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CLINICAL EXPERIENCE

Pediatric polygraphy: A 6-year experience

Poligrafía pediátrica: Experiencia de 6 años

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Abstract

The early diagnosis of Sleep Disordered Breathing (SDB) may allow proper intervention. Currently, polygraphy (PG) is a reliable and accessible alternative. **Objective:** To describe and analyze the PG of children ≥ 1 year old with suspicion of SDB. **Patients and Method:** PG of children ≥ 1 year old and adolescents from Concepcion, Chile, with suspected SDB were included, from December 2011 to August 2017. Demographic, clinical and polygraphic variables were collected. It was used descriptive statistics, expressing results in median and range. The association between apnea-hypopnea index (AHI) and oxygen saturation was determined by Spearman's Rho, considering significance of $p < 0.05$. **Results:** 190 studies were analyzed. Age 7.9 years old (1.0-20.6), 61% males. Diagnosis: neuromuscular disease (NMD) (24.2%), chronic lung damage (21.1%), upper airway obstruction (UAO) (19.5%), neurological damage (11%), Down syndrome (8.9%), upper airway malformations (7.4%), central hypoventilation (3.7%), obesity (2.6%), and others (1.6%). 55.3% were altered PG, with 53.3% of mild Obstructive Sleep Apnea Hypopnea Syndrome (OSAHS), 30.5% moderate, and 16.2% severe. There were no significant differences in AHI between groups of pathologies ($p = 0.032$), highlighting a higher AHI in obese patients 9 (0.41-51), and those with NMD 23.9 (0.4-36.6). It was found association between AHI and oxygen saturation parameters: mean saturation (rho = -0.425; $p = 0.001$), minimum (rho = -0.654; $p = 0.001$), and oxygen saturation below 90% (rho = 0.323; $p = 0.001$) in the whole sample. **Discussion:** There was a high percentage of OSAHS in at-risk pediatric patients, especially in those with NMD and obesity. PG is an accessible and implementable tool in a public hospital, a situation that can potentially be extrapolated to other healthcare centers.

Keywords:
Polygraphy;
Apnea;
Sleep Disordered Breathing;
Sleep Studies

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Introduction

Sleep-disordered breathing (SDB) includes a broad entities spectrum, ranging from primary snoring, and upper airway resistance to obstructive sleep apnea-hypopnea syndrome (OSAHS) in its different degrees (mild, moderate, and severe)[1,2]. International epidemiological meta-analyses account for 7.5% of habitual snorers, and 1-4%[2,3] infant OSAHS prevalence.

There are some pathologies in children and adolescents where the SDB frequency is much higher, such as adenotonsillar hypertrophy, obesity, genetic diseases, neuromuscular diseases (NMD), cerebral palsy, and craniofacial malformations[4], therefore, diagnostic efforts should be considered in its management.

SDB can potentially generate multisystem consequences that include neurocognitive, cardiovascular, and metabolic alterations; which are related to the severity degree and are identified through a sleep study[5,6].

Polysomnography (PSG) is the test of choice for diagnosing SDB, however, due to its limited availability and high cost, alternatives such as polygraphy (PG) are used, which is more accessible, has a lower cost, and its results may be more representative of the child usual respiratory pattern, as it can be performed at home[4]. PG has a high concordance index regarding PSG for the SDB study; it has been used and recommended in different groups of patients at risk[7-10]. Recently published international guidelines consider that PG is a very useful test in the pediatric population and the main alternative to PSG[11].

Adequate diagnosis and timely intervention could allow to avoid or decrease the potential SDB consequences, especially neurocognitive ones, and additionally, they can reduce its impact on the quality of life and health costs[12,13].

The objective of this study was to describe and analyze PGs performed on children over 1 year of age with suspected SDB treated in a public hospital in our country.

Patients and Method

Design

Retrospective study that included PG records performed on children over 1 year of age and adolescents, with SDB suspicion referred to the *Sleep Medicine Center* of the Pediatrics Service, Guillermo Grant Benavente Hospital, Concepción, between December 2011 to August 2017. Different specialists referred patients at OSAHS risk, according to information reported by parents and legal guardians about sleep (Appendix 1).

