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Title of Thesis

CLINICAL CORRELATIONS TO DISTINGUISH FROM MILDER FORMS OF OBSTRUCTIVE SLEEP APNOEA SYNDROME USING OVERNIGHT OXIMETRY TO PRIORITIZE ADENOTONSILLECTOMY IN A LOW RESOURCE SETTING

DECLARATION

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TITLE: Clinical correlations to distinguish severe from milder forms of obstructive sleep apnoea syndrome using overnight oximetry for prioritising adenotonsillectomy in a limited-resource setting

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KEY WORDS: Overnight Oximetry (OO), OSAS (Obstructive Sleep Apnoea Syndrome), McGill Oximetry Score (MOS), RCS (Resource Constrained Setting), Sleep Disordered Breathing (SDB), Primary Snoring (PS), Adenotonsillar Hypertrophy (ATH), Body Mass Index (BMI)

ABBREVIATIONS USED

OSAS Obstructive Sleep Apnoea Syndrome

PSG Polysomnography

MOS McGill's Oximetry Score

OO Overnight Oximetry

IQR Interquartile Range

BMI Body Mass Index
RR Risk Ratio
SSS Symptom Screening Scores
SDB Sleep-disordered Breathing
ATH Adenotonsillar Hypertrophy
PHT Pulmonary Hypertension
PAP Pulmonary Artery Pressure
ODI Oxygen Desaturation Index

ABSTRACT

Background: In resource-poor settings with limited surgical services, it is essential to identify and prioritise children with severe and very severe obstructive sleep apnoea syndrome (OSAS) to expedite surgery. McGill's Oximetry Score (MOS) has been validated against polysomnography for OSAS and is affordable and easy to use.

Aims: The aim of this study was to assess the correlation of tonsillar size and clinical symptoms with MOS grade 3 or 4, to identify who requires overnight oximetry and who to prioritise for adenotonsillectomy.

Methods: Children with suspected OSAS were recruited from the otolaryngology clinic at the Red Cross War Memorial Children's Hospital. Demographics, symptom screening scores (SSS), patient characteristics, overnight oximetry (OO), echocardiography and MOS scores (graded 1- 4) were recorded. Multivariate modified-Poisson regression models were used to examine correlations of patient characteristics 'with grade 3 or 4 MOS.

Results: One-hundred-and-three children were analysed, 38% were female, and median (IQR) age was 3.8 (2.5-5.3) years. Increased tonsil size was associated with a 60% increased risk of grade 3 or 4 MOS, risk ratio (RR) 1.59, 95% CI 1.10-2.29 (p=0.014). Children with witnessed apnoeic events during sleep had 1.3 times increased risk of MOS Grade 3 or 4, RR 1.31, 95% CI (p=0.033). A significant correlation was shown with grade 3 or 4 MOS, RR 1.15, 95% CI 1.03-1.27 (p=0.010) by combining tonsillar size with the following symptoms:

apnoeic events; struggling to breathe during sleep and; needing to stimulate the child to breathe.

Conclusion: Identifying children with suspected OSAS who require overnight oximetry can be performed using a simple 3-question screening tool: witnessed apnoeic events, struggling to breathe and the need to shake them awake to breathe. This is more precise with an additional clinical finding of grade 3 or 4 tonsils. These children should have surgery expedited. Any child with a MOS 3 or 4 score on OO needs to have expedited surgery.

Introduction

Snoring in children is a common symptom and occurs throughout the spectrum of sleepdisordered breathing (SDB) that includes primary snoring, upper airway resistance syndrome and obstructive sleep apnoea syndrome (OSAS). OSAS is estimated to occur in 0-5.7% of children and is defined as repeated episodes of upper airway obstruction during sleep that are associated with a reduction in oxyhemoglobin saturation or hypercarbia or both [1]. The commonest cause of OSAS in childhood is adenotonsillar hypertrophy (ATH) [1,2].

The most severe and life-threatening complications of OSAS in children are pulmonary hypertension (PHT) and subsequent *cor pulmonale*. However, the reported prevalence of PHT in children with OSAS varies widely, ranging between 0-85% [3]. Other complications of OSAS include growth impairment, dyslipidaemia, systemic hypertension, behavioural problems and neurocognitive deficits [1]. The treatment of choice for OSAS in children with ATH is an adenotonsillectomy. It is essential to be aware of preventable but serious perioperative complications such as airway obstruction, hypoxia, and death. However, predicting which children are at risk of such complications is notoriously difficult. Furthermore, the value of routine preoperative echocardiography to predict perioperative complications is unclear [4]. In the absence of polysomnography (PSG), the best predictors of perioperative complications have been shown to be young age, obesity, and nadir oxygen desaturation <90% in preoperative evaluation across several studies [5-7].

