

Sharing Innovations and Insights with Our Partners in Care

PEDIATRIC ROUNDS

Untreated sleep disorders in children can lead to neurocognitive dysfunction. Sleep studies help identify these disorders and, in some cases, find information that suggests other serious medical conditions.

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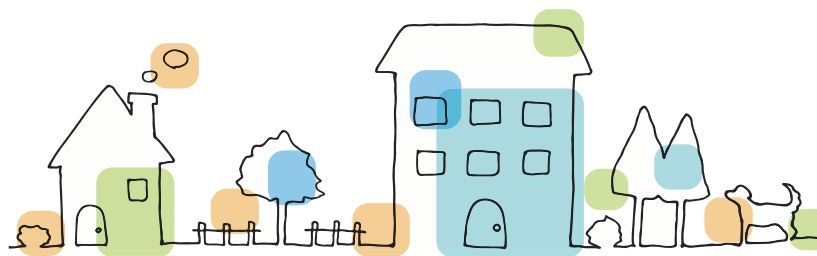
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UPFRONT

Insights and transparent talk from leadership

To refer a patient, call (800) 266-0366.

Helping our community

To meet significant challenges, we offer solutions

BY JASON A. JARZEMBOWSKI, MD, PhD

Recently, providers in the Children's Specialty

Group (CSG) participated in a virtual retreat where we had the opportunity to discuss the many issues we are facing as part of the Wisconsin community in general and the health-care community in particular. We discussed the uncertainty and challenges facing us and our patients, and how we might address them.

At the top of that list, of course, is our continued need to respond to the COVID-19 pandemic. In 2020, we adopted safety protocols for staff and patients, temporarily cut back on surgeries that were nonemergent, and expanded telehealth services. We also adjusted staffing levels in the hospital and developed contingency plans that allow us to cover for providers who are sick or in quarantine. We've worked hard to restore our patient care services and operations to as close to normal as possible under the circumstances.

We've also looked at how CSG and Children's can use our expertise and capacity to help the wider healthcare community. We have accepted young adults — ages 26 and under — who have conditions that pediatricians normally see, like diabetes and asthma. We've also offered to take kids who are hospitalized at other health systems to help free up adult beds so desperately needed during this pandemic.

In the face of all today's challenges, we are still pursuing our mission to provide the best care for patients, and try to take care of ourselves, each other and our community.



Jason A. Jarzembowski, MD, PhD, Interim Chief Executive Officer, Children's Specialty Group; Medical Director, Pathology and Laboratory Medicine, Children's Wisconsin; Vice Chair and Professor, Department of Pathology, and Interim Senior Associate Dean of Clinical Affairs, Medical College of Wisconsin

Download the First Five Minutes App

The First Five Minutes app — developed in 2017 by UWM's App Brewery, the Medical College of Wisconsin and Children's Wisconsin — is a streamlined, digital version of the First Five Minutes booklet that physicians, nurses, pharmacists, respiratory therapists and paramedics rely on to assist with decision-making during Code events. Entering a patient's age or weight produces a table with dosing and other standardized information, saving time and reducing the potential for error. Look for the updated First Five Minutes booklet and app coming out this year.

The free First Five Minutes app is available on the App Store and Google Play.



JA Jarzembowski, MD, PhD

NEWS & NOTES

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Children's Wisconsin

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Meet the Regional Medical Directors

Children's newest physician leaders are ready to serve

Children's Wisconsin is thrilled to welcome three new Specialty Group Regional Medical Directors to our family. After serving as the Children's Specialty Group Medical Director of Regional Services for 15 years, Mike Earing, MD, left the organization in May 2020. The position is now split into three geographical areas of responsibility: Northeast, Southeast and West.

Since July, these three physicians have been working to build relationships and grow services within these communities.

Look for the 2021 Children's Specialty Group Pocket Directory to arrive in your mailbox. Didn't receive yours? You can request a copy at childrenswi.org/medical-professionals/tools-and-resources/pocket-directory.



**SOUTHEAST REGION:
Alexander J. Khammar, MD**

As an ophthalmologist, Dr. Khammar is not only focused on how children see, but how they learn and adapt to their environments. He has been a member of the Children's Ophthalmology department since 2015, and like his colleagues, he is committed to providing premium medical and surgical care to his patients.



**NORTHEAST REGION:
Matthew W. Buelow, MD**

Dr. Buelow joined the Children's Cardiology department in 2016. He is board certified in Adult Congenital Heart Disease and Pediatric Cardiology. He has conducted extensive research and published scholarly papers on these subjects in order to best serve his patients.



