-sectional area (ΔCSA) for three UA regions: R1 (base of tongue level); R2 (hyoid bone level) and R3 (epiglottis level), along with change in total UA length (ΔL, %). Data were analysed using linear-mixed effects modelling, and expressed as intercept ± confidence interval (CI) (i.e. value at TD = 0 mm for each MA) and slope ± CI (i.e. % change per mm of TD at each MA; %/mm).
Results: ΔCSA intercept (i.e. MA without TD) significantly increased from MA = 0 to 2.2 mm for R1, R2 and R3 by 18 ± 5, 28 ± 13 and 15 ± 4%, respectively, and for MA = 4.5 mm by 40 ± 5, 69 ± 13 and 24 ± 4%, respectively (all $P < 0.01$). At MA = 0 mm, ΔCSA for R1, R2 and R3 increased significantly with TD by 3 ± 1, 5 ± 1 and 3 ± 1%/mm, respectively (all $P < 0.01$); values were not significantly different to respective values for MA = 2.2 and 4.5 mm (both $P > 0.2$). ΔL intercept decreased by −1.6 ± 0.9% at MA = 2.2 mm and −3.1 ± 0.9% at MA = 4.5 mm (both $P < 0.01$). At MA = 0 mm, ΔL increased with TD by 1.6 ± 0.1%/mm ($P < 0.01$), a value not significantly different to the corresponding value at 2.2 and 4.5 mm of MA (both $P > 0.1$).
Conclusion: Graded MA without TD increases UA CSA and decreases UA length. Graded TD increases UA CSA and UA length similarly irrespective of MA level. We conclude that the effect of MA on UA geometry depends on the prevailing level of TD. Individual subject responses to MA in the treatment of OSA may depend on the associated level of lung volume.

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CHANGE IN PHARYNGEAL AIRWAY DIMENSIONS WITH MANDIBULAR ADVANCEMENT USING CONE BEAM COMPUTER TOMOGRAPHY

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Introduction: The use of Mandibular Advancement Appliances (MAA) for the treatment of Obstructive Sleep Apnea (OSA) is an alternative conservative treatment to Continuous Positive Airway Pressure (CPAP). MAAs advances the mandible to improve the patency of the pharyngeal airway during sleep, with a success rate of approximately 70%.

This is a retrospective study to review the dimensional changes in the pharyngeal airway with mandibular advancement. Cone Beam Computer Tomography (CBCT) is a low cost and potentially readily available procedure for evaluating the pharyngeal airway. While CBCT is aimed at detecting mineralized tissues, using software analysis of the data set allows CBCT to be reliable at differentiating between air space and soft tissue within the head and neck.
Method: A retrospective study of 25 patients (14 male; 11 female; 60.5; ± 5.4 average age) diagnosed with OSA attended a dental practice requesting or using MAA for assistance with OSA. All patients had evaluated CPAP and were looking for an alternative from of treatment. As part of their initial work up for treatment with MAA routine CBCT examination were performed including the dental arches, Cephalometrics, temporo-mandibular joints and measurements of the pharyngeal airway.
Results: The 25 patients had different degrees of initial airway opening ranging from anterior posterior 1.0 mm to 10.5 mm (3.2 mm average, SD ± 2 mm) and lateral width form 7.0 mm to 30.05 mm (Average 20.7 mm, SD ± 6.6 mm. The mandibular advancement was approximately 60% of anterior protrusion. The pharyngeal airway increased in 13 cases with 9 cases showing mild or no improvement, and 6 cases showing a decrease in airway dimensions. After advancement the average anterior posterior dimensions for all cases was 4.9 mm ± 1.9 mm and lateral width was 21.5 mm ± 6.8 mm. MAAs were constructed for 24 cases; with 15 cases reporting success, (62%) and long term use of 2 years being 12 cases (50%). The patients that reported an improvements in sleep with the use of MAA were the patients that the showed an increase in pharyngeal airway dimension.
Discussion: The Use of CBCT may help determine which patients will benefit from the use of Mandibular Advancement Appliances with assistance in treating OSA.

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POLYSOMNOGRAPHIC PHENOTYPES OF OSA AND MANDIBULAR ADVANCEMENT SPLINT TREATMENT OUTCOME

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Mandibular advancement splints (MAS) are an efficacious OSA treatment, however, some patients will not respond to MAS therapy. Previously less severe and supine OSA has been associated with treatment success. Our aim was to compare different baseline OSA phenotypes of severity, body position and sleep stage on MAS response in terms of total AHI.

Methods: Retrospective analysis of diagnostic polysomnography (PSG) of MAS treated patients (n = 386). PSG classification as mild (AHI < 15/hr), moderate (AHI 15–30/hr) or severe (AHI ≥ 30/hr), supine-predominant (AHI_{supine} : $AHI_{nonsupine}$ ratio ≥ 2), non-supine dependent (<2), REM predominant (AHI_{REM} : AHI_{NREM} > 2), NREM predominant (AHI_{REM} : AHI_{NREM} > 0.5) or non-stage dependent (AHI_{REM} : AHI_{NREM} 0.5–2) was performed. MAS response was defined by total AHI reduction in two ways: 1) MAS AHI < 5/hr, 2) ≥50% reduction.

Results: 66 patients were mild, 189 moderate and 131 severe. Severe patients were older (52.6 ± 11.4 *vs*. 48.6 ± 10.1 years) with higher BMI (29.6 ± 5.1 *vs*. 28.2 ± 5.1 kgm^2) than mild. There was a relationship between severity and portion of responders by definition 1 (mild 57.6%, moderate 68.3%, severe 22.9%, p > 0.001) but not definition 2 (mild 60.6%, moderate 68.3%, severe 67.9%). When classified on position, proportion of responders did not differ between supine predominant and non-positional OSA groups by definition 1 (38% *vs*. 40.9%) or 2 (68% *vs*. 81%). In sleep stage phenotypes, REM predominant patients had a higher BMI than NREM predominant (p < 0.05). Baseline AHI was higher in patients with no sleep stage dependence (p < 0.01). There was a trend for association between sleep stage OSA patterns and response by definition 1 (REM 45.3%, NREM 39.7%, non-state 31.3%, p = 0.052) but not by definition 2 (REM 61.5%, NREM 67.6%, non-state 69.7%).

Conclusion: Complete response (post-treatment total AHI < 5/hr) occurred in a lower proportion of severe patients however there was no overall difference in AHI reduction between severity groups. Phenotypes based on position or stage dependency alone did not show any significant differences in MAS treatment response. This contrasts previous work suggesting supine-dependent OSA is associated with a better response. Analysis is ongoing to assess the specific effects of MAS on AHI in sleep-stage and body position.

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THE USE OF A SIMPLIFIED SLEEP MONITOR BY DENTISTS TO GUIDE ORAL APPLIANCE TITRATION DOES NOT IMPROVE OUTCOMES FOR PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA

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Introduction: The use of oral appliances (OA) to treat obstructive sleep apnoea (OSA) is suggested for those with mild to moderate disease and for those unable to use continuous positive airways pressure. It is recommended that after the oral appliance has been supplied and titrated by the dentist, the patient should return to the sleep physician for assessment of efficacy. However further forward titration of the device may be indicated, with prolongation of the treatment initiation time and patients often fail to attend for review. In an attempt to streamline the process, we suggest that the use of a simplified sleep monitor may assist the dentist in determining when adequate forward titration has been achieved, with consequent improved patient outcomes.

Methods: All eligible patients attending 2 dentists (1 in Melbourne, 1 in Bunbury) for management of OSA with an OA were invited to participate. They were randomly assigned to usual care or usual care plus the use of an ApneaLink assessment of sleep to guide titration. When the dentist judged that optimal titration had been achieved, participants had a repeat sleep study. Secondary outcomes were subjective sleepiness (Epworth Sleepiness Scale, ESS), quality of life (Functional Outcomes of Sleep Questionnaire, FOSQ and sf36) and symptoms (Sleep Apnoea Symptom Questionnaire, SASQ).

Results: From November 2010 until November 2011, 27 participants were enrolled, 41% Melbourne, 59% Bunbury, 24% female, age (mean ± SD) 51.8 ± 12.1 years, AHI 30.1 ± 18.0 (range 10–85). There were no significant differences in any baseline parameters between the 2 sites. Thirteen participants were randomised to ApneaLink assessments to guide titration, 14 had usual care. Five participants failed to complete the post-treatment assessments, 3 intervention and 2 control participants. There were no significant differences in any polysomnographic variables (AHI, arousal index, oxygen saturation, sleep efficiency, total sleep time) or daytime function parameters between the 2 groups. There was a significant clinical and statistical treatment response in both groups (p < 0.01).

Conclusion: The use of a simplified sleep monitor does not improve the accuracy of the dentist titrating an oral appliance. There were no additional benefits with the use of the monitor in any sleep-disordered breathing or daytime functional outcomes.

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DEAD SPACE VENTILATION ADDED TO CPAP THERAPY AS A POSSIBLE TREATMENT FOR CENTRAL SLEEP DISORDERED BREATHING

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Introduction: Central apnoeas may occur when the arterial CO2 is reduced below the 'apnoeic threshold'. Studies show that the addition of deadspace to CPAP increases the arterial CO2 to exceed the apnoeic threshold, thus potentially rendering the patient responsive to CPAP by stabilizing chemoreflex influences.
Methods: This descriptive observational study reports 5 patients from a tertiary centre that have central sleep apnoea, Cheyne-Stokes respiration or complex sleep apnoea (predominantly OSA on diagnostic PSG with emergent central apnoeas during CPAP administration). All patients had a diagnostic PSG, CPAP titration and further evaluation of added deadspace (+ASV alone for latter half of the night). Patients had either an unsuccessful CPAP implementation study or had failed a trial of CPAP therapy. During the CPAP/deadspace study, CPAP and supplemental oxygen were titrated in the conventional manner and a fixed volume of deadspace was used with TcCO2 monitoring. Baseline characteristics and clinical outcomes were reviewed.
Results: Addition of deadspace to CPAP improved the sleep architecture, AHI and ODI once mask leak was addressed in 3/5 patients. Following deadspace study, 2 patients are being trialled on CPAP/deadspace, 1 is being managed with ASV and 2 are awaiting review.
Discussion: Deadspace added to CPAP therapy is a simple, possibly efficacious and cost-effective treatment for patients with central sleep disordered breathing. Important considerations comprise patient selection, addressing mask leak, evaluating the significance of varied deadspace volumes and CO2 monitoring and indeterminate long term effects of deadspace ventilation.
Acronyms: AHI = apnoea-hypopnoea index, ASV = adaptive servo controlled ventilation, CO2 = carbon dioxide, CPAP = continuous positive airway pressure, ODI = oxygen desaturation index, OSA = obstructive sleep apnoea, PSG = polysomnogram, TcCO2 = transcutaneous CO2.

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MILD OVERNIGHT HYPERCAPNIA: A NOVEL THERAPY FOR THE TREATMENT OF OBSTRUCTIVE SLEEP APNOEA?

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Background: Obstructive sleep apnoea involves complex interactions between anatomic and non-anatomic factors and markedly improves in stage 3/4 sleep, in even severe OSA patients. Recent data suggest that rising baseline end-tidal carbon dioxide ($ETCO_2$) and consequently ventilatory drive in deepening sleep could help explain this improvement. Therefore, the aim of this study is to determine the effect of mild overnight hypercapnia on OSA severity; to test the hypothesis that mild hypercapnia to stimulate ventilatory and upper airway muscle activity helps protect against cyclical airway collapse in sleep.
Methods: The study is ongoing, and aims to recruit 15 obese male patients (BMI 25–35 kg/m^2, age 18–65 yrs) with at least moderate severity OSA (AHI > 20/hr). Subjects will attend the laboratory on 2 separate nights, in a randomised placebo controlled crossover experiment using mild hypercapnia on one night ($ETCO_2$ elevated by 3–4 mmHg above quiet wakefulness levels via ~500 ml/min CO_2) and medical air on the other night, both delivered via nasal cannula. Standard polysomnography measures will be collected on both nights and scored according to current AASM criteria, with the scorer blinded to treatment allocation. The primary outcome measures are apnoea-hypopnoea (AHI) and arousal (AI) indices, with more detailed sleep-stage specific measures as secondary outcomes, using paired and mixed effects tests to examine gas condition effects.
Results: Six subjects (age 48.7 ± 3.9 yrs, BMI 31.5 ± 0.7 kg/m^2) have completed testing and preliminary analysis. In this group, full night AHI and respiratory AI were not different between CO_2 versus the control conditions (AHI 35.2 ± 9.8 vs. 43.2 ± 12.9/hr, p = 0.2; AI 18.5 ± 8.4 vs. 27.4 ± 12.8/hr, p = 0.3).
Discussion: Testing is ongoing and a larger sample and more detailed analyses are needed to fully address the study hypothesis. Should our hypothesis be supported, this would provide new insights into mechanisms allowing OSA patients to stabilise their own breathing in deep sleep, and could help inform new treatments that might be better tolerated than existing mask-based treatments such as CPAP.