Surgical constraints

In a low resource setting, many patients wait a long time for surgery. In our hospital, operating time is shared amongst all surgical specialties. Limited bed and high care availability for otolaryngology patients restricts the number of patients that can have surgery for OSAS. All these factors lead to long waiting periods for adenotonsillectomies. Therefore prioritising patients that require surgery for significant OSAS becomes important.

The diagnosis of OSAS is difficult as most children are asymptomatic while awake and symptom-based screening tools are unreliable [8]. OSAS can be difficult to distinguish from primary snoring without the use of objective measures like PSG. PSG is considered the gold standard for the diagnosis of OSAS [1,9]. However, it is expensive, labour intensive and not widely available in low- and middle-income countries (LMICs). Simple, accessible, and affordable OSAS diagnostic tools are therefore needed in resource-constrained settings.

Overnight oximetry (OO) is a widely accepted and validated objective screening tool for OSAS, especially in more severe cases [6,10]. The McGill Oximetry Score (MOS) is widely used to grade OSAS severity in children and has been validated against PSG [6, 10-12]. MOS uses the frequency and depth of oxyhemoglobin desaturations during at least 6 hours of sleep to assign a score of 1 (mild) through 4 (very severe) to the desaturation profile (Table 1).

Score	Comment	Criteria			
		Number of drops in SaO_2 <90%	Number of drops in SaO_2 <85%	Number of drops in SaO_2 <80%	Others
1	Inconclusive for OSA	<3	0	0	Baseline: Stable (<3 clusters of desaturations) and >95%
2	Mild OSA	≥3	≤3	0	3 or more clusters of desaturation events
3	Moderate OSA	≥3	>3	≤3	3 or more clusters of desaturation events
4	Severe OSA	≥3	>3	>3	3 or more clusters of desaturation events

Table 1: McGill Oximetry Score

OO as a screening tool for OSAS has been utilised in our institution since 2012 and continues to be the standard of care to evaluate suspected OSAS. Subsequent management is based on OO results with urgent surgery for MOS 3 & 4; semi-urgent surgery for MOS 2; and watchful waiting with continued medical management for MOS 1.

Clinical work-up for OSAS in our paediatric otolaryngology department even prior to OO included a screening tool in the form of a validated symptom-based OSAS scored questionnaire derived from *Spruyt et al* (8). If a parent answers "yes" to at least one question in the screening questionnaire, their child is eligible for OO (Table 2).

As a tertiary pediatric referral centre, our institution is overburdened with managing children with suspected OSAS. Over the last 3 years the OSAS burden of disease has seen a sharp increase. Waiting lists for surgery are longer, increasing the risk of complications for children with severe OSAS awaiting surgery. Furthermore, there is currently no evidence-based approach to establish perioperative risk. This is a double-edged sword that may lead to inappropriate utilisation of scarce resources or the underestimation of risk potentially causing avoidable morbidity/mortality. Due to resource constraints, surgical lists meant for complex paediatric otolaryngology surgeries are now partially utilised for adenotonsillectomies in children with severe OSAS. Adenotonsillectomy surgery for OSAS therefore needs to be suitably triaged and prioritised to ensure optimal utilisation of scarce hospital resources.

Aims

The aim of this study was to assess the correlation of tonsillar size and clinical symptoms with MOS grade 3 or 4, to identify who requires overnight oximetry and who to prioritise for adenotonsillectomy.

Materials and methods

A retrospective review of children with suspected OSAS was conducted at Red Cross War Memorial Children's Hospital in Cape Town, South Africa from 1 December 2017 to 5 November 2018. All children with suspected OSAS whose parents answered "yes" to at least one question from a screening questionnaire (derived from *Spruyt et al*) (8), and who had overnight oximetry were identified. Children with underlying genetic disorders or syndromes, cardiopulmonary (except pulmonary hypertension or controlled asthma) and neurologic conditions, and those with multi-level airway obstruction were excluded. Children with OO studies of less than 6 hours duration were also excluded.