**WEST REGION:
John V. Kryger, MD**

Since 2009, Dr. Kryger has served at Children's in the Urology department under the guiding principle that he would ensure every child is cared for exactly as if it were his own child. He works closely with patients and their families to make sure they understand their conditions and treatment options.

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School challenges

Supporting families with virtual learning

We know from research on the shift to virtual learning in spring 2020 that this educational format can have negative effects. Findings included lower morale among students and teachers, as well as decreased student attendance and contact with teachers. Effects were more severe in school districts with larger numbers of students from low-income families.

“Health care providers play an important role in supporting families during COVID-19,” says Sarah Rysdyk, PsyD, a child psychologist at the Child Development Center at Children’s Wisconsin. “One of those roles can be to help parents respond to their children’s mental health and virtual schooling needs.”

In a Connect with Children’s webinar in 2020, Dr. Rysdyk shared some tips for helping families achieve virtual schooling success:

- 1 Help parents define their role.** When kids are learning from home, it’s often necessary for parents to be more involved. But parents should be careful not to take on too much. “There’s a push for many parents to take on that role of teacher and sometimes even do more work than they should for their child,” Dr. Rysdyk said. Encourage parents to reach out to the teacher to ask for support if a child is struggling. If it’s age-appropriate, have the child email the teacher and ask for additional resources to explain concepts they don’t understand.
- 2 Boost motivation.** Some kids don’t see that what they do during virtual schooling has an impact on future school years and maybe even on applying to college. “For many kids, motivation can come from starting the day by setting three goals,” Dr. Rysdyk said. The goals should be specific and challenging, yet achievable. At the end of the day, if they achieve those three goals, they can earn a reward.
- 3 Focus on focus.** Kids with ADHD often have a hard time managing impulsivity and being organized. For these kids, it’s important that their work area has as few distractions as possible and allows them to get up and move when they need to. Parents should have their child write down all their assignments in one place (e.g., in a planner or on a whiteboard) and have a check-out at the end of each day to make sure all assignments were completed and turned in. “That’s a big one for kiddos with attention difficulties — they can say, ‘I did it,’ and they did do the work, but they didn’t make that final click to turn it in,” Dr. Rysdyk said.
- 4 Encourage mindful praise.** In a tough year like this one, parents want to give their kids all the encouragement they can. But how they praise their child matters. “They should not just focus on if those five math problems were correct, but maybe the fact that a kiddo actually did all five math problems without getting up from the table,” Dr. Rysdyk said. Being specific with praise and noticing small wins reinforces positive behaviors.



View “Supporting Families During COVID-19” and other recorded webinars at childrenswi.org/cme.

Back to school after concussion

Return to Learn gives schools knowledge and resources for head trauma

When children are in school, they spend many of their waking hours with teachers and school staff. These adults can play an important role in kids' physical health, as well as their educational well-being.

When a student suffers a concussion, keeping kids in school with adjustments is beneficial for recovery, but this process is highly individualized. How can teachers, counselors, school nurses, school psychologists and administrators help a student safely return to the classroom?

Children's Wisconsin Sports Medicine physician, Kevin D. Walter, MD, and licensed athletic trainer Trina O'Malley, MS, have developed a professional e-learning course, called Return to Learn. It is designed to educate and provide recommendations for returning students to the classroom after they have suffered a concussion.

WHAT IS RETURN TO LEARN?

Return to Learn is a free online program designed primarily for middle and high school educators, but it works for all ages. This Children's program is based on the American Academy of Pediatrics' guidelines and helps school staff members understand how to help students who have suffered concussions get back to the classroom without prolonged recovery. The approximately one-hour online course offers tools for schools to take over the Return to Learn process, as the needs of each school, teacher and student are unique.

Course objectives are:

- To better understand concussions
- To understand the complexities of Return to Learn
- To provide resources to guide implementation of Return to Learn in school settings

WORKING WITH SCHOOLS

Dr. Walter and Trina want to partner with schools through the Return to Learn program. Children's Wisconsin offers e-learning courses, resources and medical guidance to schools when needed.

"We are committed to helping educators support kids returning to academics safely after sustaining a concussion," Dr. Walter says. "We believe this year it's more important than ever given the struggles they face in light of the pandemic. This webinar is helpful for educators in any setting, whether they are in a traditional classroom or in a virtual setting."

To learn more or to sign up for the Return to Learn course, visit healthykidslearnmore.com/concussion.

Breakthroughs in childhood cancer

A new clinical trial takes CAR-T therapy to the next level



Julie An M. Talano, MD, is a pediatric bone marrow transplant and cellular therapy physician at Children's Wisconsin and a professor at the Medical College of Wisconsin.