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DOES THE PRESENCE OF INSOMNIA AFFECT TREATMENT DECISIONS AND TREATMENT OUTCOMES IN PATIENTS WITH SLEEP DISORDERED BREATHING

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Introduction: Recent data show an unexpectedly high prevalence of overlapping OSA and insomnia suggesting potentially quite complex and co-dependent relationships between these two disorders in clinical practice. Co-morbid insomnia in patients with OSA could influence OSA management; by influencing CPAP prescription decisions and CPAP adherence.
Aims: 1. To investigate the impact of insomnia on referral for CPAP titration in patients presenting to sleep clinic. 2. To investigate CPAP titration failure and first night (on CPAP) sleep characteristics among patients initiated on CPAP treatment.
Methods: Retrospective single centre observational study of patients referred for investigation of OSA.
Results: There was no significant difference in the rate of CPAP titrations among patients with (36/82 = 44%) and without (51/129 = 40%, Fisher's p = 0.885) insomnia symptoms. In 87 OSA patients who completed insomnia questions and CPAP titration, the CPAP titration failure rate was not different between patients reporting difficulty initiating or maintain sleep (7/36; 19%) versus those who did not (5/51; 10%, p = 0.222). 51 patients aged <65 yrs completed full-night CPAP titration, including 23 patients with versus 28 without symptoms of insomnia. Sleep onset latency was longer with insomnia (mean ± SEM 33 ± 5 vs 19 ± 4 min, p = 0.033), but sleep efficiency (71 ± 3 vs 73 ± 2%), wake after sleep onset (92 ± 9 vs 88 ± 9 min) and the % of each stage of sleep were not different between groups.
Discussion: The presence of insomnia symptoms did not affect treatment decisions (in this case referral for CPAP titration), in this group of patients. The higher sleep onset latency in patients with insomnia

might make OSA-insomnia patients less enthusiastic about wearing the CPAP mask but otherwise the comparable response to CPAP does not support the concept that OSA-insomnia patients have initial difficulties sleeping with CPAP. Thus long term failure to adhere to CPAP in OSA-insomnia is unlikely to be explained by an acute adverse initial experience with treatment.

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TREATMENT OF OBSTRUCTIVE SLEEP APNOEA WITH A NOVEL HYPOGLOSSAL NERVE STIMULATION SYSTEM: SINGLE CENTRE EXPERIENCE WITH RECRUITMENT, SCREENING AND ENROLMENT

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Introduction: Continuous Positive Airway Pressure (CPAP) is effective in treating obstructive sleep apnoea (OSA). However, PAP is often poorly tolerated with poor patient usage. Thus an ongoing issue for clinicians is providing alternative, effective treatments for OSA. In feasibility studies, stimulation of the hypoglossal nerve (HGN) has shown promise as an effective treatment. We report a single center's experience in assessing participants for a randomised controlled trial of a novel HGN stimulation (HGNS®, Apnex Medical, Inc) system.
Methods: Potential research subjects were identified from the clinic patient population at the Austin Hospital, a newspaper article and direct referrals from sleep physicians. Research volunteers were pre-screened for history of CPAP failure/intolerance and body mass index ≤35 kg/m^2. Those who chose to progress were then further evaluated clinically, which included a complete medical history and physical examination, in-lab overnight polysomnography and nasoendoscopy.
Results: Since September 2011, our research centre has contacted 220 patients from our database of patients started on CPAP therapy in the past 2 years and 890 people telephoned us following a small informative article in a tabloid newspaper in December 2011. Of those from the CPAP database, 100% were eligible at pre-screening, 20% were interested in receiving further information and 1% were implanted. Of those who responded to the newspaper article, 69% were eligible at pre-screening, 69% were interested in receiving further information and to date 2% have been implanted. Baseline demographics of implanted subjects are: 82% male, 54 ± 9 years old and a baseline AHI of 34 ± 14 (2007 American Academy of Sleep Medicine alternative definition). Complete baseline clinical data on all enrolled and randomized participants will be presented.
Conclusions: At this centre, there was a high degree of interest in participating in this clinical trial with over 1000 individuals evaluated for participation in a 10 month period. Many potential participants who initiated contact with our research office were still using CPAP for 2–4 hours per night, but very keen to try an alternative form of therapy. These individuals were not enrolled in the study. To date we have consented and completed screening for 44 participants of whom 17 have passed screening and progressed to implantation of the HGNS system.

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EXPERIENCE WITH MOUTHPIECE NON-INVASIVE VENTILATION IN PATIENTS WITH DUCHENNE MUSCULAR DYSTROPHY

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Introduction: Mouthpiece Non-Invasive Ventilation (MNIV) has been utilised in selected centres in North America, Japan and Europe for more than a decade. We report our institution's experience with the first five patients who have utilised MNIV.
Methods: 5 patients with Duchenne Muscular Dystrophy were commenced on MNIV in addition to their regular nocturnal and diurnal NIV. They reported poor quality of life with an inability to leave their residence for prolonged periods because of dyspnoea prior to MNIV.
Results: Tabulated below are demographics, lung function, details of NIV and MNIV

Age (years)	Year of last VC	VC % Pred.	Year NIV started	Usage/day of NIV (hr)	MNIV Mode	MNIV Setting
37	2003	12	1998	14.5	ACV	V_T 1 L
35	2006	9	1998	17.1	ACV	V_T 1.1 L
33	2007	15	2006	14.8	ACV	V_T 0.6
26	2007	9	2005	15.1	PS	14–16

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THE EFFECT OF AN EXTERNAL MECHANICAL STIMULUS DEVICE TO TREAT OBSTRUCTIVE SLEEP APNEA

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Introduction: 100 million people worldwide have obstructive sleep apnea (OSA), of which more than 80% remain undiagnosed. Current OSA treatment has side effects which lead to OSA sufferers failing to comply with treatment. An external mechanical stimulus device to treat OSA that is comfortable and convenient has been tested in hopes of leading to a higher compliance and treatment of OSA.
Methods: A prospective, multicentre, open label, single group safety and efficacy clinical trial. Adult patients with previously diagnosed OSA, previous CPAP experience, and a completed sleep medicine evaluation were included. A total of 25 patients completed the study. Patients underwent a ten day study including seven days in the home with the investigational device. Type 1-PSG results were compared from baseline (device off) to the last night after using the device for ten days (device on). Epworth Sleepiness Scale (ESS) and Functional Outcomes of Sleep Questionnaire (FOSQ) completed prior to study were compared to ESS and FOSQ completed at end of study. Questionnaires comparing patients' preference to current OSA treatment versus the investigational device were filled.
Results: Results from 19 subjects were analysed. Type-1 PSG results indicated that the Apnea Hypopnea Index (AHI) decreased by 46%, oxygenation improved by 23%, and the Arousal Index improved by 23% with the device on. ESS dropped by 16.4% in average and FOSQ increased by 13.6% indicating overall improvement in daytime sleepiness and function. A majority of the patients preferred

the investigational device to CPAP and 99% of patients felt that the investigational device was very easy to use. 6 subjects were excluded from the results of the study: two for morbid obesity (BMI greater than 40), two for investigational device failure, and two for ineffectiveness.
Discussion: Use of the investigational device significantly improved AHI without worsening sleep quality. Also, subjective daytime sleepiness and function improved with the use of the investigational device which patients felt were comfortable and easy to use.

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ARE THERE BIDIRECTIONAL RELATIONSHIPS BETWEEN ANXIETY, DEPRESSION, AND DIFFERENT SLEEP DISTURBANCES? A SYSTEMATIC REVIEW

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Introduction: This systematic review aimed to assess whether there is a bidirectional relationship between anxiety, depression, and any sleep disturbance, and thus identify potential causes for each problem. Such knowledge could identify key aetiological factors that would inform public health campaigns and clinical interventions for sleep disturbances, anxiety and depression.
Methods: Relevant studies were identified by searching PubMed, PsychINFO, Embase and Scopus databases, and reference lists of eligible studies. Publication dates ranged from the beginning of each database to December 2011. Studies assessing potential bidirectionality between sleep disturbances and anxiety or depression were included. Treatment studies and those based on high-risk cohorts were excluded.
Results: Nine independent studies were eligible for this systematic review. One cross-sectional study found a one-way relationship where anxiety disorders lead to insomnia, which lead to major depressive disorder, but not vice-versa. Longitudinal studies consistently suggested insomnia and sleep quality were bidirectionality related to anxiety and depression, and a combined depression/anxiety measure, respectively. Sleep problems significantly predicted higher levels of depression and depression/anxiety, but not vice-versa. One study found a bidirectional relationship between excessive daytime sleepiness (EDS) and anxiety, but not depression.
Discussion: The limited studies in this area and heterogeneity of cohort samples used across studies allow for few definitive conclusions to be made about bidirectionality between sleep disturbance, anxiety and depression. However, it seems bidirectionality studies are likely to yield different results across different methodologies (cross-sectional, longitudinal) and sleep disturbance variables. Furthermore, the best available evidence suggests insomnia is bidirectionally related to anxiety and depression, and highlights the complex inter-relationship between sleep disturbances, anxiety and depression.

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PERSISTENT SLEEP DISTURBANCE IS ASSOCIATED WITH TREATMENT RESPONSE IN ADOLESCENTS WITH DEPRESSION

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Background: Sleep disturbances are highly prevalent in adolescents with depressive disorders. To date there is limited evidence of the extent to which sleep disturbances are associated with treatment response in adolescents. This study aimed to examine the extent to which self reported sleep disturbances are associated with treatment response in adolescents with depression.
Method: Sleep data were gathered from a sample of 166 adolescents (aged 12–18 years) with a diagnosis of a DSM-IV depressive disorder who underwent 3 months of treatment (psychosocial and/or pharmacotherapy (Sertraline)) in community based research programs. The subjective report of sleep disturbance within depressive disorders was assessed using the Kiddie Schedule for Affective Disorders and Schizophrenia at three time points: pre-treatment, post-treatment and 6 month follow-up.
Results: Sixty nine percent of participants had a sleep disturbance pre-treatment and approximately 75% of these participants had threshold symptoms. Threshold sleep disturbances that persisted from pre- to post-treatment assessments were positively associated with depression at 6 month follow-up. An ordered logistic regression model controlling for gender, treatment group and comorbid anxiety estimated a 39% probability of depression for those with persistent sleep disturbance. Treatment group, anxiety and gender generally had no significant effect on the relationship between sleep and depression.
Conclusion: Presence of persistent sleep disturbance in adolescents with depression is associated with poorer antidepressant treatment outcome. We suggest that future studies should evaluate the efficacy of sleep-related intervention strategies in improving treatment outcomes in this population.

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DRIVER SLEEPINESS SELF-REGULATION: PHYSIOLOGICAL AND SUBJECTIVE EVIDENCE

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Introduction: Sleepiness contributes to a substantial proportion of fatal and severe road crashes. Efforts to reduce the incidence of sleep-related crashes have largely focussed on driver education to promote self-regulation of driving behaviour. However, effective self-regulation requires accurate self-perception of sleepiness. The aim of this study was to assess capacity to accurately identify sleepiness, and self-regulate driving cessation, during a validated driving simulator task.
Methods: Participants comprised 26 young adult drivers (20–28 years) who had open licenses. No other exclusion criteria where used. Participants were partially sleep deprived (05:00 wake up) and completed a laboratory-based hazard perception driving simulation, counterbalanced to either at mid-morning or mid-afternoon. Established physiological measures (i.e. EEG, EOG) and subjective measures (Karolinska

Sleepiness Scale), previously found sensitive to changes in sleepiness levels, were utilised. Participants were instructed to 'drive' on the simulator until they believed that sleepiness had impaired their ability to drive safely. They were then offered a nap opportunity.
Results: The mean duration of the drive before cessation was 36.1 minutes (±17.7 minutes). Subjective sleepiness increased significantly from the beginning (KSS = 6.6 ± 0.7) to the end (KSS = 8.2 ± 0.5) of the driving period. No significant differences were found for EEG spectral power measures of sleepiness (i.e. theta or alpha spectral power) from the start of the driving task to the point of cessation of driving. During the nap opportunity, 88% of the participants (23/26) were able to reach sleep onset with an average latency of 9.9 minutes (±7.5 minutes). The average nap duration was 15.1 minutes (±8.1 minutes). Sleep architecture during the nap was predominately comprised of Stages I and II (combined 92%).
Discussion: Participants reported high levels of sleepiness during daytime driving after very moderate sleep restriction. They were able to report increasing sleepiness during the test period despite no observed change in standard physiological indices of sleepiness. This increased subjective sleepiness had behavioural validity as the participants had high 'napability' at the point of driving cessation, with most achieving some degree of subsequent sleep. This study suggests that the nature of a safety instruction (i.e. how to view sleepiness) can be a determinant of driver behaviour. Despite other driving demands (e.g. destination, motivation and, time constraints) that may be important factors with sleep-related crashes, these data have implications for road safety strategies to improve self-regulation of sleepiness on the road.