Demographic, clinical, and polygraphic variables were collected, considering total study duration, validated study duration, apnea-hypopnea index (AHI), mixed obstructive apnea-hypopnea index (MOAHI), central apnea index (CAI), minimum and average oxygen saturation, and oxygen saturation percentage under 90% during the study. Patients younger than 1 year of age and those using oxygen therapy or mechanical ventilation during the test were excluded. Those patients with more than one polygraphy, only the first study was considered.

Polygraphy

The Alice PDx System (Philips Respironics) was used to perform PG which included the following channels recording: nasal flow with nasal pressure transducer, oxygen saturation, heart rate, microphone, and chest and abdominal belts which was installed by a professional trained in technical and methodological aspects of the test (Figure 1).

Acceptability criteria were those with at least 4 hours of recording, with less than 20% of the recording time occupied by disconnections and/or mechanisms. Registrations that did not meet these criteria were excluded. The OSAHS severity was categorized according to the AHI value in normal (AHI < 1), mild (AHI 1-5), moderate (AHI 5-10), and severe (AHI > 10)[5,6].

Statistical analysis

Results for variables with normal distribution were expressed in average and standard deviation, while data without normal distribution were expressed in median and range. The Kruskal-Wallis test was used to compare the polygraphic parameters of altered test among pathologies. Additionally, the correlation between AHI and oxygen saturation variables was determined by calculating the Spearman's rho. Finally, partial correlations were made, determining the type of pathology as a confounding variable. Statistical analysis was performed with the SPSS statistics v23 statistical software, defining a $p< 0.05$ value as significant.

Results

During the study period, 366 PGs were carried out. 154 (42%) were excluded due to oxygen therapy use, mechanical ventilation, and repeated test. Out of the 212 remaining PGs, 22 cases (10.37%) were excluded due to uninterpretable records of which 14 were due to insufficient time, 7 due to flow sensor loss, and 1 due to oximetry sensor loss. Finally, 190 PGs were available for analysis (Figure 2).

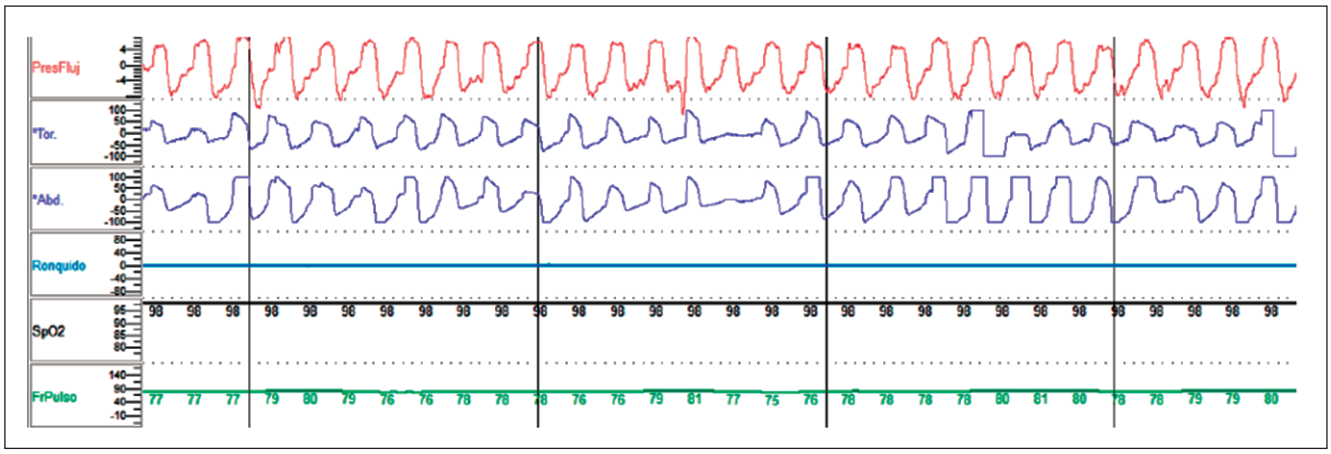


Figure 1. Normal polygraphic recording. In descending order, evaluated channels are shown; nasal flow with pressure transducer, thoracic band, abdominal band, microphone, oxygen saturation and heart rate.

