Pediatric Neurology 57 (2016) 39–45

Contents lists available at ScienceDirect

Pediatric Neurology

journal homepage: www.elsevier.com/locate/pnu

Original Article

Establishing a Role for Polysomnography in Hospitalized Children

Nataliya Tkachenko MD [a,b,1], Kanwaljit Singh MD [c,1], Nicolas Abreu MD [d], Anne Marie Morse DO [e], Christy Day RPSGT [a], Kathyrn Fitzgerald PNP [f], Mikhail Kazachkov MD [f,2], Sanjeev Kothare MD [a,*,2]

[a] *Pediatric Sleep Program, Department of Neurology, New York University Langone Medical Center, New York, New York*
[b] *Department of Pediatrics, Dnepropetrovsk State Medical Academy, Dnepropetrovsk, Ukraine*
[c] *Department of Pediatrics, University of Massachusetts School of Medicine, Worcester, Massachusetts*
[d] *Department of Pediatrics, New York University, Langone Medical Center, New York, New York*
[e] *Division of Child Neurology, SUNY Downstate, Brooklyn, New York*
[f] *Division of Pediatric Pulmonology, Department of Pediatrics, New York University Langone Medical Center, New York, New York*

ABSTRACT

BACKGROUND: Children with medical complexity have a high prevalence of sleep disorders. However, outpatient polysomnography to evaluate for these conditions may be difficult to perform because of lack of skilled nursing care. The aim of this study was to explore polysomnography indications in hospitalized children and assess its impact on patient care. **METHODS:** Data from 85 inpatient polysomnographies of 70 children hospitalized between March and December 2014 were retrospectively collected. **RESULTS:** Sixty percent of patients were boys with ages 6.5 ± 6 years. Chronic respiratory failure was present in 33.8%, airway obstruction due to defects of the tracheobronchial tree or craniofacial abnormalities in 54.3%, neurological complications of the perinatal period in 22.9%, genetic syndromes and neurodegenerative disorders in 31.4%, congenital myopathies in 5.7%, metabolic diseases in 4.3% and congenital cyanotic heart defects in 4.3%. Indications for polysomnography included assessment of chronic pulmonary disease (60%), ventilator requirements (41.2%), apnea/desaturation (23.5%), and acute life-threatening events (1.2%). Abnormal results were found in 89.4%. The observed diagnosis was obstructive sleep apnea in 64.7%, signs of chronic lung disease in 34.1%, hypoventilation in 9.4%, periodic breathing in 3.5%, and periodic limb movement of sleep in 4.7%. The following interventions were performed: adjustment of ventilator parameters (45.8%), positive airway pressure initiation (24.7%), otorhinolaryngology referral (30.6%), supraglottoplasty (2.4%), tracheostomy decannulation (2.4%), and tracheostomy placement (3.5%). Nine patients had available follow-up polysomnograms, all showing improvement in sleep variables after adherence to recommended interventions. **CONCLUSIONS:** In individuals with complex medical disorders, inpatient polysomnographies give invaluable information to guide immediate medical decision making and should be strongly considered if resources allow this.

Keywords: inpatients, polysomnography, child, infant, child, hospitalized, sleep disorders

Pediatr Neurol 2016; 57: 39-45

Work performed at: New York University Langone Medical Center, New York, New York.

Disclosure: None of the authors have any financial support or conflicts of interest to disclose. No off-label use of drugs or products has been discussed in the article.

Article History:
Received July 20, 2015; Accepted in final form December 21, 2015

* Communications should be addressed to: Dr. Kothare; Pediatric Sleep Program; 223 East 34th Street; New York, NY 10016.
E-mail address: Sanjeev.Kothare@nyumc.org
[1]First coauthors.
[2]Last coauthors.

0887-8994/$ – see front matter © 2016 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.pediatrneurol.2015.12.020

Introduction

Sleep disordered breathing is a major cause of morbidity and mortality in children with neuromuscular disease with a prevalence of greater than 40%,[1] a 10-fold greater rate than in the general population.[2] Congenital craniofacial malformations and defects of the tracheobronchial tree in children are also associated with high risk for sleep disordered breathing.[3,4] Another high-risk group includes children with neurodevelopmental delay.[5] These high-risk patients, therefore, have a strong indication for evaluation by polysomnography (PSG) for the detection and management of sleep disordered breathing. However, routine outpatient sleep studies are often difficult to obtain in such patients because of their complex medical issues that require skilled nursing care. Alternatively, PSG in this select group of patients could be performed in the hospital.

Limited data are available on the validity of performing inpatient sleep studies. A recently published study used inpatient PSG to evaluate adults with cardiac conditions who were found to have symptoms of sleep disordered breathing and demonstrated improved outcomes following appropriate selection, initiation, and titration of positive airway pressure therapy.[6] Similar data on the utility of performing inpatient PSGs in children are lacking.