For the past two years, Children's Wisconsin has offered new therapies that harness a patient's own immune system to fight cancer. Children's is one of only about 40 pediatric hospitals in the country authorized to treat patients with relapsed or refractory B-cell acute lymphoblastic leukemia (ALL) using CAR-T immunotherapy Kymriah™ (tisagenlecleucel). While Kymriah uses a CD19-directed genetically modified autologous T-cell immunotherapy to treat patients, clinicians and researchers at Children's and The Medical College of Wisconsin have now developed their own CAR-T product targeting both the CD19 and the CD20 antigens.

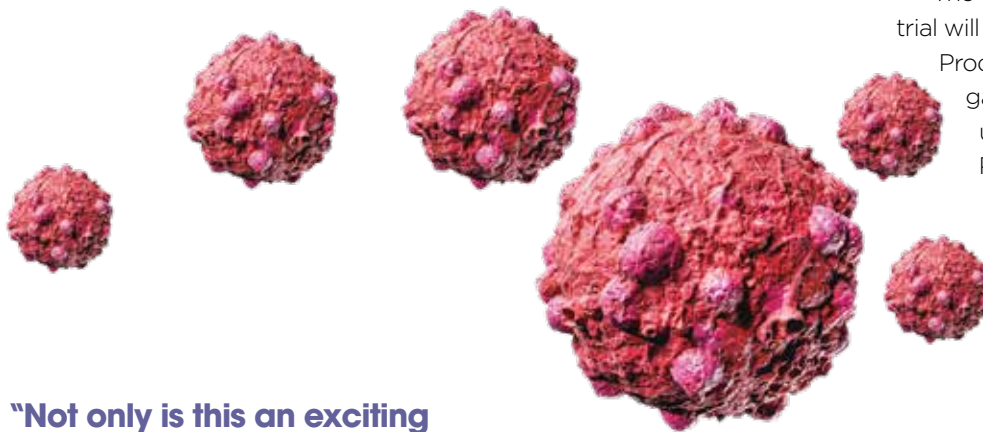
"The thought is that by targeting both the CD19 and CD20, instead of just the CD19 like Kymriah does, hopefully, there is less chance of cancer cells escaping the therapy and returning," says Julie An M. Talano, MD, a pediatric bone

marrow transplant and cellular therapy physician at Children's and associate professor at the Medical College of Wisconsin, who leads the bone marrow transplant clinical research team at Children's.

Children's new clinical trial, which was approved and launched in the fall of 2020, is open to patients with refractory leukemia that have failed traditional therapy and commercial products. Patients must be relatively stable; have adequate heart, oxygen and kidney function; and be under the age of 39.

One of the chief challenges with Kymriah, which led to the development of this new treatment, is the 50% relapse rate. "It also takes several weeks to manufacture the cells (at Novartis)," Dr. Talano says. "And these children are fragile and often quite ill, so there's a very small window of opportunity to help them."

The cells for Children's new CD19 and CD20 trial will be manufactured locally using the Prodigy system in the lymphocyte propagation laboratory at the Medical College under the direction of Bryon Johnson, PhD, and Tyce Kearn, MD, PhD. This on-site manufacturing has shortened the turnaround time for cells from four-to-six weeks down to two



"Not only is this an exciting development for us and our patients, but it was a huge undertaking by multiple people across this campus."

— Julie An M. Talano, MD

For information and eligibility requirements on the CD19 and CD20 clinical trial, visit clinicaltrials.gov and search for NCT04049383.

Possible side effects

One of the greatest risks with any CAR-T immunotherapy treatment is cytokine release syndrome (CRS), in which the large, rapid release of cytokines into the blood from the modified immune cells leads to fever, nausea, headache, rash, rapid heartbeat, low blood pressure and respiratory problems. Neurologic side effects may also occur, including encephalopathy.

"We mandate that the patients be monitored very closely for 30 days after the cells are infused. And we closely monitor them throughout the trial," Dr. Talano says.

Dr. Talano and her team have also worked closely with the emergency room and intensive care unit staff to educate them about the treatment and the early signs of CRS and other complications.

weeks, which is critical for fragile patients. Plus, in the midst of a global COVID-19 pandemic, being able to treat patients locally gives them and their loved ones less to worry about, adds Dr. Talano.

"Not only is this an exciting development for us and our patients, but it was a huge undertaking by multiple people across this campus — and we've also partnered with local scientists who will be studying these samples to learn more about the immune system as well," Dr. Talano says. "These efforts position Children's on the cutting edge of cellular therapy treatments."

Good to great

Children's Physician Referral and Consultation Center revamp aims to improve a highly valued service

**The Children's Wisconsin Physician Referral and Consultation Center**

is a highly valued and well-utilized service; about 2,000 calls come into the center each year.