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ARE PERCEPTIONS OF SLEEP NEED TASK DEPENDENT? EXAMINING PERCEPTIONS OF OPTIMUM SLEEP TO DRIVE, WORK, AND FUNCTION EMOTIONALLY, PHYSICALLY AND MENTALLY

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Introduction: The optimum amount of sleep required for effective day time functioning is generally accepted to be approximately 8 h. The consequences of insufficient sleep vary depending on what tasks need to be performed during wake; for instance, inadequate sleep may be less problematic for doing paper work than for driving a truck. How much sleep people obtain may depend, in part, on how much sleep they think they need. However, little is known about whether people perceive that their sleep requirements depend on the tasks they need to perform upon waking.
Method: A large scale online sleep survey was conducted to investigate perceptions of sleep need. Participants were asked how much sleep they thought they needed to function mentally, emotionally and physically, and how much sleep they thought they needed to drive a car safely, work safely and to feel refreshed and well rested. A stratified sample was created with equal numbers of males and females, age groups (18–34 y, 35–54 y, 55–74 y) and shift workers/non-shift workers (n = 1920).
Results: Perceptions of sleep need depended on the task or function that was required during wake ($F(5, 9540) = 271.61$, $p < 0.001$). Participants reported needing approximately 25 minutes more sleep per night to feel refreshed and well rested than they thought they needed to function emotionally (7 h 33 m), mentally (7 h 31 m), or physically (7 h 22 m). Participants perceived that they would need the least amount of sleep to work (7 h 12 m) or drive safely (7 h 11 m), although this depended on occupation, gender and age. Females' reported a greater sleep need to both work and drive safely compared to males. 18–34 y males felt that less sleep was necessary to work safely than males over the age of 35 y. There was a significant effect of occupation of sleep needed prior to work, $F(10, 1909) = 3.06$, $p = 0.001$, but those in industries considered to be high risk (e.g. transport workers, manual labour and trades) did not feel that they needed more sleep to work safely than those in low risk occupations.
Discussion: Findings indicate that perceived sleep need varies depending on the task needed to perform upon wakening. These findings may be used to target drowsy driving initiatives and to guide sleep and fatigue education in high risk work places.

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DIFFERENCES IN ACCURACY OF SELF-REPORTED SLEEP DURATION BETWEEN WOMEN WHO RECEIVE PRENATAL SLEEP EDUCATION AND THOSE WHO DO NOT

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Introduction: A growing body of knowledge exists about the direction and magnitude of sleep changes during the peripartum, and new evidence is emerging around women's subjective experiences of sleep at this time. The purpose of this study was to trial a behavioural educational sleep intervention for first time mothers, aimed at promoting mother and infant sleep in the first 12-wks postpartum. Analyses were conducted to 1) determine how accurate self-reported total sleep time in 24 hrs (TST) is compared to objectively measured TST, 2) investigate if accuracy differs by level of sleep education.
Method: Forty first-time mothers (mean age 33.32 yrs, *SD* = 2.84), participated in the Parent Information on Parent & Infant Sleep study. Control group mothers (CGM), n = 20, attended a short, prenatal, general information session and received two contact-only telephone calls at 2 and 4 wks postpartum. Intervention group mothers (IGM), n = 20, attended a 2-hour prenatal sleep education session and received weekly support calls in the first 6 wks postpartum. Self-reported TST was collected from a health and sleep habits questionnaire at 12 wks postpartum. Actigraphy and sleep diaries (48 hrs) were completed for all mother-infant pairs at 12 wks postpartum (mean infant gestational age 52.1 wks, *SD* = 1.52). Mean actigraphic TST in 24 hrs was calculated and t-tests were used for all analyses.
Results: At 12 wks postpartum CGM mean self-reported TST was 461 mins compared to mean 413 mins as measured by actigraphy (+48 mins, $t(19) = -2.29$, $p = 0.03$). IGM mean self-reported TST in 24 hours was 428 mins compared to 420 mins using acti-graphy (+8 mins, $t(19) = -0.588$, $p = 0.56$). Fifty percent of CGM over-estimated TST by >30 mins whereas only 30% of IGM made the same level of over-estimation (35% and 15% respectively overestimated by >60 mins). Further analysis showed that the extent of over-estimation was not significantly different between these two groups ($t(36) = 1.73$, $p = 0.09$).
Conclusion: Women in this study who received prenatal education, including information about realistic postpartum sleep patterns, showed a tendency to more accurately self-report actual TST compared to those who received no formal sleep education. The effect of surmised self-report biases (such as *being seen* to sleep well) and the contribution of sleep education to these findings warrant further investigation in a larger sample of peripartum women.

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SLEEP PATTERNS OF INDIGENOUS VS. NON-INDIGENOUS CHILDREN IN A RURAL COMMUNITY

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Introduction: School performance in indigenous children (IC) is worse than in non indigenous children (NIC) and may be impacted by poorer school attendance rates. Sleep patterns, such as wake times before school, are likely to impact school attendance. This has not been compared in rural indigenous vs non indigenous children.
Method: Self report sleep data were collected using the adapted Sleep Timing Questionnaire (1), on a Monday morning) from an area school in a rural community in South Australia in IC (n = 19) and compared to NIC (n = 49).
Results: 'Usual Sleep Time prior to a School Day' did not differ between groups [9.3 hrs, (1.9) vs. 9.9 hrs, (1.3); F(1, 68) = 1.64, $p = 0.21$] nor did 'Usual Sleep Time prior to a Day Off from School' [10.2 hrs, (2.1) vs. 10.0 hrs, (2.0); F(1, 68) = 0.04, $p = 0.85$). However, differences between IC and NIC group's sleep behaviour were found in bedtimes and waketimes. IC went to bed earlier [F(1, 64) = 4.69, $p = 0.034$] and had a much more unstable wake times before school days [$X^2(9, N = 52) = 20.18$, $p = 0.017$] compared to NIC. This latter finding infers that IC have more variation as to their Getup Timings than NIC. Get up time also was found to have a strong impact on the length of sleep as Total Sleep Time Before a School Day was highly associated with Get Up Time on a School Day ($r = 0.687$, p = 0.003).
Conclusions: These data, whilst preliminary, may suggest that sleep duration is less indicative of understanding sleep patterns in IC compared to bedtimes and wake times. In addition, the unstable and later wake times in IC may be impacting school attendance.

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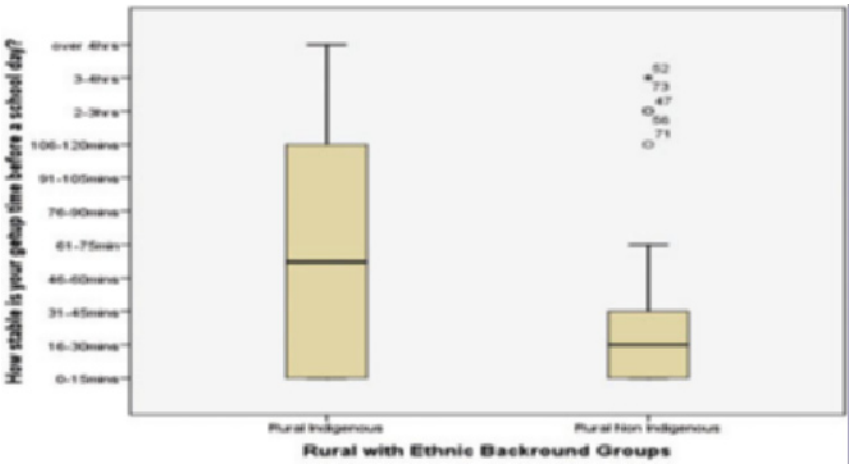

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COMPARING SLEEP DURATION AND QUALITY PRIOR TO AND DURING LATE PREGNANCY: RESULTS FROM A LARGE SAMPLE OF NEW ZEALAND WOMEN

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Introduction: Women experience profound changes to their sleep during pregnancy. However, there is currently no information about the sleep of pregnant women in New Zealand. The aim of this study was to compare characteristics of sleep before and during pregnancy in a large sample of New Zealand women.
Method: The *E Moe, Māmā: Maternal Sleep and Health in Aotearoa/New Zealand* study is a questionnaire-based project designed to investigate sleep changes across the perinatal period and the relationship with maternal health and mood. A total of 1091 women aged 16–46 yrs completed the first questionnaire between 35–37 wks gestation at which time they were asked about their pre-pregnancy and current sleep habits. Participants were asked their usual sleep duration across a 24-hour period and to report the number of nights/week they experienced a good night's sleep; loud snoring; breathing pauses during sleep; and legs twitching/jerking during sleep (0–7 nights, where ≥3 nights/week was considered frequent). Differences between mean sleep in pre-pregnancy and at 35–37 wks were compared using paired t-tests.
Results: Participants reported significantly shorter usual sleep duration (mean ± SD, 7.41 ± 1.82 vs. 8.23 ± 1.23, t = 14.02, $p < 0.0001$) and fewer good nights of sleep per week (2.63 ± 1.86 vs. 5.23 ± 1.48, t = 40.14, $p < 0.0001$) in late-pregnancy compared with pre-pregnancy. Twenty two percent of women reported snoring ≥3 nights/week in late pregnancy compared with 15% of women prior to pregnancy (t = −6.46, $p < 0.0001$). There was very little change in the proportion of women who reported breathing pauses during sleep in late pregnancy compared with pre-pregnancy (4% vs. 3%, t = −1.68, $p = 0.09$). Legs

twitching or jerking during sleep was reported by 14% of women in late pregnancy and 16% prior to pregnancy (t = 2.67, $p = 0.008$).
Conclusion: Compared with pre-pregnancy, self-reported sleep in late pregnancy is shorter and of poorer quality and loud snoring is more common. Future research should investigate the impact of sleep disturbances associated with pregnancy on maternal health and wellbeing and determine whether or not post-partum sleep duration and quality recovers to pre-pregnancy levels.

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READABILITY ASSESSMENT OF CONSUMER INFORMATION MATERIAL ON SLEEP AND HEALTH FROM AUSTRALIAN WEBSITES

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Introduction: National surveys have found that 59% of Australian adults do not have the health literacy skills that enable them to meet the complex literacy demands of health care systems. Numerous studies have shown healthcare materials are often written at a reading level too high for most readers, as most adults read on average at a Year 8 level.
Methods: We assessed the readability of consumer information on sleep topics available at the Australasian Sleep Association/Sleep Health Foundation website in 2012 and 2010. The Simple Measure of Gobbelydegook (SMOG) Readability Index and Gunning-Fox Index were calculated using online calculators (http://webpages.charter.net/ghal/SMOG.htm). These formulas are considered to be rigorous reading assessment tools because they focus on the length of words and sentences rather than on words alone. USDHHS guidelines recommend maximum readability at sixth-grade level to ensure understanding.
Results: Forty separate consumer information documents were examined which dealt with information regarding sleep conditions, sleep lifestyle factors, treatment of sleep disorders, and sleep in other health problems or states. Titles, subtitles, references, weblinks and advertising text were excluded from the analysis, with only body text and bullet point text included. The average percentage of complex sentences identified was 19%, (range 14–25). The table shows the distribution of information sheets by USDHHS classification and grade level. Of consumer information sheets sourced in 2010, 6/7 (86%) had reading levels at >12 grade, compared to 2.5% in 2012.

USDHHS classific.	Grade level	SMOG (% articles)	Gunning-Fog (%)
Easy	4^{th}–6^{th} grade	0%	0%
Average	7^{th}–9^{th} grade	32.5%	67.5%
Difficult	10^{th}–12 grade	65%	30%
	$>12^{th}$ grade	2.5%	2.5%

Conclusion: Despite improvements since 2010, most information was written above the capabilities of the average adult and none complied with the USDHHS maximum recommended grade level. Future work will assess other websites and document layouts.