The median age of the sample was 7.8 years (1.0-20.6), and 61% (n = 116) were male. Regarding the patient diagnoses, 24.2% presented NMD, 21% chronic lung damage, and 19.5% upper airway obstruction (UAO) (n = 37). Table 1 shows the studied patients' diagnoses.

The average PGs total duration was 9.1 ± 1.9 hours, with a validated time period of 7.2 ± 1.3 hours. The average test oxygen saturation was 95.9 ± 2.6%, with a minimum average oxygen saturation of 85.1 ± 10.9%. The median AHI was 1.6 (0-51), MOAHI was 1.5 (0-50), and CAI was 0 (0- 15.1).

44.7% (n = 85) of the analyzed PGs were normal. Out of the altered ones, 53.3% (n = 56) were classified as mild OSAHS, 30.5% (n = 32) as moderate, and 16.2% (n = 17) as severe. Table 2 shows the altered PGs results according to diagnostic category.

No significant difference was found in AHI among pathology groups (p = 0.032), however, a higher AHI stands out in obese patient groups 9.0 (0.41 - 51.0); NMD 3.9 (0.4-36.6), and those with neurological damage 3.7 (0.5-13.9).

Correlation was established between AHI and mean oxygen saturation (rho = -0.425; p = 0.001), AHI and minimum oxygen saturation (rho = -0.654; p = 0.001), and AHI and under 90% oxygen saturation (rho = 0.323; p = 0.001) over the entire sample (Figure 3).

Finally, in the partial correlations analysis, there was correlation between AHI and average oxygen saturation (rho = -0.372; p = 0.001), AHI and minimum oxygen saturation (-rho = 0.670; p = 0.001), and AHI and under 90% oxygen saturation (rho = 0.195; p = 0.007).

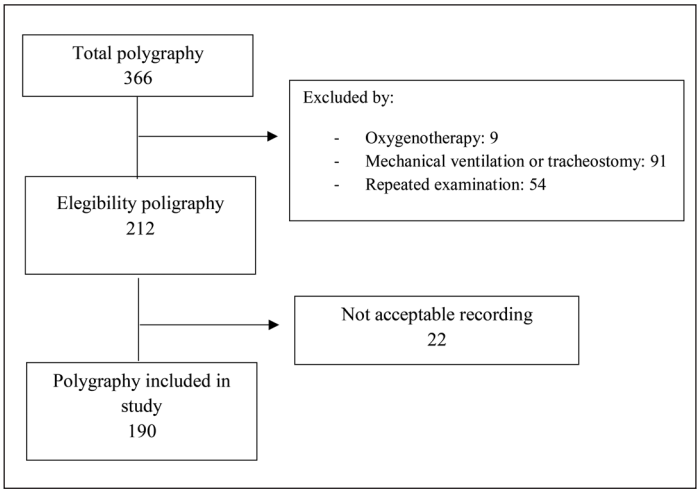


Figure 2. Eligibility criteria flowchart.

Table 1. Main diagnoses of patients included in study

Diagnoses	n	(%)
Neuromuscular diseases	46	(24.2)
Chronic lung damage	40	(21.1)
Upper airway obstruction	37	(19.5)
Neurological damage	21	(11)
Down syndrome	17	(8.9)
Upper airway malformation	14	(7.4)
Central hypoventilation syndrome	7	(3.7)
Obesity	5	(2.6)
Others	3	(1.6)
Total	190	(100)