"As the number of our specialists and the general pediatric market have grown, the number of calls that come in through this line on a daily basis has grown exponentially," says Carey A. Ehlert, MD, a neonatologist at Children's Specialty Group and associate professor of Pediatrics at the Medical College of Wisconsin. To keep up with that growth, Children's is undertaking a multi-year initiative to revamp the Physician Referral and Consultation Center.

Currently, Children's is piloting a new system of call triage for the six specialties with the highest call volumes: cardiology, endocrinology, ENT, gastroenterology, neurology and orthopedic surgery. Referring providers who call the line with a matter related to one of these specialties will answer key intake questions that help Children's determine the level of urgency and, if physician consultation is needed, the best specialist to speak with.

There are also behind-the-scenes improvements, including using Epic to pull in patient data from other hospital systems, so Children's specialists have more information before a consultation. "That's going to translate to a more efficient process, as well as better and safer guidance for these patients, because we'll have all of the information at our fingertips," Dr. Ehlert says.

The pilot program will run through Spring 2021, after which it might be rolled out to more specialties.

"Ultimately, we hope the only changes our referring providers notice is a more efficient way of getting them and their patients the help they need," Dr. Ehlert says. "As always, we welcome feedback on how we can continue to improve this highly valued service."

The Physician Referral and Consultation Center is staffed 24 hours a day.

- Refer a patient
- Discuss a case
- Arrange a transport
- Direct admission

(414) 266-2460**Toll-free: (800) 266-0366**

The future of fertility

The Fertility Navigation program provides an important service for patients

When pediatric cancer patients start their treatment journey,

there are a lot of questions. One important question isn't always top of mind: What does cancer treatment mean for a child's future ability to have their own biological children?

Addressing fertility at the beginning of a patient's treatment is not only a recommended best practice for pediatric cancer programs, but it also helps patients and families feel some modicum of control over a situation that is often beyond their control. Children's Wisconsin's MACC Fund Center for Cancer and Blood Disorders created its Fertility Navigation program in 2019 to ensure that patients receive the fertility support they need.

"We identified two needs," explains Kerri Beckett, MD, pediatric oncologist at Children's. "First, fertility coordination is becoming more complicated, but in a good way, because there are more options. It's very important for current patients to understand what risks they may face. The other need is to support patients who weren't offered these services when they were diagnosed and now as survivors need to be educated on their options. We felt the best way to do this was to have a dedicated fertility team."

BUILDING THE PROGRAM

Katy Tomlinson, BSN, RN, a clinical research nurse, is Children's first dedicated fertility navigator. Tomlinson and her colleagues at Children's developed their program by looking at best practices from other successful programs across the country, as well as their own experience.

"We've learned from research and from our survivors that it's sometimes a difficult topic to talk about," Tomlinson says. "Facing a diagnosis that requires treatment like chemotherapy, radiation, surgery or bone marrow transplant is stressful. Patients are also under time pressure, and it's emotionally overwhelming. That's why this is such an important touch point at the beginning, as well as at any time of significant transition with treatment plans. When we're doing a consult, we take into account the patient's age, stage of development, what their treatment is, how sick they are and many other factors."

Tomlinson has already seen how having these discussions can impact patients' experiences. "Families have been appreciative of the information," she says. "It can be delivered within a hopeful framework, because the goal is to cure children of cancer and have that hope for the future. That is an important component."



To refer a patient to the MACC Fund Center for Cancer and Blood Disorders, call (877) 607-5280.

"We had a wonderful experience not only collaborating with our colleagues at Children's, but also nationally with other onco-fertility programs."

— Katy Tomlinson, BSN, RN

EXPLORING NEW OPTIONS

With continuing research into fertility and egg and sperm preservation, the options for pediatric patients are increasing.

Children's is participating in several studies that support pediatric fertility research. Currently, Children's patients can participate in an ovarian cryopreservation study for which we are collaborating with Lurie Children's Hospital of Chicago. We are also studying testicular tissue cryopreservation.

"The testicular tissue cryopreservation study is something we offer through our urology department that isn't offered everywhere," says Rachel Phelan, MD, pediatric bone marrow transplant specialist at Children's. "And novel studies and treatment options are definitely something we're looking to expand on. The data from this study will help us identify potential barriers to the process for this study and future studies that we need to address."

LISTENING AND COLLABORATING

The fertility navigation team is also performing internal research, using patient surveys to understand how well they are communicating information to patients and how they can improve. The program has already been successful due to a number of factors.