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THE INFLUENCE OF EXTRA ANTENATAL AND POSTNATAL EDUCATION ON SAFE SLEEPING FOR PREVENTING SUDDEN UNEXPECTED DEATH IN INFANCY (SUDI)

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Introduction: Interventions to prevent sudden unexpected death in infancy (SUDI) have generally been population-wide interventions instituted after case-control studies identified specific childcare practices associated with SUDI. While successful overall, in New Zealand SUDI rates are still high by international comparison. A large RCT to prevent excessive weight gain in early childhood provided an opportunity to determine if extra education on safe sleeping altered practice.
Aim: To determine whether extra education on safe sleeping practices effectively influenced practices of the parent/s receiving this education.
Methods: Within the 4-arm trial (n = 805), 391 parent/s received extra antenatal and postnatal education to aid healthy sleep including information on safe sleeping practices. The remaining participants did not receive this education. Participants completed interviewer-administered questionnaires antenatally and at 3 weeks and 19 weeks after birth. The questionnaires after birth asked about sleep position, place of sleep, bedding (under and over baby), smoking, dummy use and breastfeeding. Telephone interviews were also conducted to obtain information about sleep practices at 7, 11, 15 and 23 weeks.
Results: The study found no significant differences in safe sleep practices between groups who received extra education and those that did not (all $P > 0.05$). Within the whole group (n = 805), 87% and 89% of infants were sleeping in the safest position (supine) at 3 and 19 weeks respectively. Room sharing in a cot or bassinette at 3 weeks was common practice (64.6%) but transition to sleeping in a separate room increased over time. Bed sharing was practiced in 15% of participants at 3 weeks of age, reducing by half at 7 weeks and remaining relatively stable up to 19 weeks of age. Dummies were used in 9%, 18% and 18% of infants on a daily basis at age 3, 19 and 23 weeks respectively.
Discussion: Although the extra education made no difference to practice, an area identified for improvement was bed sharing in infants under the age of 1 month which was twice as common at this age than at 3 months. This finding is of concern because if the mother also smokes, significant risks are associated with bed-sharing, especially during the first weeks of life.

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DAYTIME ENERGY EXPENDITURE IS ASSOCIATED WITH BETTER SLEEP IN HEALTHY ADULTS

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Epidemiological studies have suggested an association between self-reported physical activity levels and subjective sleep measures. Conversely, interventional studies using acute physical training have provided inconsistent results. This study aimed to assess the association between habitual physical activity levels and sleep-wake patterns with ambulatory instruments and to identify whether polysomnographic sleep variables correlate with physical activity levels.

Twelve healthy young adults underwent 5 to 9 days and nights of continuous actigraphy monitoring, wearing two actimeters simultaneously to measure active energy expenditure (EE) during the main wake episode and nighttime rest efficiency. A second sample of ten healthy young adults wore an EE monitor for 7 days before a polysomnography night. Two-tailed Pearson correlations were conducted between EE and sleep variables.

Ambulatory rest efficiency correlated with vigorous EE ($r = 0.64$, $p = 0.02$) and vigorous activity time ($r = 0.67$, $p = 0.02$). SWS and REM sleep correlated with moderate activity time ($r = 0.68$, $p = 0.03$ and $r = 0.63$, $p = 0.05$ respectively). Positive correlations were found between physical activity and spectral power in low frequency bands: 0.5–1 Hz correlated with moderate activity time (P2: $r = 0.68$, $p = 0.03$) and sustained EE (O2: $r = 0.66$, $p = 0.04$), and 1–4 Hz correlated with sustained EE (O2: $r = 0.69$, $p = 0.03$) and sustained activity time (O2: $r = 0.66$, $p = 0.04$). Spectral power in higher frequency bands correlated negatively with physical activity: 8–14 Hz correlated with sustained activity time (Fp1: $r = -0.81$, $p < 0.01$, Fp2: $r = -0.71$, $p = 0.02$) and sustained EE (Fp1: $r = -0.70$, $p = 0.02$).

Habitual physical activity integrated into an active lifestyle may promote better sleep quality through enhanced sleep consolidation, higher SWS and REM sleep and enhanced synchrony of the sleep EEG. Importantly, our data suggest that even moderate activity is linked to better sleep. As opposed to acute interventions, habitual physical activity patterns integrated over long periods may facilitate sleep promotion mechanisms.

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USING SOCIAL MEDIA FOR RESEARCH COMMUNICATION: SHOULD SLEEP RESEARCHERS BOTHER?

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Introduction: Social media has been touted as a powerful tool for research communication. Social networking sites and microblogs are increasingly used by health professionals and advocacy groups and research blogs in variety of fields have proliferated in recent years. However the value of these online tools for communicating research, raising awareness, and engaging the public are still unclear. The aim of this case study was to explore the relative costs and benefits of communicating sleep research using social media to a lay audience.
Methods: We created a sleep research blog and an associated Twitter account and maintained these over the 12 months from September 2011 (to September 2012). The blog posts were based on sleep research papers and were designed to be entertaining and/or timely and targeted towards a general audience. Posts averaged 700 words in length and were uploaded regularly every 2–3 weeks. The Twitter account was used daily to post links to sleep-related news stories, to announce blog posts, and to converse with other users on general issues around sleep and research. The reach of these activities were evaluated through the number of visitors to the blog and the number of 'followers' gained on Twitter. The impact of these activities was evaluated by the number of click-throughs on links sent through tweets, the number of 'retweets', and the number and valence of reader feedback on blog posts.
Results: Preliminary results from the first 6 months of this project show that blog posts were well-received and comments were overwhelmingly positive but readership was low (in the order of 10^1 views). Messages sent using Twitter had a large potential reach (in the order of 10^5) and the number of 'followers' grew linearly over time. In contrast, dedicated interest in the content provided remained relatively constant (retweets and clicks were both in the order of 10^1).
Conclusions: Social media offers flexibility, control, and ease of use for researchers wanting to communicate their work to the public. However there are significant trade-offs in the time and effort required to maintain an active online profile.

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SLEEPINESS AND THE BURDEN OF COMORBIDITIES IN A POPULATION SAMPLE OF MEN

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Introduction: Sleepiness and its relationship with sleep disordered breathing and chronic disease is unclear at a population level.
Methods: We determined the prevalence of sleepiness and related comorbidities in a population-based cohort of men aged over 40 yrs (MAILES) (n = 1869). The Epworth Sleepiness Scale (ESS) and Pittsburgh Sleep Quality Index (PSQI) was administered in men (n = 846) who did not have a previous diagnosis of OSA and underwent full in-home unattended polysomnography (Embletta X100) scored by current AASM (alternate) criteria.
Results: Day time sleepiness (Epworth ≥10) was present in 17.7% (150). Mean age was 58.0 (SD = 10) compared with 60.0 (SD = 11) in non-sleepy men ($p = 0.03$). Sleepiness was significantly associated with PSQI > 5 (adjusted OR, 95% CI: 1.78, 1.22–2.60), but no associations with OSA (AHI ≥ 10), oxygen desaturation index or socio-demographic factors were observed. Sleepiness was significantly associated with

depression (age adjusted OR: 2.40, 1.53–2.77) lower urinary tract symptoms (LUTS, OR: 1.83, 1.23–2.71) and abdominal obesity (waist to hip ratio >1.0, OR 1.43, 1.00–2.07). As shown in the table, the presence of OSA exacerbates the rates of comorbidities including hypertension, diabetes and the metabolic syndrome (MetS).

	ESS < 10		ESS ≥ 10		
	AHI < 10	AHI ≥ 10	AHI < 10	AHI ≥ 10	Chi^2 p
diabetes	8.1 (27)	14.7 (54)	10.6 (7)	19.3 (16)	0.01
MetS	33.6 (111)	48.3 (168)	30.3 (20)	59.8 (49)	<0.01
LUTS	23.9 (79)	21.9 (77)	35.9 (23)	32.5 (26)	0.04
hypertension	46.6 (153)	63.2 (220)	41.5 (27)	66.3 (55)	<0.01

Discussion: There is a significant burden of untreated day time sleepiness in men aged over 40 years that was related to depression and LUTS and is. The comorbidity burden is increased with men with sleepiness and concomitant OSA.

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TARGETING SLEEP PROBLEMS AND ANXIETY IN CHILDREN WITH HIGH FUNCTIONING AUTISM

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Introduction: Evidence shows that children with High Functioning Autism have greater levels of anxiety and worry than their typically developing peers. These same children are also known to suffer from higher levels of sleep disturbance throughout their developmental years. What is generally overlooked is the interaction between sleep and anxiety in this population of children. Although it is widely accepted that the causes of anxiety in autism are idiosyncratic to the disorder, anxiety is generally assessed through the use of questionnaires primarily designed for typically developing children. Here, we used a novel comic strip task specifically designed to assess anxiety in children with autism; exploring it's interaction with sleep disturbance.
Method: Participants were 6–10 year old children with High Functioning Autism who were compared to both chronological and mental age matched controls. The Child Sleep Habits Questionnaire and sleep diaries were used to assess sleep disturbance (actigraphy watches were used in a subset of the sample to validate findings.) The Spence Children's Anxiety Scale and the Worry Comic Strip Task were used to assess anxiety.
Results: As expected, the autistic group showed higher levels of anxiety than the control group and this was linked to the level of observed sleep disturbance.
Conclusion: These findings demonstrate the necessity to acknowledge anxiety as a prominent and challenging feature of autism. Furthermore, the widespread effect of anxiety on other aspects of the child's life, notably sleep quality, needs to be appreciated.

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SLEEP SPINDLE ACTIVITY AND COGNITIVE FUNCTION IN HEALTHY CHILDREN

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Introduction: Sleep spindles have been argued to function as a mechanism through which long term changes are made in the neocortex. They are also thought to play an important role in the consolidation and reorganisation of memories, and research has shown spindles to be associated with the offline consolidation of declarative and procedural memory, full scale and fluid intelligence. However, few studies have examined the role of sleep spindles in populations of normal children. As childhood sleep patterns and development likely form one of the foundations of adult cognitive life, it is important that this area be explored. This study aims to assess the association between sleep spindles and cognition in healthy children.
Method: Participants underwent a single night of overnight polysomnography in a hospital sleep laboratory after completing measures of intelligence and neurocognitive functioning. Sleep spindles were visually identified by an experienced sleep scoring technician and separated algorithmically into fast (>13 Hz) and slow spindle (<13 Hz) categories.
Results: Data for 27 healthy children was used in analyses (mean age 8.19 years; 14 female, 13 male). Total number of fast spindles was significantly correlated with narrative memory and sensorimotor functioning. Mean central frequency of spindles was negatively correlated with sensorimotor functioning ($p < 0.05$), planning ability ($p < 0.05$) and working memory ($p < 0.005$).
Conclusions: Basal sleep spindle activity is associated with different aspects of cognitive functioning in children; however the direction of association differs from that reported in adult populations. These differences in associations between adult and paediatric populations further support the idea of sleep playing an important developmental role.

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A NOVEL CONTINUOUS MULTISITE ACCELEROMETRY SYSTEM DISCRIMINATES SLEEP FROM WAKE BETTER THAN A COMMERCIAL ACTIGRAPH

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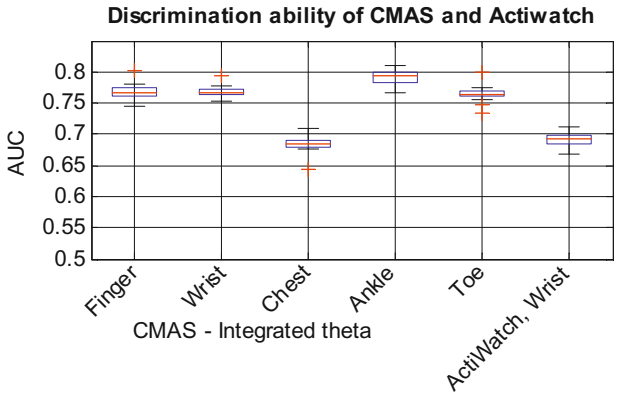
Introduction: Actigraphy has proven to be a useful tool in sleep medicine because of its ability to non-invasively classify sleep and wake states. However, conventional actigraphs have a number of limitations – in particular, they have poor sensitivity for detecting wake during sleep periods. We hypothesised that a novel Continuous Multisite Accelerometry System (CMAS) which records 100 Hz tri-axial

accelerometry data at the left wrist and middle finger; left ankle and great toe; and the sternal notch, would discriminate sleep from wake better than a conventional commercially available actigraph.
Methods: Fourteen paediatric participants aged 5–15 years (median 7 years) with suspected sleep apnoea were studied using polysomnography, CMAS, and a commercial actigraph (Actiwatch® Mini Motionlogger) on the left wrist. Four time domain features were calculated from each accelerometer, and their ability to discriminate sleep from wake on a 30 second epoch basis (as defined by manual scoring of the polysomnogram) was assessed using the Area Under receiver operating characteristic Curve (AUC).
Results: When analysed using integrated angle of accelerometer rotation (integrated theta), the ankle accelerometer had the best sleep/wake discrimination ability with a mean AUC of 0.792 ($P < 0.001$). The finger, wrist, ankle and toe accelerometers performed better than Actiwatch activity counts ($P < 0.0001$), which achieved a mean AUC of 0.692. At an operating point with specificity = 0.8, sensitivity for wake was 0.74 and 0.58 with CMAS and Actiwatch respectively.