Data Collection

Demographic data collected included date of birth, age at diagnosis and gender. The use of intranasal corticosteroids, and/or antihistamines and/or montelukast was also included. Tonsil size was graded using the Brodsky classification system [13] Echocardiography was done on all children. Symptom-based OSAS scores from the screening questionnaire (Table 2) were collected.

OO was performed using aNonin PalmSAT 2500® (Nonin Medical Inc, Plymouth, USA) pulse oximeter. Recordings were downloaded and analysed with accompanying NVison® software. At least 6 hours of recording was considered satisfactory. Using the MOS grading system, children were stratified into no/mild (MOS 1), moderate (MOS 2), severe (MOS 3) and very severe OSAS (MOS 4). Desaturations had to be less than 90% with at least 3 such clusters to be significant.

Question	Never	Rarely (Once per week)	Occasionally (twice per week)	Frequently (3-4 x per week)	Almost always (> 4 x per week)
How often does your child snore?	0	1	2	3	4
Does your child have very loud snoring?	0	1	2	3	4
Are you concerned about your child's breathing during sleep?	0	1	2	3	4
Does your child ever struggle to breathe during sleep?	0	1	2	3	4
Does your child ever stop breathing during sleep?	0	1	2	3	4
Do you ever shake your child to breathe during sleep?	0	1	2	3	4

Table 2: Screening Questionnaire: Symptom-based OSAS score adapted from *Spruyt et al* (8).

Statistical analyses

All analyses were conducted in Stata v. 13.0 (Stata Corp., College Station, TX, USA). Frequencies and proportions were used to summarise categorical variables and mean (standard deviation), median (interquartile range) where appropriate for continuous variables. The Pearson's chi-square test (or Fischer's exact test) was applied to compare categorical variables, whereas the Mann-Whitney-U test (or student t-test) was used to compare continuous variables.

Individual and combined symptom scores from the screening questionnaire were evaluated for their sensitivity and specificity. Receiver operating characteristics (ROC) curves and the *roctest* in Stata were fitted to determine the area under the curve (AUC) and the symptom score (individual and combined) cut-offs with the highest sensitivity and specificity were determined. A modified-Poisson regression model was used to assess the relationship between patients' main characteristics, symptom scores and the likelihood of having severe/very severe McGill Oximetry Scores (grade 3/4). All p-values < 0.05 were considered statistically significant.

Ethics statement

Approval for the study was obtained from the University of Cape Town Human Research Ethics Committee (HREC No. 456/2018).

Results

Characteristics at baseline of the study patients

One-hundred-and-three patients were recruited into the study; the majority were male (60.2%); the median age was 45 months (IQR 30-63) or 3,75 years (IQR 2,5-5,25); and two-thirds had grade 2 or 3 tonsillar hypertrophy. Most patients were already on intranasal steroids (76.7%), nadir oxygen saturation was a median of 85% (80-90); mean pulmonary

artery pressure (PAP) was 18 mmHg (range 7-30); and median oxyhaemoglobin desaturation index (ODI) per hour was 3.7 (IQR 1.8-8.9). (Table 3)

Characteristic	TOTAL (n=103)	MOS 1 (n=44)	MOS 2 (n=35)	MOS 3&4 (n=24)	pvalue
A) Demographic					
Male Sex, n (%)	62 (60.2%)	29 (65.9%)	19 (54.3%)	14 (58.3%)	0.564
Age (months), median (IQR)	45 (30-63)	48 (29 – 68)	43 (33 - 61)	39 (29 – 59)	0.530
BMI (kg/m^2), median (IQR)	16.1 (15.1-18.1)	15.6 (14.9-18.4)	16.6 (15.1-18.2)	16 (15.4-17.1)	0.659
B) Underlying risk factors					
Tonsillar hypertrophy					0.206
• Grade 1	13 (12.6%)	9 (20.5%)	3 (8.6%)	1 (4.2%)	
• Grade 2	34 (33.0%)	17 (38.6%)	12 (34.3%)	5 (20.8%)	
• Grade 3	35 (34.0%)	12 (27.3%)	12 (34.3%)	11 (45.8%)	
• Grade 4	20 (19.4%)	6 (13.6%)	7 (20.0%)	7 (29.2%)	
Other Comorbidities*	1 (0.97%)		1 (2.85%)		0.887
C) Medications					
Intranasal steroids	79 (76.7%)	34 (77.3%)	27 (77.1%)	18 (75.0%)	0.975
Antihistamines	41 (39.8%)	21 (47.7%)	11 (31.4%)	9 (37.5%)	0.328
Montelukast	38 (36.9%)	17 (38.6%)	10 (28.6%)	11 (45.8%)	0.382
D) Clinical indices					
Symptom score, mean (SD)	16.0 (5.7)	15.2 (6.2)	15.6 (5.5)	17.9 (4.7)	0.384
PAP (mmHg), mean (range)	18 (7-30)	17 (7-26)	17 (7-30)	19 (12-29)	0.265
Nadir O2 (%), median	85 (80-90)	90 (85-91)	85 (82-88)	74 (64-79)	**<0.001**
ODI per hr, median (IQR)	3.7 (1.8-8.9)	1.8 (1.0-3.2)	4.1 (2.5-6.4)	13.5 (9.4-22.3)	**<0.001**