"I think our program is doing well because we have really made it a point to build relationships across disciplines," Dr. Beckett says. "Buy-in is important, and when we presented our case to the team, we made the case using data — for example, for many patients, fertility is the No. 1 thing they regret having not talked about before treatment. I also think a key reason this was successful is having Katy as a dedicated navigator."

Tomlinson also credits success to the growing onco-fertility medical community: "We had a wonderful experience not only collaborating with our colleagues at Children's but also nationally with other onco-fertility programs," she says. "People are very eager and generous in sharing program-building tips and experience. There is really a great network of people dedicated to filling this gap."

And while filling the gap has become a little more difficult with the restrictions put in place due to the coronavirus pandemic, Tomlinson and her colleagues have been able to keep up with the need by taking advantage of telehealth and videoconferencing. "It's been critical to keep this program moving," Dr. Phelan says. "We just needed to navigate a new way of doing things, and the team has worked well, continuing to make it happen."

A life-changing treatment

Sacral neuromodulation proves to be effective for children with hard-to-treat urinary or fecal incontinence

When Nika was 5 years old and had been having encopresis every day for years, her parents were referred to Children’s Wisconsin for GI motility testing. Children’s is known for having one of the most comprehensive motility labs in the country. Nika’s tests revealed dysmotility of a significant portion of the colon after ruling out a number of other conditions, such as Hirshprung’s disease.

TREATMENTS

Most patients with urinary and/or fecal incontinence are successfully treated with behavioral therapy, oral medication, laxatives, bowel stimulants and/or biofeedback therapy. In addition to having been subject to one or more of these treatment modalities at one time or another, Nika underwent creation of a cecostomy.

In this procedure, an 8-10 French channel (frequently consisting of the appendix with or without a segment of cecum) is created. While the surgery gave Nika, now an active 7-year-old, more control over her bowel movements, her urinary incontinence increased in severity and frequency. In addition, to accomplish the flushing, Nika had to spend approximately an hour on the toilet each day.

After consulting with multiple specialists at Children’s, including Manu Sood, MD, a pediatric gastroenterologist, and Hrair-George Mesrobian, MD, a pediatric urologist, Nika’s parents decided to pursue sacral neuromodulation.

SACRAL NEUROMODULATION

“The patients who see me and Dr. Sood usually have failed all types of standard treatments,” Dr. Mesrobian says. “During evaluation, we usually do not find any structural anomalies, but rather poor and discordant function between the

end organ (bladder or colon), spinal cord and brain centers for micturition and defecation.”

The procedure is minimally invasive and involves placing a lead electrode in the sacral foramen parallel to the S3 nerve root. It is completed on an outpatient basis in the operating room and takes one to two hours.

A watch-size device (embedded posterior to the sacral crest) sends mild continuous electrical impulses to the sacral nerves. It is believed that low-amplitude electric stimulation of the specific nerve roots results in improved signaling to the brain center, which in turn sends the appropriate downstream message to the end organs (bladder and colon). The exact mechanism of action at the cellular levels is thought to be through a change in the electric potential of specific nerve fibers in the bladder (C fibers).



A lead electrode is placed in the sacral foramen.

NEWS & NOTES

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In sacral neuromodulation, a watch-size device sends mild continuous electrical impulses to the sacral nerves.

After implantation of the device, Nika could feel a sensation of urgency to defecate, resulting in well-formed bowel movements. Her mother calls Nika's life "100 times better" after the procedure.

According to Dr. Mesrobian, "life-changing" is a sentiment he hears often from families.

"When these patients undergo this procedure and it's successful, it's like you turned their life to 'normal' just like that," Dr. Mesrobian says. "They are no longer hampered from participating in sleepovers and school trips. They can grow up just like all the other kids."

SMALL DEVICE, BIG IMPACT

"The impact of urinary and fecal incontinence on the child and family is significant — much worse than what you would see in children with other chronic disorders," Dr. Sood says. "It's very difficult to be discreet about this condition. If you have an accident at school, everyone knows. Many of these kids are picked on and socially ostracized, or they self-limit their social interactions."

Sacral neuromodulation was approved by the U.S. Food and Drug Administration (FDA) for use in patients over age 18 with bladder overactivity in 1998, and later in adults with fecal incontinence. In 2015, Dr. Sood approached Dr. Mesrobian about collaborating to offer sacral neuromodulation for children when standard therapies had failed. Children's became one of the earliest adopters of this treatment, with children from across the country seeking it out.

"There are a few studies published in peer-reviewed medical journals that show short- and long-term safety and efficacy in children," Dr. Mesrobian says. "We use it off-label, relying on evidence accumulated from other medical

centers in Europe, where the regulatory environment is rigorous but less stringent."