Conclusion: The CMAS system achieved improved sensitivity for wake when compared with the conventional actigraph, and the analysis algorithms are applicable to any hardware which records raw tri-axial accelerometry. CMAS has the ability to improve actigraphy performance in sleep medicine and research applications where detection of wake periods during sleep is important.

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THE IMPACT OF THE NEW AASM 2007 SCORING CRITERION ON POLYSOMNOGRAPHIC APNOEA-HYPOPNEA INDEX IN A SLEEP CLINIC POPULATION

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Introduction: The American Academy of Sleep Medicine (AASM) published a new manual for scoring sleep studies in 2007. There is little literature about the effect of these new criteria on Apnoea-hypopnea index (AHI) and hence, classification of sleep apnoea severity.
Study Objectives: To assess the impact of using the two new 'Recommended' and 'Alternate' AASM 2007 scoring criteria on PSG AHI (AHI_{rec} and AHI_{alt}) relative to the 1999 AASM criteria. (Also known as Chicago criteria, AHI_{chi}).
Methods: PSGs of all patients studied in the Canberra Hospital laboratory between 1/7/2010 and 31/12/2010 were re-scored for AHI using the new AASM 2007 recommended and alternate criteria and the results compared with the AHI obtained at the time using the old Chicago criteria. Friedman tests along with Chi square tests were employed using SPSS V19.0.
Results: 82 consecutive patients were included in the study. The average age was 51.3 years (SD = 13.6) with average BMI of 34.5 (SD = 9.1) with 57.3% being male. The median AHI_{chi} was 30.5/hr. (IQR 11.3–71.6) compared with median AHI_{rec} 16.2/hr. (IQR 4.0–61.1) and median AHI_{alt} 28.4/hr. (IQR 9.7–70.8). ($P < 0.0001$). 51.2% (42/82) were considered to have severe OSA on the Chicago criteria while only 36.6% (30/82) and 46.6% (39/82) were classified as severe on the recommended and alternate criteria respectively. ($P_s < 0.0001$). Furthermore of those staged as mild OSA by the Chicago criteria 57.1% (8/14) were normal when scored by the recommended criteria and 14.3% (2/14) by the alternate criterion respectively. ($P < 0.0001$).
Conclusion: Using AASM 2007 hypopnea definitions leads to marked shifts in AHI. This shift is not a simple recalibration of the severity cut off categories. The two new scoring criteria gave results for AHI which were different from each other and independent of the results obtained by the Chicago criteria. This implies that a new severity scoring scale based on the new criteria needs to be developed.

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CONCORDANCE OF SLEEP DATA BETWEEN ACTIGRAPHY, SENSEWEAR AND POLYSOMNOGRAPHY

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Introduction: Portable devices, wrist actigraphy and Sensewear armband are increasingly used in sleep research, although polysomnography (PSG) remains the reference measurement. In this study, the concordance of the Actiwatch 2 (AW, Respironics) and Sensewear (SW, BodyMedia) data with PSG was evaluated for commonly used sleep indices – Sleep Onset Latency (SOL), Wake after Sleep Onset (WASO), Total Sleep Time (TST) and Sleep Efficiency (SE).
Methods: Nine subjects (23.3 ± 4.1 years of age) were studied for each of 9 nights in random order, after an adaptation night, and under three defined ambient temperature conditions (17°C, 22°C and 29°C). They wore both AW and SW while PSG was being simultaneously recorded.
Results: Generally, moderate to large correlations ($0.49 < r < 0.91$) were observed between the measures (AW, SW) and PSG. For SOL, correlations were mid-range (AW: $r = 0.61$; SW: $r = 0.52$), although there was some evidence of temperature dependency of the difference between SW and PSG estimates of SOL. For WASO, the correlations were moderate to strong (AW: $r = 0.73$; SW: $r = 0.49$), similar to that observed for TST (AW: $r = 0.72$; SW: $r = 0.54$). For SE, the correlations were much stronger (AW: $r = 0.91$; SW: $r = 0.83$). Bland Altman plots for the comparisons were derived, as a widely practiced means of representing the degree of agreement of the techniques. Given some evidence of level-dependent differences between the techniques, care needs to be used in interpreting the Bland-Altman-derived assessment of relative agreement.
Discussion: In this pilot study, AW demonstrated a higher level of agreement with PSG than SW for all sleep indices assessed, and it appears SW measures may be influenced by ambient temperature conditions. This may possibly reflect the differing principles of

measurements for the devices, where AW detects sleep based on wrist movement whereas SW detects sleep based on skin temperature, heat flux, skin conductance and movement. Overall, while the results presented suggest a good level of concordance of the measures assessed and PSG, complexities have been observed, and suggest the need for further research.

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COMPARISON OF THE TWO AASM 2007 EOG ELECTRODE PLACEMENTS: IMPACT ON REM SLEEP STAGING

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EOG measurement during polysomnography (PSG) is important for the identification of rapid eye movements (REMs) seen during REM sleep. The AASM recommendations allow for two alternate EOG electrode placements. These placements are known to record eye movements differently, however there is no published data assessing their impact on sleep staging, particularly REM. Aim: To evaluate the accuracy and reliability of REM sleep scoring using the two EOG electrode placements. Methods: 40 consecutive PSGs were scored by 4 experienced scorers from 3 Australian clinical sleep laboratories. Each scored separate sets of 10 PSGs twice, once using each montage (Rec and Alt). To examine the impact on inter- and intra-scorer reliability, all 4 scorers scored a randomly selected subset of 10 PSGs 4 times, twice using each method. All PSGs were de-identified and scored in random order. Results/Discussion: Mean (standard deviation (sd)) relative accuracy is shown in Table 1 and a summary of reliability is shown in Table 2.

Table 1. Relative accuracy of REM staging

	Method			
	Alt	Rec	Alt-Rec	p value
REM (min)	37.9 (29.6)	35.6 (30.1)	2.3 (7.5)	0.06

Table 2. Mean reliability of REM staging

REM (min)	Alt	Rec
Intra-scorer reliability	0.3 (1.7)	0.3 (4.4)

All diff's were not statistically significant.

Although the overall mean values are similar, approximately 8% of studies had a mean difference of >15 minutes with a mean (std dev) difference of 21.8 (3.3) minutes. Intra-scorer variance (sd) for Rec is more than twice Alt (1.7 vs 4.4) suggesting that Alt is more reliably scored than Rec, although further analysis of this is required to verify significance. Conclusion: There is a trend toward a small increase in REM sleep being detected and for scoring reliability improvement using the AASM-Alternate EOG electrode placement. The subset showing greater method differences requires further investigation to elucidate causes and clinical significance.

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PERFORMANCE CHARACTERISTICS OF 2 RADIOMETER TRANSCUTANEOUS CO2 (TCCO2) ELECTRODES

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Radiometer recently released a new transcutaneous electrode with claimed improved performance. There is, however, no published data comparing the performance of this new electrode (model 54) with the old electrode (model E5260).
Aims: To evaluate 1) accuracy, 2) calibration stability, 3) response time and 4) equilibration time of the new and old Radiometer tcCO2 electrodes.
Methods: Accuracy and calibration stability data were obtained retrospectively from 178 consecutive PSGs incorporating tcCO2 monitoring and arterial blood gas sampling evening and morning. Accuracy was expressed as the difference between transcutaneous and arterial CO2 values (ΔCO2tc-a), and calibration stability as the change in ΔCO2tc-a from evening to morning. Equilibration and response times were measured in a separate experiment in 2 normal subjects. Equilibration time was measured as the time from electrode application to 95% of the stabilised value, during stable breathing. Response times (5–95%) were measured from a step change in CO2 obtained by sudden recovery from rebreathing (peak tcCO2 > 55 mmHg).
Results:

	Electrode Type				
	New		Old		
Accuracy (mmHg)	Mean (SD)	Range	Mean (SD)	Range	p value
Evening	−0.5 (3.0)	−6.4, +21	+3.3 (7.4)	−24.9, +19	0.001
Morning	−2.5 (3.9)	−14, +7	−2.1 (9.5)	−23, +24	0.78
Calibration Stability (mmHg)	−2.1 (4.8)	−25, +10	−5.5 (8.0)	−21, +17.5	0.01

Electrode Type	Average Equilibration time (sec)	Average Response time (sec)
OLD	136.8	170.3
NEW	599	296

Conclusion: The new electrode was significantly more accurate than the old electrode showing lower mean and range of errors across subjects. There was also significantly less calibration drift for the new electrode. The new electrode showed an approx. four-fold increase in equilibration time and almost two-fold increase in response times compared to the old electrode. The implications of the slower response time on PSG measurements of CO2 requires further investigation.

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CALCULATION OF MEASUREMENT UNCERTAINTY IN COMMONLY DERIVED PSG STATISTICS

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It is understood that all polysomnographic (PSG) measurements have a certain amount of imprecision. This imprecision can be attributed to a combination of random, systematic and spurious effects. There are no data describing the measurement uncertainty of even commonly derived PSG measurements, such as Apnoea-Hypopnoea Index (AHI), Total Sleep Time (TST), and Arousal Index (AI). Six PSG's recorded according to the ASTA/ASA guidelines were chosen to represent the AHI spectrum from approximately 4/hr up to approximately 95/hr. This was to enable discernment of proportional error across the spectrum. The PSG's are recorded in a standardised fashion to reduce all possible sources of error. All six PSG's were de-identified and scored twice each by ten experienced scorers in random order. Usual measures of inter-scorer variability were calculated, such as Fleiss kappa and proportion of specific agreement (PSA). Standard uncertainty was calculated by combining the relative standard uncertainty of the inter-scorer imprecision and the relative standard uncertainty of the intra-scorer imprecision and multiplying this to the true value (taken as the mean of all scorers). The standard uncertainty was then multiplied by 2 to give the expanded uncertainty with a confidence range of 95%. Despite there being substantial agreement for sleep scoring (kappa 0.72 ± 0.04) and respiratory event and arousal scoring (PSA 0.75 ± 0.05 and 0.85 ± 0.05 respectively), the measurement uncertainty was proportional to the AHI magnitude (see table left). This is the first study to report on the measurement uncertainty for PSG statistics. The calculation of measurement uncertainty is useful in providing an objective assessment of the quality of PSG statistics between laboratories. It can also be used as a starting point for reducing measurement variability through improving and clarifying various rules for the scoring of PSGs.

Study	Mean AHI	Expanded Uncertainty	Confidence Interval
1	4.0	2.0	2.0–6.0
2	9.5	3.6	5.9–13.1
3	20.3	5.4	14.9–25.7
4	30.2	6.8	23.4–37.0
5	62.6	8.6	54.0–71.2
6	94.4	16.6	77.8–111.0

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A QUALITY ASSURANCE PROGRAM FOR POLYSOMNOGRAPHY

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Introduction: Polysomnography (PSG) deals with large volumes of recorded data from a multitude of channels over an 8 hour period, with the added complication of substantial variability of signals across the night related to both biological and equipment factors. Early detection of equipment issues would improve overall signal quality but requires a quality assurance program (QAP) that continuously monitors PSG signal quality. As there are few QAPs for PSG signals described in the current literature, we have developed a continuous feedback QAP to detect equipment related issues that reduce PSG signal quality.
Aim: To describe a QAP developed for PSG signal quality that enables early detection of systematic signal problems related to equipment factors.
Methods: For each PSG recorded, equipment and sensors were identifiable through an allocated bed number (n = 6). Following scoring of each PSG, scientists rated the quality of each PSG signal using a predetermined scoring system to provide an overall signal quality of each PSG study (rating from 0–100%) and noted any individual signal problems. Data were analysed by combining the quality rating of all studies to give an average signal quality for each one month period and reviewed in a monthly meeting.
Results: Signal quality data from January 2010 to May 2012 were analysed (1355 studies), with an overall signal quality of 90.4 ± 2.0% (mean ± SD). The trend of the monthly average signal quality has identified periods of poor signal quality and made appropriate interventions possible including timely replacement of faulty equipment and staff in-service training. Linear regression analysis of the monthly SD's of the mean signal quality over 29 months did not demonstrate any significant change ($r^2 = 0.07$; $p = 0.17$).
Conclusion: This QAP for PSG signal quality has demonstrated that intermittent episodes of reduced signal quality can be detected as a change from baseline signal quality. In addition, over a 29 month period, we have demonstrated that overall signal quality and variance has been maintained. The QAP for PSG signal quality is an important component of a sleep laboratory continual improvement program.