TABLE 3: Demographic and clinical characteristics of participants with suspected OSAS

*Comorbidities – 1 patient with allergic rhinitis

[#] Oxyhaemoglobin Dissociation Index

The number (%) of patients in each MOS group is represented in Figure 1 and includes MOS grade 1, 43% (n=44), grade 2, 34% (n=35), grade 3, 9.1% (n=10) and grade 4, 13.6% (n=14). The median symptom score was 17 (IQR 12-20). Nadir oxygen saturation was a median of 85% (IQR 80-90); mean pulmonary artery pressure (PAP) was 18mmHg (range 7-30); and median oxyhaemoglobin desaturation index (ODI) per hour was 3.7 (IQR 1.8-8.9). (Table 3)

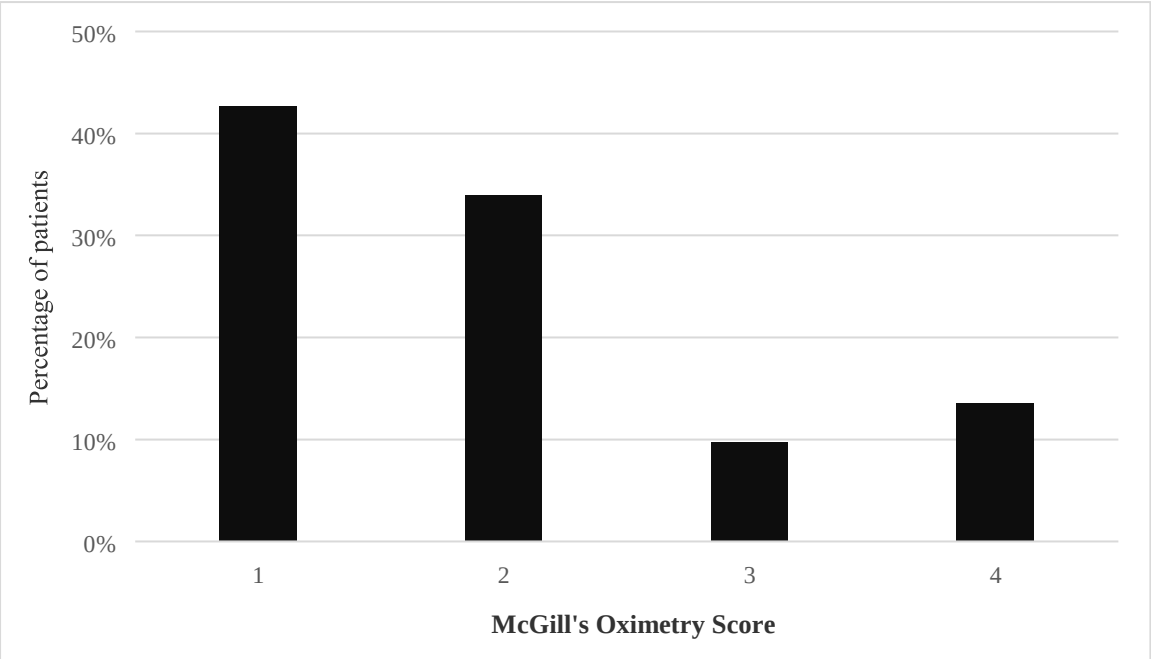

Figure 1. Proportion of patients in each MOS group

Abnormal PAP values (PAP >25mmHg) were found to be similar among those with mild/moderate vs. severe/very severe MOS (p=0.811). Median nadir oxygen saturation values were higher among those with MOS 1/2 (87%) compared to those with MOS 3/4 (74%), (p<0.001); and median ODI per hour were lower in the MOS 1/2 group (3/hr) when compared to the MOS 3/4 group (13.5/hr), (p<0.001) (Table 3).