Table 2. Results of polygraphs altered according to diagnosis

Variable	NMD	CPD	UAO	ND	DS	UAM	CHS	OB	Others	p-value[a]
(n)	46	40	37	21	17	14	7	5	3	-
PG altered (n/%)	34/73.9	19/47.5	20/54.05	16/76.1	17/100	11/78.5	3/42.8	3/60	2/66.6	-
Age	11.2 (1.3-16.5)*	5.38 (1.5-17)	4.2 (2.2-12.5)*	7.5 (1-17.5)	5.6 (1-12.2)	4.9 (1.5-15.8)	14.3 (13-15)	12 (8-13.5)	9.9 (9.6-10.2)	0.001
Validated total time (hrs)	7.3 (4-10.5)	7.4 (4-9.7)	7.5 (6-9)	7 (4.8-9.4)	7.5 (5-10.3)	7.5 (5.2-8.6)	7.1 (6.5-7.4)	7.5 (6.18.2)	6.9 (6.6-7.3)	0.858
Validated time (min)	441 (243-630)	444 (240-582)	449 (360-540)	422 (288-564)	450 (300-618)	450 (312-516)	426 (390-444)	450 (363-492)	417 (396-438)	0.872
Main saturation	97 (89-98)	95 (89-98)	97 (93-98)	96 (89-98)	96 (87-98)	96 (94-98)	96 (92-96)	96 (92-97)	85 (80-89)	0.065
Minimal saturation	87 (0-94)	86 (69-93)	86 (58-94)	85 (69-95)	87 (65-94)	89 (60-93)	87 (73-87)	88 (50-90)	72 (59-85)	0.814
AHI	3.9 (0.4-36.6)	3.2 (0.4-10.3)	2.7 (0.3-18.2)	3.7 (0.5-13.9)	2.7 (0-19.1)	1.8 (0.5-20.6)	3.4 (1.2-10.5)	9 (04.1-51)	1.1 (0.3-2)	0.032
MOAHI	3.6 (0.4-24.9)	2.6 (0-9)	2.2 (0.2-18.2)	3.5 (0.5-13.7)	2.6 (0-19)	1.8 (0.5-20.2)	3.4 (1.2-9)	9 (4-50)	1.1 (0.3-2)	0.0372
CAI	0 (0-15.1)	0 (0-8.5)	0 (0-1)	0 (0-4)	0 (0-0.4)	0 (0-0.4)	0 (0-1)	0.1 (0-1)	0 (0-0)	0.978

NMD: neuromuscular disease; CPD: chronic lung damage; UAO: upper airway obstruction; ND: neurological damage; DS: Down syndrome; UAM: upper airway malformation; CHS: central hypoventilation syndrome; OB: obesidad; PG: poligraph; AHI: apnea-hypopnea index; MOAHI: mixed obstructive apnea-hypopnea index; CAI: central apnea index. [a]Kruskal Wallis test. *Statistically significant difference between groups p < 0,05 NMD y UAO.

Discussion

This study aimed to show the experience with polygraphics studies in patients over than one year of age, at risk of SDB, treated in a tertiary care public hospital of our country, considering the wide variety of clinical entities that require an evaluation with this type of diagnostic tools to adopt therapeutic actions[14].

It is important to emphasize that PSG is the test of choice to diagnose SDB, however, its availability in our sphere is currently quite reduced, thus some international and expert recommendations suggest using PG as an alternative test to improve diagnostic accessibility[11,15].

Through this study, it was possible to verify that 90% of the studies met the validity criteria in the first test, performance similar to that observed in previous studies both at the hospital and at home[9,16]. This may also be interpreted as that 10% of patients must repeat the test in order to interpret it more reliably. The main reasons attributed to the test validity were insufficient time recording and flow sensor loss.

The main diagnoses of the studied patients included chronic entities, such as NMD and chronic lung damage, however, the higher SDB prevalence in pediatric patients is linked to adenotonsillar hypertrophy. This is explained because children were recruited mainly from a sleep medicine center and referred by specialist professionals, generally in complex clinical settings, where this study was relevant for establishing actions such as ventilatory support and/or specific surgeries.

55% of the PGs were altered, in different degree according to the established criteria, and without significant difference between the respiratory indexes and the type of pathology, although there was a tendency to greater alteration in obese patients, NMD, and neurological damage. Regarding the age of these patients, there were significant differences between two groups only (NMD and UAO).

Epidemiological studies show that 1-4% of children present OSAHS, however, this percentage increases when there are risk factors and/or nosological entities such as NMD, craniofacial malformations, obesity, genetic syndromes, chronic lung disease, among others[2,3,14]. The studied population has a high SDB risk, which explains the high alteration percentage.