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A COMPOSITE MEASURE OF SLEEP FRAGMENTATION MEASURES IN CHILDREN WITH SLEEP DISORDERED BREATHING

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Sleep fragmentation (SF) has been linked to a myriad of cognitive, behavioural and health problems in children and adults. Sleep Disordered Breathing (SDB) is known to cause SF. The measurement of SF in children with SDB has yet to be accurately formulated. Several inherent problems contribute to the resolution of this, including 1) the variable nature, symptoms and severity of the disease, 2) the variable nature of the adaptive responses to the disease, 3) the variable developmental changes occurring in the subjects and 4) the variable fragmentation of sleep caused by the measurement of sleep variables in standard clinical polysomnograms (PSG). We hypothesise that a combined (or composite) index of various known and novel indices of SF would more accurately measure the disruption of sleep in children with SDB.
Methods: Subjects were 92 primary school aged children [48 controls, 23 primary snorers and 21 with Obstructive Sleep Apnoea Syndrome (OSAS)]. We analysed the correlations and interactions of known SF measures to build a composite SF index that takes into account these variables. We then compared this composite index to other individual indices for its ability to discriminate between children grouped by SDB severity. We also compared correlations between this and other indices and known important daytime cognitive and behavioural outcomes of SDB.

Results: The composite index more accurately discriminated between groups of children with varying severities of UAR ($p < 0.05$) than any of the trialled indices. The composite index also correlated with important neurobehavioural outcomes better than any of the trialled indices ($p < 0.05$).
Discussion: A composite index may be a useful tool in diagnosing children at risk of negative outcomes caused by SDB. It appears particularly useful in identifying children with what are traditionally considered mild symptoms that are at an increased risk of negative sequelae. A composite index also allows for a reduced PSG montage and hence less sleep disruption from the measurement process itself.

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COMPARISON OF THE RECORDING OF LEG MOVEMENTS DURING POLYSOMNOGRAPHY USING THE PIEZO MOVEMENT SENSOR AND ANTERIOR TIBIALIS ELECTROMYOGRAM

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Introduction: The measurement of leg movements is an integral part of the standard polysomnographic investigation. The Sleep Disorders Laboratory at the Royal Adelaide Hospital has traditionally used piezo movement sensors to detect movement of the legs. In 2007 the American Academy of Sleep Medicine (AASM) issued new guidelines for the measurement of limb movements which use a surface electromyogram (EMG) to record muscle activity in the anterior tibialis muscle. The purpose of the study is to establish if the recordings of leg movements using the laboratory standard piezo movement sensors provide a comparable measurement to leg EMG signals which are recommended by the new AASM guidelines.
Methods: 44 consecutive patients underwent diagnostic polysomnograpy for assessment of suspected sleep related breathing disorder. As part of the investigation anterior tibialis muscle movement was simultaneously measured with piezo sensors and leg EMG. Each measurement method was analysed by an experienced scientific officer using the 2007 AASM criteria. We compared periodic limb movements in sleep index (PLMSI) and number of leg movements per hour during the sleep time. The outcome measures were compared by Wilcoxon signed rank test. The study had 80% power to detect a difference of 10/hr with a standard deviation of 24/hr (paired t-test).
Results: There were 24 male and 20 female patients, aged 50 ± 15 years (mean ± SD) with BMI of 35 ± 9 kg/m2 and Epworth Sleepiness Scale score of 10 ± 10. There was no significant difference in the PLMSI measured using piezo sensors 1.2/hr; 0.0–9.7/hr (median; interquartile range) and leg EMG 0.9/hr, 0.0–8.6/hr ($p = 0.47$). Similar results were obtained for total leg movements per hour of sleep measured with piezo sensors 30/hr; 9–73/hr and leg EMG 28/hr; 4–74/hr ($p = 0.30$). Two (of 8) patients with PLMSI more than 15/hr with piezo sensors had an index less than 15/hr with leg EMG. One (of 7) patients with PLMSI more than 15/hr with leg EMG had an index less than 15/hr with piezo sensors.
Discussion: In this study piezo leg movement sensors were not different to the AASM recommended leg movement EMG sensors for measuring PLMSI and leg movements during a standard polysomnogram.

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VALIDATION OF AN AUTOMATED INSPIRATORY SNORE DETECTION AND ANALYSIS SYSTEM

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Introduction: Snoring is a common consequence of increased upper airway resistance during sleep. Emerging data are highly suggestive of an independent role for snoring in the pathogenesis of chronic cardiovascular diseases including stroke and carotid atherosclerosis, making the quantification of snoring an important outcome variable from polysomnography (PSG). Snoring is a low frequency vibratory sound which predominantly occurs during inspiratory flow limitation. We have developed an automated snore sound detection and analysis system, which can quantify inspiratory snores.
Aim: To validate an automated inspiratory snore sound detection and analysis system against gold standard manual inspiratory snore counting.
Methods: Ten diagnostic PSG study records, each with a calibrated room sound level meter (Rion NL20) signal channel, were selected for analysis. The manual snore count was undertaken for each epoch, where a snore was defined as an obvious sound channel signal deflection above baseline in phase with inspiration (as determined using from the nasal pressure trace signal). The automated inspiratory snore detection system analysed each epoch using the nasal pressure trace to detect inspiration and the sound channel for snores. Snores were counted when the sound level during inspiration exceeded noise background levels.
Results: The Snore Index for manual scoring was 351.2 ± 334.8 snores/hr (mean ± SD), which was not different to automatic scoring (354.0 ± 349.7 snores/hr; $p = 0.76$). The difference between manual and automatic scoring expressed as a percentage of the manual score was −2.4 ± 9.1%. Linear regression analysis demonstrated a significant linear correlation (Slope = 0.95; $r^2 = 0.99$; $p < 0.0001$) between manual and automatic scoring.
Conclusion: Automatic inspiratory snore detection and counting results in a Snore Index which is not different from manual snore counting.

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HEART RATE VARIABILITY CORRELATES WITH SEVERITY OF OBSTRUCTIVE SLEEP APNOEA

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Introduction: The risk of cardiovascular disease has been well established in patients with untreated obstructive sleep apnoea (OSA). The underlying mechanism has been attributed to the changes in sympathetic tone secondary to repetitive intermittent hypoxia occurred during observed hypopnoeic/apnoeic episodes. Heart rate variability (HRV) represents autonomic cardiac dysfunction related to respiratory events during these episodes.

Methods: We studied 60 consecutive overnight polysomnographies of patients attending our multidisciplinary sleep clinic from July 2011 to March 2012. We calculated HRV by measuring beat-to-beat variability between minimum and maximum overnight heart rate.
Results: The study population has higher number of males and severe OSA patients [43 male, 39 severe OSA, mean (95% CI) age 47.2 (3.8), BMI 34.9 (2.2), AHI 44.3 (7.3)]. Our study showed a positive correlation between HRV and severity of AHI, r = 0.122, p value = 0.004, controlling for age and BMI [mean differences (95% CI) between mild-moderate vs. severe group, age 46.8 (7.5) vs. 47.4 (4.3), BMI 33.9 (4.7) vs. 35.3 (2.3)].
Discussion: In patients with OSA, HRV correlates with severity of AHI reflecting worsening autonomic cardiac dysfunction in the most severe patient. This possibly relates to severity of intermittent hypoxia and more frequent arousal during sleep. Further studies are required to assess the effect of treatment in reversing these observed changes.

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THE STATE OF A NATION: CERTIFICATION, RECERTIFICATION AND CONTINUING EDUCATION OPPORTUNITIES FOR SLEEP TECHNOLOGISTS IN AUSTRALIA

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Introduction: Australia does not currently have a system for registration of sleep technologists. This has resulted in some Australian sleep scientists seeking United States registration, which uses US based techniques and training programmes. These certifications, Registered Polysomnographic Technologist (RPSGT) and Registered Sleep Technologist (RST) require proof of continuing education for maintenance of the qualification. Prior to the establishment of a local credentialing team, there was no body to recognise continuing education programs in Australia to fulfil this requirement. We reviewed the impact of the establishment of a credentialing team on the opportunity for accredited continuing education for sleep technologists, as well as the impact of recertification on the numbers of RPSGT's in Australia.
Methods: To determine the amount of continuing education available, applications made to the Continuing Education Credit granting committee of ASTA were reviewed. Tracking of registered technologists was performed at regular intervals using online publicly available lists of RPSGT's and RST's. Individuals who had previously held a credential but no longer appeared as being registered were identified as being lapsed registrants.
Results: Since the establishment of the CEC granting committee in 2009, 242 hours of educational activity has been certified as being suitable for continuing education for sleep technologists under RPSGT requirements. The recertification requirement has resulted in a lapse in registration for more than a third of Australian RPSGT's (145 to 91). There are currently 12 RST's, all of which are also current RPSGT's.
Discussion: With increased knowledge of the availability of accreditation of educational opportunities, growth in the number of applications was expected. Further growth is anticipated.

A degree of natural attrition of registered sleep technologists is expected due to retirement or change of career. Only those who agreed to have their name publicly listed were included in analysis. Whether this reduction of registered technologists is an ongoing phenomenon remains to be seen but will continue to be monitored. An Australian based model of education and certification may improve these numbers.

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IDENTIFICATION OF FACTORS THAT INFLUENCE CANCELLATION OF SLEEP STUDY BOOKINGS

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Introduction: Information gathered from 100 Patients (68 male, 32 female) who cancelled their sleep study bookings was reviewed to determine if there are characteristics that can be used to identify those patients most likely to default in their appointments, and also assist in devising strategies to minimize cancellations.
Method: Information was obtained from prior sleep study data, hospital paperwork, pre-assessment questionnaires and stated reason for cancelling. Patients were distributed into three groups by source of referrals: GPs, Physicians and ENT Surgeons. Preliminary descriptive statistics were generated followed by further split-file analyses.

Preliminary descriptive statistics highlighted the greatest predictors of cancellation as being the referral source, ESS score, patient's demographics, and employment status. A further split-file comparison grouped patients into those who rebooked at a later date and those who did not. Patients referred by ENT Surgeons had the highest cancellation rate (16.2%), followed closely by GP-referred patients (13.5%). However, patients referred by GPs had the highest rebooking rate (47.6%) vs those from ENT Surgeons (33.3%). An ESS score of <9 was a stronger predictor of rebooking a study than a score >10. Patients who live north and north east of the Adelaide CBD made up 57% of those who cancelled. Unemployed patients and those in managerial roles had significantly higher cancellation rates (both 13%) when compared to other employment groups. The data also indicated that patients booked for diagnostic studies are more likely to rebook at a later date (63.5%) than those booked for CPAP studies (19%).
Discussion: The data highlighted that referrals from ENT Surgeons have a lower rate of rebooking their sleep studies than patients referred by GPs. In addition, patients referred for CPAP studies are less likely to rebook than those referred for diagnostic studies. This study highlights the need for increased training of ENT Surgeons and GP referrers in the education of patients about the significance of sleep studies. Further, patients may also benefit from increased education at the time of their diagnostic sleep study, as well as post-study education from their doctors regarding the benefit of CPAP therapy.

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MAXIMISING SLEEP EFFICIENCY FOR OVERNIGHT DIAGNOSTIC POLYSOMNOGRAPHY FOR PRE-SCHOOL AGED CHILDREN IN A TERTIARY PAEDIATRIC SLEEP CENTRE

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Introduction: Minimising the 'first-night effect' in paediatric patients undergoing overnight diagnostic polysomnography (OPSG), particularly their (in)tolerance of nasal cannulae (NC), presents an ongoing challenge in the diagnosis of sleep breathing disorders in children. We evaluated the provision of NC to some children aged 2–5 years for play

purposes prior to OPSG to assess any influence on sleep efficiency (SE) in our laboratory.

Methods: We prospectively enrolled 197 children undergoing OPSG in 2011. They were divided into 4 age subgroups; 0–2 years (yrs), 2–5 yrs, 5–10 yrs and over 10 yrs. A questionnaire designed to establish whether NC were provided with intended use instructions for a period of 2 weeks or more prior to OPSG was undertaken. Answer options included receipt of NC, and subsequent child's response: immediate rejection of NC as a play and placement option, played with and sited on 1–3 occasions, or played with and sited on >3 occasions. All involved sleep physicians were blinded to the study.

Results: For all OPSG divided by age sub-groups is provided in tabular form below:

Age	0–2 yrs N = 35	2–5 yrs N = 67	5–10 yrs N = 60	>10 yrs N = 35
SE	80%	84%	82%	83%

For children aged 2–5 yrs:

Opportunity for pre OPSG playtime with NC N = 18	NC Rejected N = 9	NC Played and Sited >1 N = 9
Sleep Efficiency	74%	86%

Results did not reach statistical significance.