In the past four years, Children's has evaluated close to 100 potential candidates. Approximately 68 patients have been implanted with the device. Success is defined as a 50% or better improvement in symptoms of urinary and/or fecal incontinence. Children's short-term success rate approaches 70% with a very low complication rate (5%).

Both Drs. Sood and Mesrobian believe sacral neuromodulation will become a first-line treatment for a subset of patients, even before cecostomy, because it is less invasive, offers better function and allows the body image of the patient to remain intact.

In addition, sacral neuromodulation has the potential to condition the child's body to work in a more normal way, so the device could be removed eventually. Dr. Mesrobian cited animal studies that have shown improvement of organ function at the cellular and subcellular levels in response to sacral nerve stimulation. These studies have also demonstrated the safety of low-amplitude electric nerve stimulation on the integrity of the nerve itself.

TEAMWORK

Drs. Sood and Mesrobian credit the multidisciplinary approach and collaborative environment at Children's for the treatment's high success rate.

"We have a highly dedicated team that manages the cases, including GI, urology, anesthesia, radiology and psychology. We all work together to provide personalized health care to the whole child," Dr. Mesrobian says. "I feel very strongly that a great portion of our success is dependent on this team effort."



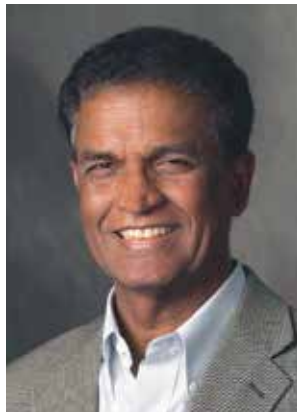
Hrair-George Mesrobian, MD, is a pediatric urologist at Children's Wisconsin and a professor at the Medical College of Wisconsin.

To refer a patient to the Children's Center for Pediatric Neurogastroenterology, Motility and Autonomic Disorders, call (877) 607-5280 or visit childrenswi.org/refer.

INNOVATIONS

Case studies and research
for better care

To refer a patient, call (800) 266-0366.



Hari Prasad Rao Bandla, MD, is a pediatric pulmonologist, Sleep Medicine physician and medical director of the Sleep Center at Children's Wisconsin and a professor at the Medical College of Wisconsin.

The value of sleep studies

Diagnosis of unsuspected medical conditions in children

BY HARI PRASAD RAO BANDLA, MD

Sleep problems are common in children. It is estimated that 25%–30% of children and adolescents experience sleep problems, and about 4% have a formal sleep disorder diagnosis.^{1,2} Untreated sleep disorders can lead to neurocognitive dysfunction that includes daytime sleepiness, irritability, behavioral problems, learning difficulties and poor academic performance.³ Furthermore, sleep disordered breathing complicated by obesity in children can lead to cardiovascular dysfunction and metabolic dysregulation.⁴

Early recognition and treatment of sleep disorders in children is of paramount importance. A typical evaluation of a child with sleep problems includes an initial evaluation in the sleep clinic by a provider, and sometimes these children also need diagnostic polysomnographic studies (sleep studies) to identify the appropriate sleep disorder.

Many children referred to the sleep laboratory are suspected to have sleep disordered breathing, with obstructive sleep apnea (OSA) being the most common diagnosis. During the process of performing these physiological studies, we may identify findings and information in the study that suggest a serious medical diagnosis that was not suspected at the time of initial evaluation.

We present two cases that were referred to the sleep laboratory for suspected OSA but were found to have a serious medical diagnosis upon performance of the study and interpretation by the sleep physician.

CASE 1: 3-YEAR-OLD GIRL WITH NOISY BREATHING

GE is a 3-year-old female who was seen for evaluation of noisy breathing and stridor that had been occurring for one year. Her parents reported loud snoring with mouth breathing, restless sleep and hyperextension of the neck while sleeping. She was a product of a full-term pregnancy and uncomplicated neonatal course. Her medical history is significant for recurrent respiratory infections requiring hospitalizations. Additionally, GE was noted to have deformational plagiocephaly and torticollis. Her growth and development were age appropriate.



Preparing for a sleep study involves placing leads to monitor various parameters. (See parameters measured on page 15.)