Likelihood of patient characteristics and screening tool questions to predict grade 3/4 MOS

In the regression models, increased tonsil size (graded 1 to 4) was significantly associated with an approximately 60% increased risk of grade 3/4 MOS, RR 1.59, 95% CI 1.10-2.29 (p=0.014). No other single patient demographic or clinical characteristic was significantly associated with an abnormal MOS (Table 5). The majority of individual questions in the symptom based OSAS screening score questionnaire did not demonstrate a positive association with grade 3/4 MOS, except 1 individual symptom, namely: those children who reported "witnessed apnoeic events" during sleep. This individual symptom was found to have 1.3 times increased risk of grade

MOS 3/4 when compared to children who did not have reports of apnoeic events during sleep.

Characteristic	Risk Ratio (95% CI)	p-value
Baseline demographic and clinical characteristics		
Male sex	0.93 (0.45-1.88)	0.83
Age (months)	1.00 (0.98-1.01)	0.62
BMI (kg/m2)	1.02 (0.96-1.08)	0.60
Pulmonary hypertension present	1.45 (0.28-7.53)	0.66
Tonsillar hypertrophy (grade 1 to 4 increase)	**1.59 (1.10-2.29)**	**0.014**
Symptom screen questions		
How often does your child snore?	1.29 (0.76-2.19)	0.345
Does your child have very loud snoring?	1.11 (0.80-1.55)	0.527
Are you concerned about your child's breathing during sleep?	1.38 (0.96-1.99)	0.085
Does your child ever struggle to breathe during sleep?	1.20 (0.88-1.65)	0.255
Does your child ever stop breathing during sleep?	**1.31 (1.02-1.68)**	**0.033**
Do you ever shake your child to breathe during sleep?	1.24 (0.98-1.57)	0.075

Table 4: Participant characteristics, screening tool questions and likelihood of grade 3 / 4 MOS *Diagnostic accuracy of the symptom-based screening tool and combination of selected symptoms*

The symptom based OSAS score screening tool at an arbitrary cut-off of 12 out of a possible total 24 had high sensitivity (91.7%), low specificity (25.3%) and RR 3.00 (95% CI 0.7611.82). After fitting a ROC curve to determine the cut-off value with a trade-off with both the highest sensitivity and specificity, the resulting cut-off of 18 out of possible total of 24 had a sensitivity of 62.5% and specificity of 56.4% in predicting grade 3/4 MOS. Risk ratio for predicting grade 3/4 MOS was 1.80 (95% CI 0.87-3.75). When only the following three questions were combined (*Does your child ever struggle to breathe during sleep; Does your child ever stop breathing during sleep?* and *Do you ever shake your child to breathe during sleep*?), sensitivity remained similar but specificity marginally improved: sensitivity 62.5%, specificity 59.5% and RR 1.99, 95% CI 0.95-4.14 (cut-off 8 out of a possible 12). Adding magnitude of tonsillar size to this combined symptom score (cut-off 11 out of possible total of 16) improved both sensitivity, specificity and resulted in greater magnitude and precision of the risk ratio: sensitivity 66.7%, specificity 63.3% and RR 2.58 (95% CI 1.21-5.50). (Table 5)

Question	Sensitivity	Specificity	Relative Risk (95% CI)	p-value
Symptom Score: OSAS screening tool (≥12)	91.7%	25.3%	3.00 (0.76-11.82)	0.120
Symptom Score: OSAS screening tool (≥18)	62.5%	56.4%	1.80 (0.87-3.75)	0.115
Combined Score: struggle + stop breathing + shake child (≥8/12)	62.5%	59.5%	1.99 (0.95-4.14)	0.067
Combined Score: struggle to breath + stop breathing + shake + tonsil size (≥11/16)	66.7%	63.3%	2.58 (1.21-5.50)	**0.014**

Table 5: Diagnostic accuracy of in-house screening tool and combined symptom score in predicting grade 3/4 MOS

Time to surgery

The mean time to surgery from time of diagnosis for MOS 3/4 was 10.86 days, although our objective is to perform adenotonsillectomy within 3 days of OO diagnosis of severity.