In conclusion, there is a high OSAHS percenta-

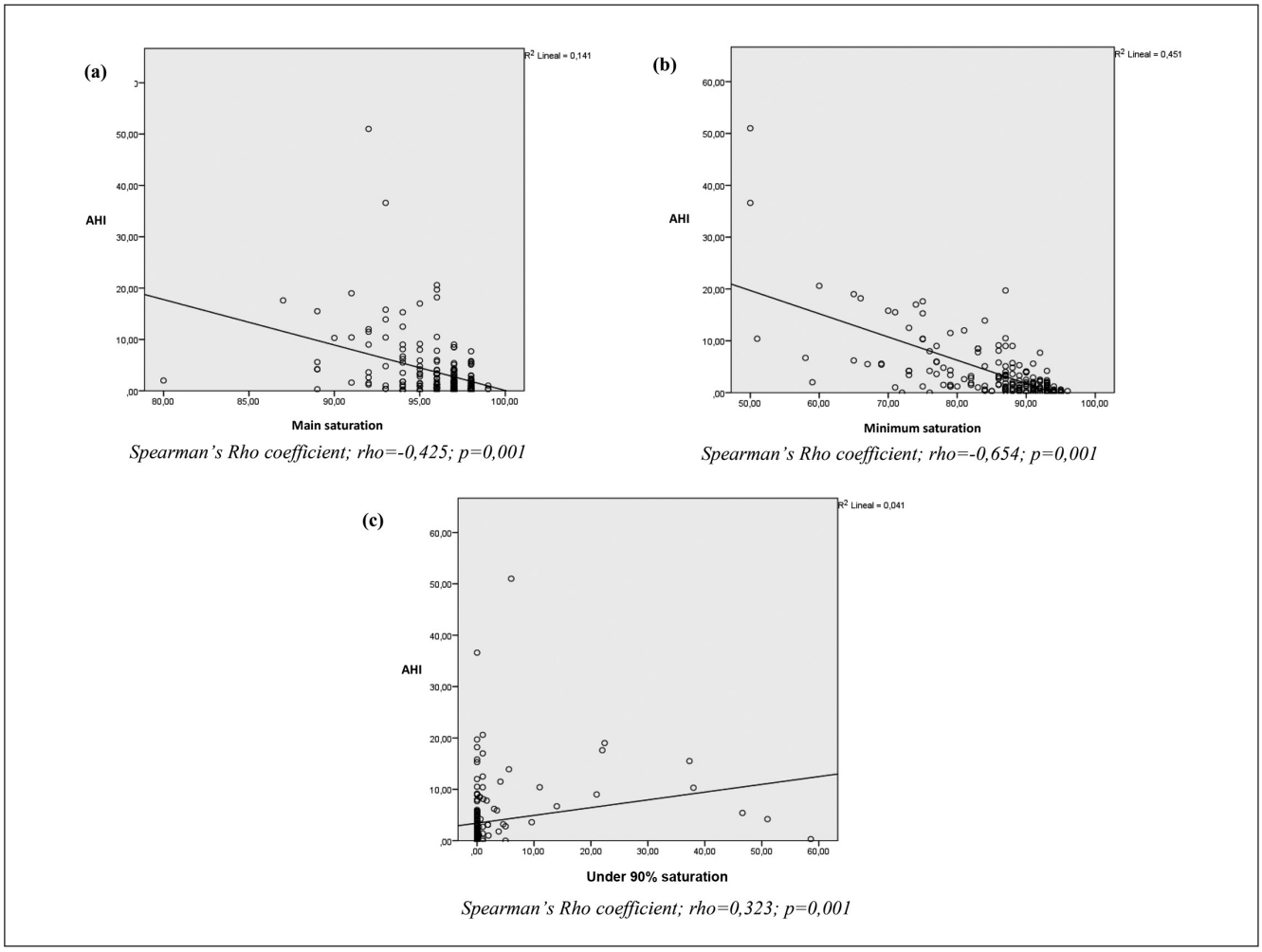


Figure 3. Correlation between AHI and Main saturation **(a)**, Minimum saturation **(b)** y Under 90% saturation **(c)**.