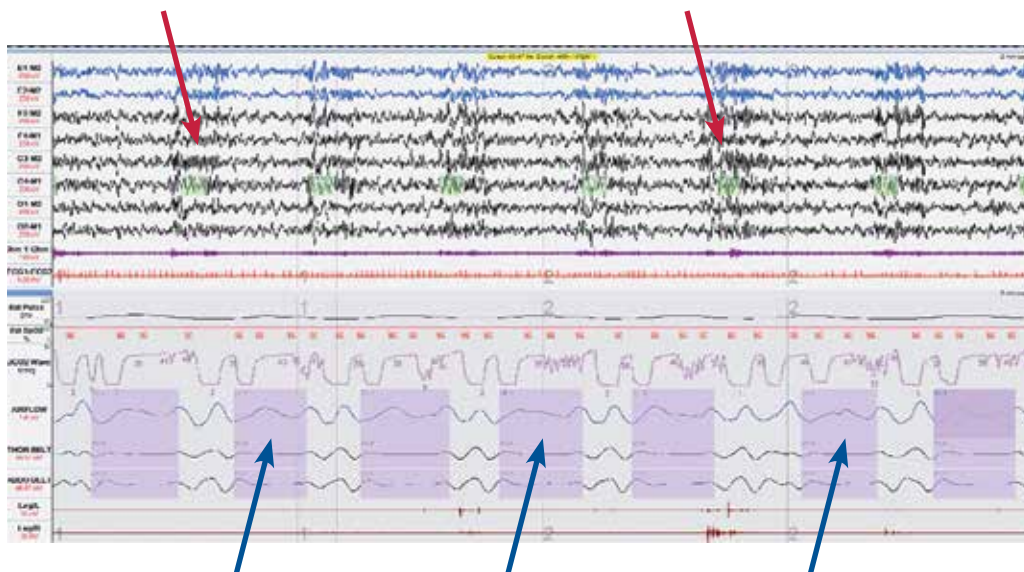


Figure 1. Two-minute PSG fragment with several central apneas (blue arrows) associated with arousals (red arrows).

Flexible laryngoscopy revealed findings consistent with laryngomalacia. She has noted fullness of the vestibular folds with mild anterior displacement of the arytenoids on inspiration and near complete contact with epiglottis on crying. She was started on Singulair and Flonase with no resolution of nocturnal snoring. Given the concerns for biphasic stridor in association with snoring during the night, she was referred to the sleep laboratory for overnight polysomnographic study to evaluate for sleep disordered breathing. The sleep study was abnormal with findings of severe central apnea with a central apnea index (number of central apneas per one hour of sleep) of 25. (Normal is less than 5.) The central apneas were

associated with arousals and sleep fragmentation. There was no hypoxemia or hypoventilation. A representative two-minute tracing of the sleep study is shown in **Figure 1**.

Due to the demonstration of severe central sleep apnea in association with biphasic stridor, Chiari malformation was suspected. She underwent a brain MRI that confirmed the findings of Chiari malformation type 1, platybasia and basilar invagination. Cerebellar tonsils were low-lying,

extending approximately 15 mm below the level of foramen magnum. She was referred to neurosurgery for further evaluation and management.

CASE 2: 7-YEAR-OLD GIRL WITH SNORING

HW is a 7-year-old female who was seen in the sleep clinic with a history of chronic habitual snoring that had been occurring for several months. Snoring occurs nightly, is moderately loud and is associated with observed pauses in breathing and heavy breathing. She has difficulty waking up in the morning and a tendency to take naps. She underwent adenotonsillectomy with no improvement of snoring.

Given the concerns for persistence of snoring despite adenotonsillectomy, she was referred to the sleep laboratory for overnight polysomnographic study to evaluate for OSA. The sleep study did not reveal any findings of OSA. However, in the limited six-channel EEG utilized for the polysomnographic study, intermittent high-amplitude spike and spike wave discharges were noted with no associated clinical seizures.

HW was referred to the neurophysiology laboratory for a full montage 26-channel EEG study. This study confirmed the spike and spike wave discharges. She was referred to neurology for further evaluation and management. Representative tracing of the polysomnographic study is shown in **Figure 2**.

DISCUSSION

These two patients illustrate the ability of polysomnographic studies to identify previously undiagnosed and unsuspected serious medical conditions that include Chiari malformation and seizure disorder. Thus, polysomnographic studies are comprehensive in nature for the evaluation of sleep disorders in children. Although these studies are challenging to perform in young children, they measure multiple physiological variables of cardiorespiratory and neurological systems. The studies provide not only the information that leads to a diagnosis but also the criteria to estimate the severity of the disease. In addition, polysomnographic studies can be repeated after therapeutic intervention to assess the efficacy of the treatment.⁵