Perioperative complications

All our patients undergoing adenotonsillectomy were assessed for perioperative complication rates. Intraoperatively, there were no recorded reports of severe hypoxia, bradycardia, laryngospasm, bronchospasm, pulmonary hypertensive crisis, or cardiac arrest. Postoperatively, as part of our institutional standard of care, patients are admitted post adenotonsillectomy for 24 hours for observation and monitoring. Only one patient (MOS 3) had a post tonsillectomy bleed within 24 hours of surgery that we took back to theatre to achieve haemostasis, no blood transfusion was required. From the remaining patients, none required a nasopharyngeal airway, supplemental oxygen, CPAP, or unplanned ICU admission. In addition, none of them had severe hypoxia (SpO2 <80% for more than 20 seconds) or apnoea requiring intervention. They were all discharged within the 24-hour period.

Discussion

Our patient cohort fell within the age group of 3-6 years, known to be at highest risk age group of snoring and ATH [16]. The oldest patient was 5 years 3 months, which is somewhat lower than in most published studies [12]. Although there were more males (62%) than

females (38%), this was not significant (p=0.83), which is in line with other studies that have shown no gender bias in the prevalence of OSAS in pre-pubertal children [15].

In our cohort of 103 children, 47% had MOS 1, and 53% had MOS 2, 3 and 4 (moderate, severe, and very severe OSAS respectively), which is similar to other reported studies [10].

MOS 1 has a low sensitivity (40%) to detect an apnoea/hypopnoea index (AHI) of >1 episode an hour due to the stringent threshold for the definition of abnormal oximetry (at least three clusters of desaturation events and at least three drops of oxyhaemoglobin saturation measured by oximetry (SpO_2) below 90%) [19]. According to the literature up to 60% of patients with MOS 1 have an element of OSAS [10]. In our study children found to have MOS 1 were initially not offered surgery. However, surgery was offered to those with persistent symptoms on follow-up assessment.

In patients with MOS 2,3 and 4, OO has a positive predictive value of close to 100% [10]. Studies have shown that symptom scores, as observed by caregivers, are notoriously inaccurate in predicting the severity of OSAS [8]. This is because caregivers tend to exaggerate the symptoms. Our study confirmed these results; our symptom-based tool that was adapted from *Spruyt* [8] (cut-off 12/24) was 91.7% sensitive and 25.3% specific in detecting grade 3/4 MOS and statistical analysis showed that it had very little discriminatory value. The best balance of sensitivity and specificity using a higher cut-off (18 out of 24) resulted in a sensitivity of 62.5% and specificity of 56.4%.

Symptoms like difficulty breathing, obstructive apnoeic events witnessed by parents, and stimulating the child to start breathing were more common in patients found to have severe OSAS than in those found to have simple snoring or normal breathing during sleep (p=0.046); this finding is in keeping with the literature [10]. A significant correlation was shown between grade 3/4 MOS and the following symptoms: apnoeic events, struggling to breathe during sleep and needing to wake the child up to breathe (p=0.046). This may be stratified further. This (study showed that the additional clinical finding of grade 3 or 4 tonsils made the risk ratio of those 3 questions more precise (RR 1.15; 95% CI 1.03-1.27 p=0.010).

It is estimated that 70% of children with snoring have primary snoring, a benign form of SDB [17]. Despite snoring being the most reported symptom, it was not associated with MOS 3/4 in our study (p=0.345).

ATH has long been known to be associated with OSAS, particularly in children [18, 19]. Our study showed a 60% increased risk (risk ratio 1.59) of severe/very severe OSAS with increase in tonsil size (p=0.014). There was a significantly higher proportion of patients with grade 3 and 4 tonsil size among those with MOS 3 or 4 OSAS. Notwithstanding that adenoid hypertrophy alone has been shown to be associated with severe OSAS [23, 24]. Children with adenoid hypertrophy alone, however, were not identified, as this did not fall under our study objectives. This may highlight a limitation of our study and could promote further research on this patient cohort, together with response to INS. Furthermore, diagnosis of adenoid hypertrophy is also limited by access to flexible nasendoscopy, which is not routinely available in resource constrained settings [25].