Discussion: Achieving high levels of sleep efficiency remains a goal of all paediatric sleep units, particularly in the pre-school age group. The provision of NC for pre-OPSG is an innovative attempt to ameliorate potential distress in this group. Refusal to participate in play with NC prior to OPSG may assist in identifying a subgroup of infants and children who may require further support and encouragement to successfully undergo OPSG.

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SLEEP DISTURBANCE DURING LATE PREGNANCY IN NEW ZEALAND WOMEN

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Introduction: Disruption to sleep during pregnancy is not uncommon. In the third trimester factors including having to go to the bathroom and discomfort associated with the increasing size of the foetus and uterus, as well as pain, being too hot or cold, restless legs syndrome, leg cramps, heartburn and carpal tunnel pain have been associated with disturbed sleep[1,2,3]. The current study investigates sleep disruption in New Zealand women during late pregnancy.

Method: As part of the *E Moe, Māmā: Maternal Sleep and Health in Aotearoa/New Zealand* study investigating sleep across late pregnancy and early post-partum, questionnaires were completed by women (n = 1091; 16–46 yrs) between 35–37 weeks gestation. Participants identified the number of nights in the last week that potential sleep-disrupting factors occurred (scale 0–7 nights), with ≥3 nights/week considered as frequent.

Results: The majority of women (89.3%) reported going to the bathroom disturbing sleep ≥3 nights in the previous week. The next most common factors (≥3 nights) were not being able to get comfortable (68.6%), pain in back/neck/joints (66.0%), and baby moving around (baby kicking) (59.3%). Other frequently cited reasons (≥3 nights) included feeling too hot or cold (51.0%), thinking or worrying about things (48.5%), just can't get to sleep (46.7%), dreams (36.4%), and heartburn (35.9%). In the National Sleep Foundation Poll (NSF, 2007) women in their 3rd trimester most often identified sleep being disturbed by needing to go to the bathroom (92%), pain in the back, neck or joints (66%), leg cramps (54%) and/or heartburn (51%), whilst Mindell and Jacobson (2000) reported women had difficulties falling asleep and staying asleep at 35–38 weeks of pregnancy due to factors including needing to go to the bathroom (94.6%), uncomfortable position (78.4%), aching/one position (54.1%), thoughts (45.9%), and sleeping not in a usual position (45.9%).

Discussion: Needing to go to the bathroom and pain commonly disturb sleep in late pregnancy, as well as other physical and psychological factors that may vary in prevalence across populations. As there is a high likelihood that sleep quality will be compromised in the third trimester of pregnancy due to sleep disruption, it is important that women are informed of this and supported to prioritise sleep.

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DAYTIME SLEEPINESS, MOOD AND ANXIETY DISORDERS IN AUSTRALIAN WOMEN

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Objective: There is substantial evidence supporting a bi-directional relationship between non-restorative sleep and poorer mental health outcomes, but little is known about the effects of increased daytime sleepiness, and the role it may have the in the aetiology of mood and anxiety disorders. The current study aimed to determine the association between self-reported excessive sleepiness and the prevalence of both current and past instances of mood and anxiety disorders in a population-based sample of Australian women.

Methods: Of the 1095 women who participated, those who had missing data (n = 20), or who were using antidepressant medication (n = 131) were excluded from the analysis. This resulted in a final sample of 944 eligible women aged between 20–97 years (median 49 IQR 33–65). The presence of mood or anxiety disorders was assessed by the Structured Clinical Interview for DSM-IV Axis 1 Disorders (Non-Patient) (SCID-I/NP). Sleepiness was assessed using the Epworth Sleepiness scale (ESS), and cut-off points were determined using previously established clinical range. Scores ranging from 0–9 was considered in

the normal range, and scores ≥10 were considered to indicate high levels of sleepiness.
Results: The overall age-standardised prevalence of abnormal levels of subjective sleepiness was 13.2%. The age-specific prevalence for each group was 13.0% (20–29 yr), 8.2% (30–39 yr), 16.9% (40–49 yr), 16.2% (50–59 yr), 11.9% (60–69 yr), 11.0% (70–79 yr) and 14.7% (80+ yr). High levels of subjective sleepiness were associated with an increased risk for both current (OR = 2.1, 95% CI 1.1–4.1) and lifetime history (OR = 2.0, 95% CI 1.3–2.3) of mood disorders, independent of age and alcohol consumption. These findings were not explained by sedative use, BMI, physical activity, smoking, or SES. No association was found between high levels of subjective sleepiness and current (OR = 0.9, 95% CI 0.4–2.0) or lifetime history (OR = 1.2, 95% CI 0.7–2.21) of an anxiety disorder.
Conclusion: These results provide insight into sleep disturbance and sleepiness and their association with current and lifetime risk of mood disorders, but not anxiety. These findings are consistent with previously established population-based and clinical research that demonstrates the role of poor sleep and subsequent daytime sleepiness as a possible proxy factor for poorer mental health outcomes.

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DOES ACTIVITY CHANGE WITH SLEEP RESTRICTION IN A CONTROLLED ENVIRONMENT?

RELATIONSHIPS BETWEEN ACTIVITY, SLEEPINESS AND PERFORMANCE

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Introduction: Actigraphy is commonly used to assess sleep duration and efficiency during manipulations of sleep/wake schedules. However, the impact of sleep restriction on activity levels during wakefulness in laboratory-based studies has largely been ignored. Changes in activity levels may have important implications for sleep restriction studies.
Methods: Actigraphy data were available from 8 subjects who underwent a 9-day laboratory study which included two baseline nights (BL1, BL2; 10 h TIB), 5 nights of sleep restriction (SR1-SR5; 4 h TIB), and one recovery night (R1; 10 h TIB). Subjects wore an activity monitor (Actiwatch-64, Philips Respironics, Bend, Oregon) on their non-dominant wrist during their time in the laboratory except when showering, which was controlled to set times. Approximately every 2 hours during wakefulness, a Psychomotor Vigilance Task (PVT) and Karolinksa Sleepiness Scale (KSS) was completed. One-way ANOVA was used to investigate the effect of day on activity (total activity counts per 1 minute epoch) and variability in activity by comparing subjects with high and low activity (mean split; n = 4 in each group). Pearson's correlations were used to investigate relationships between PVT performance (fastest 10% reaction times (RTs) and lapses (RTs > 500 ms)), subjective sleepiness (KSS) and activity.
Results: There was no significant effect of day (p = 0.89) on mean activity scores during wakefulness. Comparing subjects with high and low activity, it was found that the group with higher activity had significantly lower KSS scores (3.8 vs 5.3; $p < 0.001$) and significantly faster RTs (228.0 vs 235.8 ms; $p = 0.05$). A significant negative correlation was found between KSS and activity on SR1 ($r^2 = -0.74$; $p = 0.04$) and a trend on SR2 ($r^2 = -0.66$; $p = 0.07$). Number of PVT lapses was positively correlated with activity on SR2 ($r^2 = 0.72$; $p = 0.04$). No correlation was found between 10% fastest RTs on PVT and activity on any day of the study.
Conclusion: Activity does not change with laboratory sleep restriction, but a relationship between sleepiness and activity exists. Although a causal role for reduced activity remains unclear, these findings could suggest that less active subjects are sleepier and less able to maintain optimal performance.

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NEUROCOGNITIVE AND LEARNING OUTCOMES IN 6-YEAR OLD NEW ZEALAND CHILDREN ASSOCIATED WITH PARENT-RATED SEVERITY OF SLEEP DISORDERED BREATHING (SDB)

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Introduction: Sleep disordered breathing (SDB) is relatively common in young children, with an estimated prevalence of 1 to 4 percent. Habitual snoring (snoring on most nights) is a marker for SDB, and may signal that breathing is disrupted during sleep. Habitual snoring has been linked to poor daytime functioning of children, interfering with memory, intelligence, behaviour and learning. This study examined whether snoring was associated with cognitive, memory and learning impairment in 6-year old New Zealand children.
Methods: One hundred and sixty three children (mean age 6.3 years) were included in this study. On average, these children have been at school for 17 months. A SDB score (also referred to as parent-rated SDB severity) was computed for each child using parental responses on 17 items from a sleep questionnaire. These items were adapted from a SDB Scale designed to assess symptoms associated with breathing difficulty during sleep. Memory, self regulatory skills, literacy and numeracy skills were assessed using subtests from the NEPSY-II and other assessments developmentally appropriate for school-aged children.
Results: Preliminary bivariate correlation analyses revealed that children's SDB score was significantly negatively correlated with several memory, executive functioning (behaviour regulation) and literacy measures ($r = -0.17$ to -0.22). Hierarchical multiple regression analyses was used to examine the relationship between SDB and neurocognitive and learning measures. After controlling for child demographic, social deprivation, and BMI, SDB was statistically significantly related to one memory measure – Memory for Design (MD), and an executive functioning measure – Statue (ST). MD was designed to assess children's visuospatial memory for novel visual material, while ST was designed to assess children's ability to control and inhibit impulses. The unique variance explained by SDB was 3% for MD and 4% for ST. SDB was no longer uniquely predictive of any literacy or numeracy outcomes after controlling for child and social demographic variables.
Discussion: These findings seem to suggest that children's neurocognitive performance differed as a function of SDB severity. Furthermore, SDB severity also statistically significantly explained proportions of unique variance, over and above the other predictors, in two specific domains: memory and executive functioning. Further research is needed to investigate whether such deficits in memory and executive functioning would persist beyond early schooling years.

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2 YEAR FOLLOW-UP OF CHILDREN WITH AND WITHOUT SNORING FROM A COMMUNITY SAMPLE

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Introduction: Existent longitudinal research suggests that snoring history is highly variable. Limited research has been conducted examining the progression of snoring and related behavioural deficits. The aim of this analysis is to compare children who snore regularly with control children over a period of two years, and determine whether snoring children display increased behavioural and co-morbid sleep problems.

Methods: From a previous epidemiological study[1], children with and without reports of snoring were invited to participate. Children reported to snore less than once per week were included in the control group (N = 83); and, children reported to snore more than 2 nights per week were included as habitual snorers (N = 17). Children underwent polysomnography; problematic behaviour was assessed through the CBCL, and co-morbid sleep problems through the Child Sleep Health Behaviour Questionnaire. Two years later children were re-assessed and re-classified based on the latest reported snoring frequency (controls, N = 87; and primary snorers, N = 10).

Results: Children were matched for gender, BMI, gestational age, ethnicity and birth weight. No differences on snoring frequency were found across seasons. Mean age was 8.3 ± 1.7 at initial assessment, and 10.35 ± 1.7 at follow-up. 4.9% of children who never snored or snored less than 1/week started to snore frequently at follow-up. In contrast, 37.5% of children reported to snore more than 2 nights per week initially continue snoring at follow-up. Results from the CBCL showed that at baseline, children who snored frequently had higher somatic complaints compared to controls. Complaints remained after two years in the snoring group. At baseline, snorers were found to have increased bedtime anxiety, night arousals and restless sleep. At follow-up, they showed increased morning tiredness, night arousals and restless sleep. Follow-up PSG results are currently being scored. Results will be used to examine sleep architecture differences.

Discussion: Findings suggest that snoring does not resolve naturally in all cases. Results also showed that snorers had increased somatic complaints and a higher frequency of co-morbid sleep problems compared to controls, not only at initial assessment, but also two years later.

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THE COMMUNITY PREVALENCE OF SUPINE PREDOMINANT OSA IN MEN AGED 40 YEARS AND OVER

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Introduction: Supine-predominant OSA is common in a sleep clinic setting, with around 30% of patients diagnosed with OSA showing a normal non-supine apnoea hypopnoea index (AHI), but elevated total sleep AHI via a supine : non-supine AHI ratio ≥2. Given normal non-supine AHI, such patients should benefit from simple supine avoidance treatments. However, to help evaluate supine OSA, patients are often encouraged to sleep supine in the laboratory, potentially exaggerating the supine-predominance of OSA in the clinic versus home setting. Supine-predominance may also be influenced by OSA severity, biasing prevalence in clinic referred patients versus the broader community. The aims of this study were to examine supine sleep time and the prevalence of supine-predominant OSA using in-home sleep studies in a large community sample of males.

Methods: Study participants were a sub-group of males in the Men Androgen Inflammation Lifestyle Environment and Stress (MAILES) study; aged 40 years and over, not previously diagnosed with OSA, and with full in-home polysomnography studies. All sleep studies with technically adequate EEG, airflow, thoraco-abdominal, SaO_2 and position sensor signals were scored by a single experienced scorer according to current AASM (alternate) criteria. %Supine sleep time was examined in all studies with >4 hr total sleep time. Positional OSA was evaluated in all studies showing >4 hr total sleep, ≥5 min supine and ≥5 min non-supine sleep time.