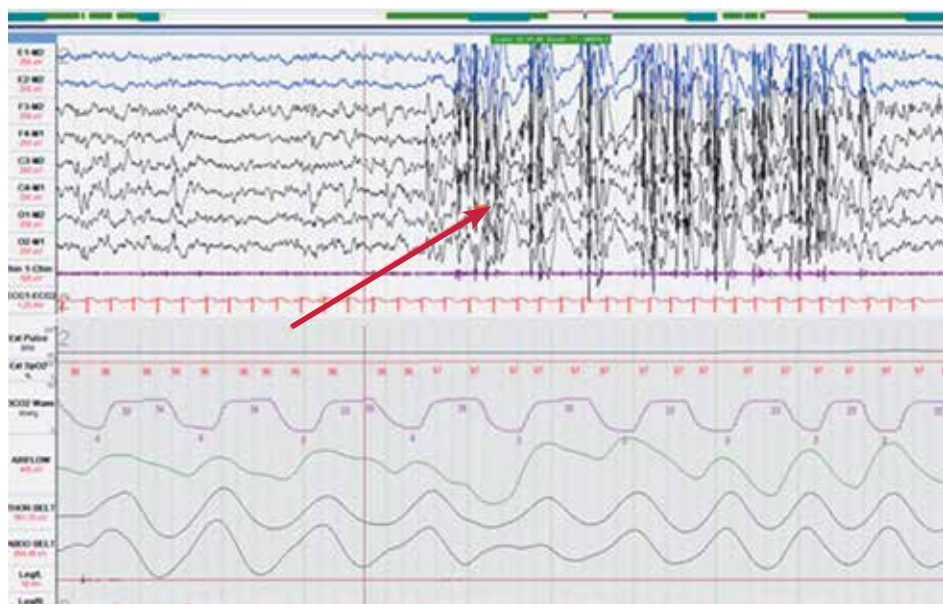


Figure 2. Thirty-second PSG fragment with spike and spike wave discharges in the EEG (red arrow).



To refer a patient to the Children’s Sleep Center, call (877) 607-5280 or visit childrenswi.org/refer.
 To make an appointment, call Central Scheduling at (414) 607-5280 or toll-free (877) 607-5280.
 For more information, visit childrenswi.org/medical-care/pulmonary-medicine.

**Children’s
Wisconsin
Sleep
Center**

What do sleep studies measure?

Nocturnal, laboratory-based polysomnography (PSG), also known as a sleep study, is the most commonly used test in the diagnosis of sleep disorders in children. These studies are performed during sleep lasting an average of seven to eight hours in a dedicated pediatric sleep laboratory staffed by registered sleep technologists and supported by board certified pediatric sleep physicians.

PARAMETERS MONITORED IN FIGURE 1:

- **E1** — left eye electromyogram
- **E2** — right eye electromyogram
- **F3, F4** — frontal electroencephalogram leads
- **C3, C4** — central electroencephalogram leads
- **O1, O2** — occipital electroencephalogram leads
- **Chin 1, Chin 2** — chin electromyogram
- **ECG1, ECG2** — electrocardiogram
- **SpO2** — continuous pulse oximetry
- **ETCO2** — end-tidal carbon dioxide tracing
- **AIR FLOW** — tracing of oral thermistor
- **THOR BELT, ABDO BELT** — effort channels
- **LEG/L, LEG/R** — leg movements

PURPOSE:

- Eye electromyogram (EMG) channels monitor horizontal and vertical eye movements to

recognize rapid eye movement (REM) sleep.

- Electroencephalogram (EEG) channels identify sleep, wakefulness and sleep stages. Additional EEG channels can be used (e.g., 10–20 montage) for suspected seizures.
- Surface EMG placed over the chin records atonia during REM sleep.
- Thermistor and nasal pressure transducer channels monitor airflow.
- Thoracic and abdominal channels monitor respiratory effort.
- Leg EMG channels identify leg movements.

OTHER PARAMETERS THAT CAN BE MONITORED IN A SLEEP STUDY:

- Transcutaneous CO₂
- Sound recordings to measure snoring
- Surface EMG monitoring to detect periodic or other limb movements
- Continuous video monitoring
- Capillary blood gas (CBG)

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The pediatric Sleep Center at Children's is the regional leader in diagnosing and treating sleep disorders in children. Each year, the program evaluates 1,500 children with sleep problems and performs 1,716 sleep studies. Here are more key facts:

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- Both locations are fully accredited by the

American Academy of Sleep Medicine

- Active noninvasive ventilation program provides respiratory support for children with sleep disordered breathing that complicates complex medical conditions
- Multidisciplinary collaboration with ENT, Craniofacial and Neurology
- Strong academic credentials with the goal of providing education in sleep medicine for medical students, residents and fellows



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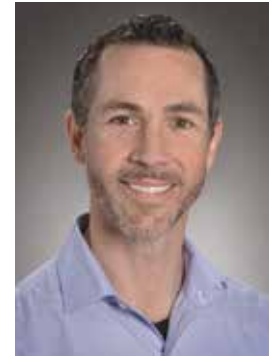
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Neuropsychology



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