ge in at-risk pediatric patients, especially those with NMD and obesity. 90% of the PGs were considered interpretable, a figure similar to that reported in other published experiences. This study suggests that PG is an accessible and implementable tool in a public hospital in Chile for the SDB study, a situation that can potentially be extrapolated to other health care centers.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

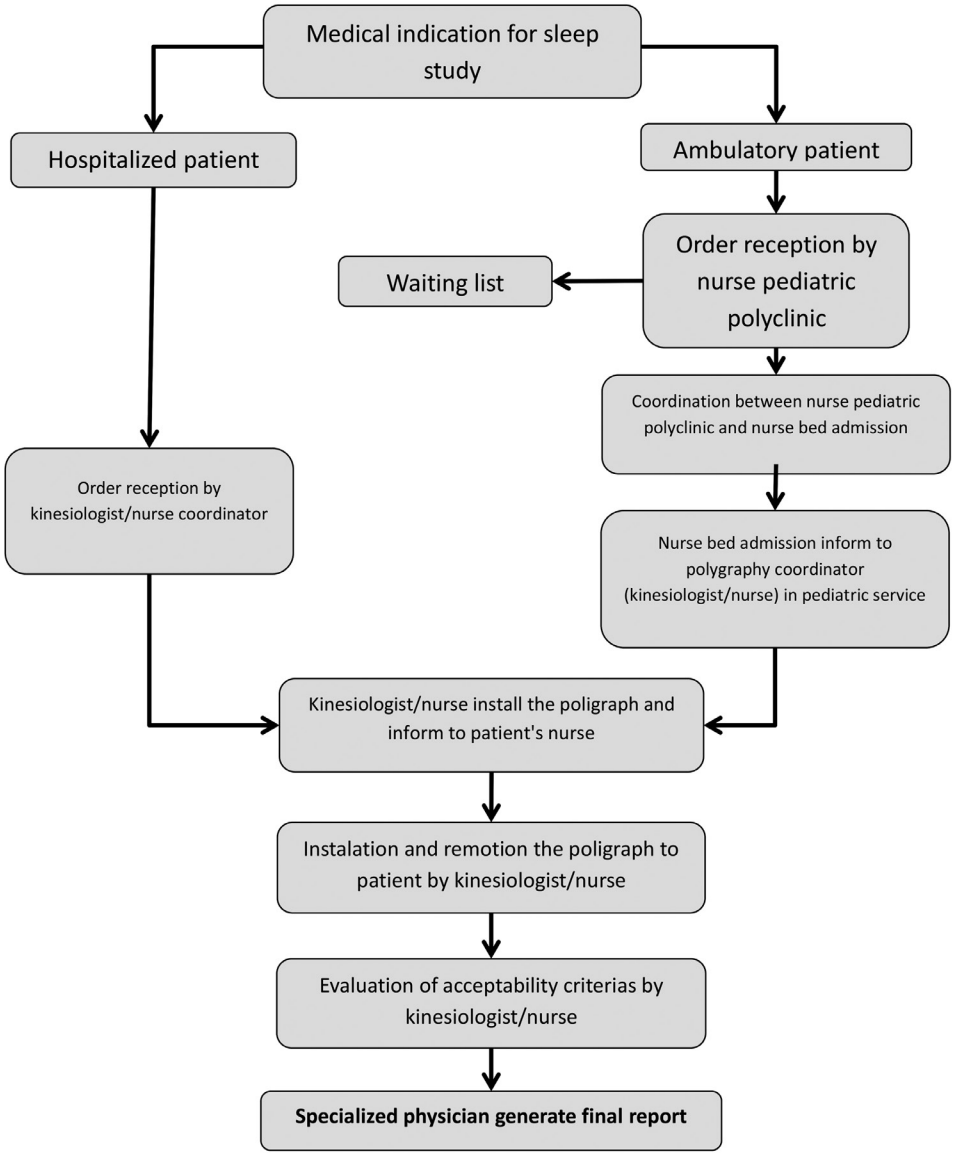
Financial Disclosure

Authors state that no economic support has been associated with the present study.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Appendix 1: Derivation flowchart, implementation and report of polygraphy



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