The association between a high BMI and SDB is well established in the literature, especially in adults and post-pubertal children [15,16]. The mean BMI (kg/m^2) of our cohort was 16.1, median (IQR) (15.1-18.1). This did not have any correlation with the severity of OSAS (p=0.6).

The association between OSAS and PHT as measured by PAP values greater than 25 mmHg is well established in literature [20,21]. PHT is potentially the most serious complication of OSAS and can be fatal [3]. Our series had a very low incidence of elevated PAP values, even among the children with the more severe forms of OSAS (MOS 3/4). Only five of our patients had elevated PAP values measured by echocardiography (mean 18mmHg, range 7-30 mmHg); this was not associated with severe OSAS (p=0.66). One explanation could be early presentation and diagnosis, and the exclusion of children with any comorbidities like Trisomy 21, craniofacial abnormalities and lower respiratory tract infections. Apart from children with clinical features of *cor pulmonale*, it is therefore worth revisiting the need for a preoperative echocardiogram in every child with OSAS especially in resource constrained settings.

Oxyhaemoglobin desaturation index (≥4%) per hour (ODI/hr) was strongly associated with severe OSAS (p<0.001). In a systematic review, *Brouillette et al* reported that this had been replicated in several studies [10]. In children with no comorbidities, an ODI of >2.05

episodes per hour had a positive predictive value of 98.1%, a high sensitivity of 77.7% and a specificity of 88.9% in predicting an AHI > 1 episode/hour [22].

Access to operating time for adenotonsillectomies is a challenge in many resource constrained settings such as ours. *Nixon et al* [6] arbitrarily assigned time intervals of 2 weeks to surgery from time of diagnosis for children with a markedly abnormal sleep study (MOS 3 equivalent in our study) and 1-2 days for those with a severely abnormal study (MOS 4 equivalent in our study). Having diagnostic tools identify children that require urgent adeonotonsillectomy would assist specialists in resource constrained settings to prioritise children requiring urgent surgery and to advocate for hospital management and government structures to better address the burden of OSAS.

Using this 3-question screening tool and clinical signs for children with suspected OSAS, children can be stratified into low, moderate and high-risk categories for OSAS. Proposed guidelines for management of these children in low resource settings are:
Low risk: screen negative for all 3 questions. These children can be booked for elective overnight oximetry.
Moderate risk: screen positive for the 3 questions with grade 1 or 2 tonsils, expedite overnight oximetry, if MOS 3 or 4 confirmed, then expedite surgery
High risk: screen positive for the 3 questions with grade 3 or 4 tonsils, expedite surgery as above

There were some limitations to our study. The small sample size did not allow for sufficient statistical power to determine the effectiveness of clinical symptoms and tonsillar size in predicting children with MOS 3 or 4. However, individual risk ratios for tonsillar size grade 3 or 4 (RR 1.59) and witnessed apnoeic events (RR 1.31) point to these as potential tools that need to be explored further in larger studies. Sensitivity and specificity of the combined symptom score of apnoeic events, ‘struggling to breathe during sleep’ and ‘needing to wake the child up to breathe’ improved when ‘tonsillar size' was added. The likelihood and precision of predicting grade 3/4 MOS also improved. This symptom cluster and clinical finding may prove useful in distinguishing children with MOS 3 or 4 from milder forms of OSAS and should also be further explored in larger studies.

Conclusion

Identifying children with suspected OSAS who require overnight oximetry can be achieved using a simple 3 question screening tool: witnessed apnoeic events, struggling to breathe and the need to shake them awake to breathe. This is more precise if the child has an additional clinical finding of grade 3 or 4 tonsils. These children should have their surgery expedited. In addition, any child with a MOS 3 / 4 score on OO needs to have expedited surgery

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23 July 2018

HREC REF: 456/2018

Drs S Peer & N Zampoli
Division of Paediatrics
Red Cross Children's Hospital
Rondebosch

Dear Drs Peer & Zampoli

PROJECT TITLE: THE UTILITY OF OVERNIGHT OXIMETRY FOR SCREEENING CHILDREN WITH SUSPECTED OBSTRUCTIVE SLEEP APNOEA SYNDROME IN A RESOURCE-CONSTRAINED SETTING: A PROSPECTIVE STUDY (MMeD-candidate-Dr R Mlauzi)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 July 2019.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

We acknowledge that the student: Dr Raphael Mlauzi will also be involved in this study.

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938