The aim of this study was to explore the use of PSG in hospitalized children and assess its impact on patient care. The research question was to evaluate the contribution of inpatient PSG in the diagnosis and treatment of patients with medical complexities.

Methods

Patient selection

Between March and December 2014, 85 PSGs were performed on 70 children hospitalized at a single medical center (NYU Langone Medical Center) in the general pediatrics unit (15 patients), the pediatric intensive care unit (50 patients), or the neonatal intensive care unit (five patients). Nine patients were studied on more than one occasion to monitor changes in respiratory parameters and sleep variables following treatment interventions. Exclusion criteria were the presence of acute exacerbation of respiratory decompensation or acute infections.

Parental consent was obtained for every sleep study. Demographics, before admission diagnoses, PSG indications, findings, and interventions were retrospectively collected.

No sedation was used during sleep studies. PSG was performed 24 hours after bronchoscopy, so that the sedation effect on PSG parameters was eliminated.

Sleep studies were performed in all children with their baseline home respiratory status. These patients were hospitalized specifically to perform sleep studies. PSG was ordered by a pediatric pulmonologist or sleep specialist for diagnosing sleep disorders such as obstructive sleep apnea and assessing respiratory status (e.g., oxygenation, respiratory rate, degree of hypoventilation) and to guide in treatment options based on its results.

Most of the patients were residents of nursing homes with constant access to skilled nursing care that included tube feeding and suctioning, oxygen delivery, ventilatory assistance, and cough assist. Because skilled nursing care is not available in standard sleep laboratories, patients with medical complexities were hospitalized to the general pediatrics floor or the pediatric intensive care unit to perform these sleep studies.

Sleep studies were performed by certified sleep technologists, who were present during the entire procedure at the bedside. All patients were kept in single rooms, thus sleep interruption during the procedure was minimized. Sleep studies were successfully completed in all patients.

All patients underwent PSGs according to established American Academy of Sleep Medicine (AASM) guidelines.[7] The data were analyzed after approval of the institutional review board of the institution.

Polysomnogram

All patients underwent at least one full-night inpatient PSG. Each PSG was conducted and scored by certified sleep technicians and scorers using the 2012 AASM guidelines.[7] PSG was performed using digital polysomnographic equipment (Natus Sleepworks, Natus Medical Incorporated, San Carlos, CA).

Detailed sleep parameters were assessed, including sleep latency, sleep efficiency, arousal index, periodic limb movement index, oxygen saturation nadir, apnea-hypopnea index, and peak $ETCO_2$.

The PSG diagnosis of the patients was based on the following definitions: obstructive apnea was defined as cessation of airflow for two respiratory cycles, with $\geq$90% reduction in airflow for $\geq$90% of the event with ongoing respiratory effort; hypopnea as decrease in amplitude of airflow signal by >30% lasting two respiratory cycles and accompanied by oxygen desaturation of $\geq$3% or an arousal. Central events were scored when there was no respiratory effort and the event lasted 20 seconds or at least two breaths with an arousal, awakening, or at least 3% oxygen desaturation. Periodic limb movements of sleep were defined as repetitive jerking of the legs during sleep $\geq$5 times per hour, 0.5-5 seconds in duration, in clusters of four or more separated by 5 to 90 seconds.

Patients with obstructive sleep apnea were classified according to the severity of their respiratory insufficiency. An apnea-hypopnea index of less than 1.5/hour was considered normal. Mild, moderate, and severe obstructive sleep apnea were determined based on an apnea-hypopnea index of 1.5-5/hour, 5-10/hour, and greater than 10/hour, respectively.

Periodic breathing was defined as more than three episodes of central apnea lasting more than three seconds separated by no more than 20 seconds of normal breathing; periodic breathing was further scored as the percentage of total sleep time.

Continuous positive airway pressure (CPAP) titration was begun at 4 cm of water and adjusted in increments of 1 cm of water until apneas, hypopneas, and snoring were eliminated and isolated electroencephalographic arousals were minimized using a split night protocol. Bilevel support was initiated at 8/4 and increased by 1 cm to 2 cm as needed to treat underlying hypoventilation. Ventilation using a volume or pressure cycled ventilator was given through tracheostomy port.

Data acquisition

All hospitalized patients who had overnight PSG were included in the study. Data analyzed included patient gender, age at PSG, diagnosis, indication for PSG, and PSG variables (sleep latency, sleep efficiency, arousal index, periodic limb movement index, oxygen saturation nadir, and apnea-hypopnea index). We also reviewed the recommended interventions in these children. For patients in whom follow-up data were available, outcomes after implementing these interventions were also assessed.

Statistical analysis

Descriptive analyses are reported on the study population, PSG indications, results, and interventions performed. The non-normative distribution of data and a small sample size require a nonparametric test; therefore the data were analyzed using the Wilcoxon signed rank sum test to compare preintervention and postintervention PSG parameters in the study. Significance was taken at $P < 0.05$.

Results

Population

During the study period, 85 inpatient sleep studies were performed in 70 children (Table 1). Among these patients,