Results: 739 (87% of 841) sleep studies had >4 hrs total sleep time and technically adequate signals, including posture all night. %Supine sleep time was; mean ± SD 30 ± 26%, median 24% [IQR 9 to 45%]. 650 participants showed ≥5 min of both supine and non-supine sleep. 176 of 328 participants with AHI ≥ 10/hr (54%; 95% CI 48 to 59%) showed supine-predominant OSA (supine : non-supine AHI ≥ 2 and non-supine AHI < 10/hr). Prevalence was similar with a cut-off of 20/hr; 86 of 149 participants (58%; 95% CI 50 to 66%). Using less stringent criteria, 263 of 328 (80%; 95% CI 76 to 85%) and 110 of 149 (74%; 95% CI 67 to 81%) participants showed supine : non-supine AHI ≥ 2 using AHI cut-offs for OSA of ≥10 and ≥20/hr respectively.

Discussion: Supine-predominant OSA is remarkably common in older males in the community. If proven effective and acceptable to patients, simple supine avoidance strategies could benefit a large community group.

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BURDEN OF UNDIAGNOSED OSA ON HEALTH-RELATED QUALITY OF LIFE AMONG MEN AGED 40 YEARS AND OVER IN THE COMMUNITY

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Introduction: The effect of OSA, sleepiness and subjective sleep quality on health-related quality of life in unselected community population samples is not well described.
Methods: We determined the relationship between the presence and severity of sleep disordered breathing and health-related quality of life in a comprehensively characterized representative population-based cohort of men aged over 40 yrs (MAILES) (n = 1869). In 2011–12, full in-home unattended polysomnography (Embletta X100) were done in 851 randomly selected men from the cohort without a prior diagnosis of OSA and scored by a single experienced scorer according to current AASM (alternate) criteria. SF-36 health-related quality of life (HRQL) scores were age adjusted and are presented as standardised z-scores, i.e. as proportion of standard deviations from general population mean scores.
Results: Sleep study participants did not differ from the rest of the cohort in anthropometry, co-morbidities or socio-economic status. Mean age was 59.6 (sd 10.8) years. Among 451 (53%) men with OSA (AHI ≥ 10) there were modest, significant ($p < 0.01$) decreases in scores across all SF-36 scales compared to no OSA (z-score difference range 0.06–0.19) except pain. SF-36 scores declined significantly with severity of OSA, with z-scores differences between mild (AHI ≥10–20) and severe (AHI > 30) ranging from 0.09–0.25. Compared to men without OSA or sleepiness (ESS ≥ 10), men with both (n = 83, 9.8%) had significantly lower scores ($p < 0.01$) across all SF-36 scales except bodily pain, with z-scores for mental health (MH) 0.62, general health (GH) 0.57 and Physical Functioning (PF) 0.42 lower. Men with OSA and disturbed sleep quality (Pittsburgh > 5) (n = 198, 23.3%) also had significantly lower scores in all scales except pain, with z-scores in MH 0.73, GH 0.47, PF 0.45 and Vitality 0.72 lower.
Discussion: The burden of undiagnosed OSA on HRQL among men in the community is substantial. The effect of OSA on HRQL is mostly seen in men who report sleepiness or decreased sleep quality, with moderate to large effect sizes reported that are comparable to other major chronic conditions.

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WHO SLEEPS WITH WHO? THE RESULTS OF THE ABC BIG SLEEP SURVEY

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Introduction: There is very little current published data about the sleeping arrangements of Australian adults. The majority of this data is in relation to infants sleeping with parents. American based population surveys have been published; however, the amount of Australian adults sharing the bed with other companions is unknown. The aim of this study was to ascertain the frequency of bed sharing in the general Australian community.
Methods: As part of National Science Week 2010, an online survey – 'the ABC Big Sleep Survey' was made available for interested citizens to complete during August 2010. This survey incorporated questions regarding sleeping arrangements, sleep disorder symptoms, and quality of life. Responses were examined, with those living in Australia, aged 18 years and over, and completed all relevant questions included.
Results: Of 7237 respondents, 5558 fulfilled criteria for analysis. Of these adults, 70 percent shared the bed with another adult, 13 percent with a child, and 25 percent with a pet, at least occasionally. Only 22% of respondents always slept alone. Multiple bed companions (partner, child and/or pet) were reported by 26% of respondents, with 8 individuals (0.1%) reporting they always slept with all three.
Discussion: Sharing sleeping space with another is a common scenario in Australia. Since the sleep and sleep disorders of adults are often investigated in the context of sleeping alone in the laboratory, this may not be representative of regular sleeping arrangements in the community. The impact of bed companions on regular sleeping arrangements and the results of domiciliary sleep studies should be taken into account during clinical assessment.

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SLEEP APNEA PREDICTS INCIDENT STROKE RISK: 17-YEAR FOLLOW-UP FROM THE BUSSELTON SLEEP COHORT

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Introduction: Obstructive sleep apnea (OSA) is a risk factor for premature mortality probably through its effects on the cardiovascular system. Because OSA causes large blood pressure changes through the night in conjunction with milder perturbations in systematic blood pressure it is thought that probably elevates the risk of stroke in particular.
Methods: In a community-based cohort of 400 residents of the Western Australian town of Busselton we quantified OSA via the respiratory disturbance index (RDI) as measured by a single night recording in November-December 1990 by the MESAM IV device, along with a

range of cardiovascular disease risk factors. Follow-up for stroke related death and hospitalisations was ascertained via record linkage to the end of 2007. Sleep apnea was classified as absent (AHI < 5), mild (AHI 5–15) or moderate-to-severe (AHI > 15).

Results: There were 24 stroke events (4 fatalities) in the 380 participants without stroke or heart attack history at baseline. People with moderate-to-severe OSA were at increased risk for stroke at both a univariate (HR = 5.7; 95% CI 1.9, 17.8) and multivariate level (HR = 5.2; 95% CI 1.5, 18.2) after control for leading stroke risk factors. Tests for linear trends across the categories of severity were positive ($p < 0.05$) and treating AHI as a continuous variable indicated that each unit increase was associated with about a 5.7% increase in risk ($p = 0.01$).

Discussion: Moderate-severe obstructive sleep apnea is an independent risk factor for stroke in the Busselton Health study. This replicates previous observations from the Sleep heart Health Study and the Vitoria sleep project.

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AN EVALUATION OF THE UTILITY OF THE MULTIVARIATE APNOEA PREDICTION QUESTIONNAIRE AND THE BERLIN QUESTIONNAIRE IN PREDICTING THE PRESENCE AND SEVERITY OF OBSTRUCTIVE SLEEP APNOEA IN PATIENTS PRESENTING TO AN AUSTRALIAN SLEEP DISORDERS CLINIC

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Aim: The aim of the project was to demonstrate that the Berlin (BQ) and Multivariate Apnoea Prediction Questionnaires (MAP) are reliable at predicting the presence or absence of obstructive sleep apnoea (OSA) in patients referred to an Australian sleep disorders clinic. The secondary aim was to compare the MAP to the BQ and determine whether a combination of the questionnaires is more predictive than each questionnaire alone.

Method: A retrospective audit of 100 patient records of patients who have previously had been administered the BQ and MAP prior to their diagnostic polysomnogram in order to gain provisional information about the approximate sensitivity, specificity and likelihood ratios of the questionnaires individually and combined. A receiver-operating characteristic (ROC) curve was generated to determine suitable cut-points for the MAP.

Results: Four charts were excluded because of missing data. At an apnoea-hypopnoea index (AHI) cut-point of 5, the sensitivity of the BQ was 81% and specificity was 54%. At an AHI cut-point of 30, the sensitivity was 90% and specificity 37%. The ROC curve demonstrated that an optimal cut point for the MAP at an AHI of 5 was 0.49 and for an AHI of 30 it was 0.59. The sensitivities and specificities for the MAP at an AHI of 5 were 87% and 68% respectively. At an AHI of 30 they were 90% and 57% respectively. When the questionnaires were combined, a low probability BQ plus a MAP score of <0.49 had a specificity of 96% (sensitivity 39%) for the absence of OSA (AHI < 5). For the male subgroup, the specificity was 98% and specificity was 42%.

Conclusion: In patients referred to an Australian sleep disorders clinic, a low probability BQ is good at excluding the possibility of OSA. A MAP score less than 0.49 is good at excluding OSA (AHI < 5) and a score less than 0.59 is good at excluding severe OSA (AHI ≥ 30). The high specificity of the combined result for the absence of OSA potentially makes these questionnaires very useful aids in appropriately triaging referrals to sleep clinics facing ever-growing workloads. This project will now be extended to a prospective data collection phase.

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EFFICACY OF AN ONLINE, SLEEP EDUCATION PROGRAM EMBEDDED INTO EXISTING CURRICULA: PILOT DATA

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Introduction: In previous sleep education trials (1) teachers have noted that adding sleep education to classroom content in already crowded curricula is difficult and further, that online modules may be better received by students than traditional delivery methods. An online sleep education module was therefore trialled to test this.

Method: One year 4/5 class ($n = 26$) [mean (SD) age 9 yrs 6 mths (2 mths)] in Adelaide South Australia, undertook the Philip's Simply-Healthy@schools online sleep education module. This includes student modules, teacher training and guidelines. The basic program was adapted and modified by the teacher so it could be included into existing areas of school curricula (e.g. sleep diary data in mathematics, the importance of sleep was explored in genre writing classes and research abilities with critical enquiry skills were advanced in group projects). Self report sleep duration at T_1 was compared to sleep duration at 4 weeks from baseline (T_2) and again in a subset ($n = 10$) at 12 weeks from baseline (T_3).

Results: Preliminary data analysed at T_2 suggests significant improvements in sleep duration but analyses to date, suggest these were not sustained at T_3 ($p > 0.05$). The majority of parents and children suggested this should be included into existing curricula.

Table 1. Descriptive responses to sleep education module

Outcomes at T_2	Students (n = 26) Parents (n = 7)	%
Increased total sleep time	24	92.3
Students wanting sleep education in curriculum	25	96.1%
Parents wanting sleep education in curriculum	7	100%

Conclusions: These preliminary data suggest that an online delivery of sleep education for junior school children can be easily integrated into the existing curricula and has potential to engage students to improve their sleep patterns. Further analyses and trials of this method will assist in assessing if sleep education online can change and sustain sleep behaviour.

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HIGH PREVALENCE OF SLEEP DISORDERED BREATHING WITH CHRONIC INTRATHECAL OPIOID THERAPY

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Introduction: The prevalence of sleep disordered breathing (SDB) in patients receiving intrathecal (IT) opioid therapy (OT) has not been studied but is likely to be high based on data in chronic oral OT. Our aims were to assess the frequency, characteristics, and severity of SDB in patients receiving long term IT OT.
Methods: Data was collected on all Veteran patients receiving chronic IT OT at a large tertiary private/repatriation hospital. In those patients already investigated for SDB prior to commencement of this study, a detailed review of medical records and sleep study data was undertaken. Patients who had not been previously investigated for SDB underwent full Level 1 in-hospital polysomnography in an accredited sleep laboratory. Data was analysed by an experienced sleep scientist in accordance with current AASM guidelines. Demographic data including age, sex, BMI and ESS and complete medication history was recorded. Each patient underwent early morning arterial blood gas sampling and spirometry.
Results: 15 male Veteran patients were identified as receiving IT opioid therapy (mean ± SD age 57.7 ± 11.5 years, BMI 34.8 ± 4.1 kg/m^2). 13/15 had SDB; 10/15 with obstructive sleep apnoea (OSA) and 3 with central sleep apnoea (CSA). 4 had documented SDB prior to intrathecal pump (ITP) insertion; 3 with OSA and 1 CSA-Cheyne Stokes respiration (CSR). Of these, 1 with OSA previously stable on CPAP developed emergent CSA on IT OT. 11 patients were studied post ITP insertion (overall AHI was 30.8 ± 18.4); 8 had OSA, 1 CSA and 2 had no SDB. 5/11 were studied prospectively. Of these, 4 had OSA and 1 had no SDB, however, all had waking hypercapnia. Concurrent IT OT and oral OT occurred in the minority of patients.
Conclusions: The prevalence of OSA in this population of patients receiving IT OT was 67%, higher than anticipated despite the mean BMI, 34.6. CSA occurred in 13%, lower than documented in chronic oral OT. Waking hypercapnia was present in all tested, even in the absence of SDB. Based on these results screening for SDB and hypercapnia is strongly advised when receiving chronic IT OT. A prospective study is planned to evaluate SDB pre and post ITP insertion to compare chronic OT via the oral and IT route.