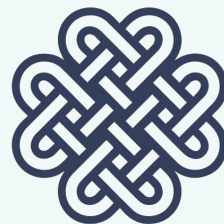




THE UNIVERSITY  
OF BRITISH COLUMBIA



**FAMILY SUPPORT**  
Institute of **BC**

# Sleeping like a baby

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# Territory acknowledgement

- We acknowledge with respect the ləkʷəŋən peoples on whose traditional, ancestral, and unceded territory the city of Victoria stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.
- We acknowledge with respect the traditional, ancestral and unceded territory of the Coast Salish peoples—Sk̓wx̓wú7mesh (Squamish), Stó:lō and Səlílwətaʔ/Selilwitulh (Tsleil-Waututh) and xʷməθkʷəy̍əm (Musqueam) Nations.

# Today's schedule

- 1 hour presentation on sleep
- 1 hour parent lead Q&A

# Today's learning plan

1. What is sleep?
2. Sleep and neurodevelopmental differences
3. What can go wrong with sleep?
4. How to take a sleep history
5. Assessments
6. Behavioral strategies
7. Medications
  - Melatonin, iron, gabapentin, clonidine, trazodone

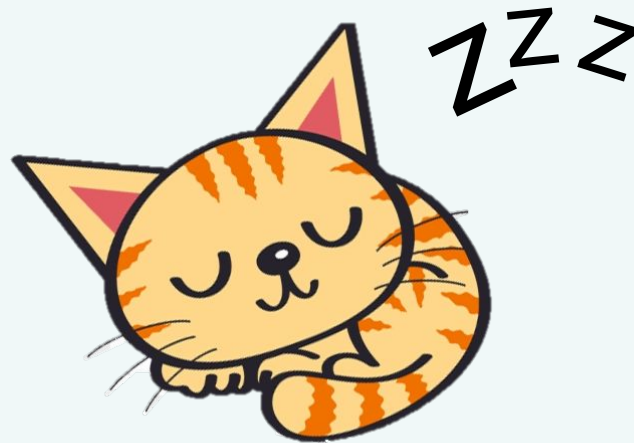
# Learning objectives

- To learn about the components of sleep and why we sleep
- To learn about sleep challenges in children with neurodevelopmental differences (NDDs)
- To learn about various behavioural strategies and medications to treat sleeping difficulties

# 1. What is Sleep?

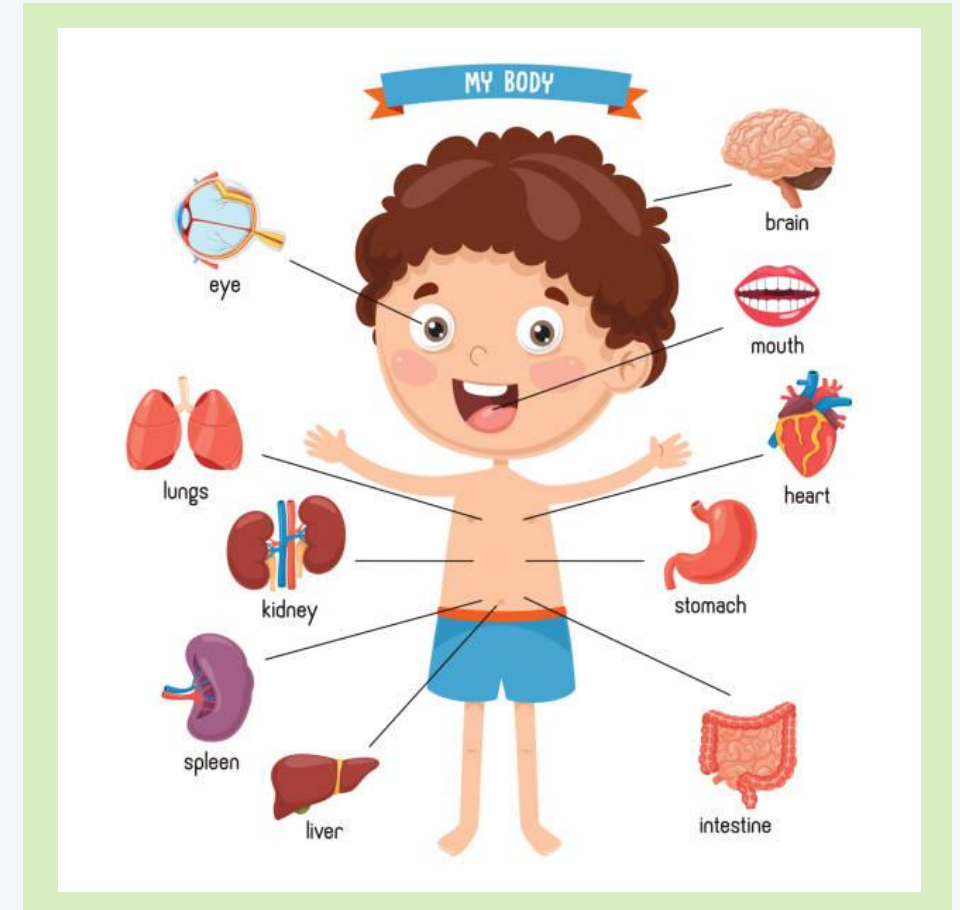
# What is Sleep?

- Definition:
  - sleep is a reversible and recurring state of decreased consciousness, sensory perception and relative immobility
- Sleep is different from anesthesia or a coma because the brain remains active



# What is the function of sleep?

- Sleep is key for:
  - forming memories
  - learning
  - reasoning
  - behaviours
  - physical growth and repair
- Sleep is essential for survival
- A lack of sleep affects every body system





# Amount of sleep

- The amount of sleep children need changes as they grow
- Every child needs a different amount of sleep

Infants (4 to 12 months old)	12-16 hours
Toddlers (1 to 2 years old)	11-14 hours
Children (3 to 5 years old)	10-13 hours
Children (6-12 years)	9-12 hours
Teenagers (13-18 years old)	8-10 hours

# Sleep stages

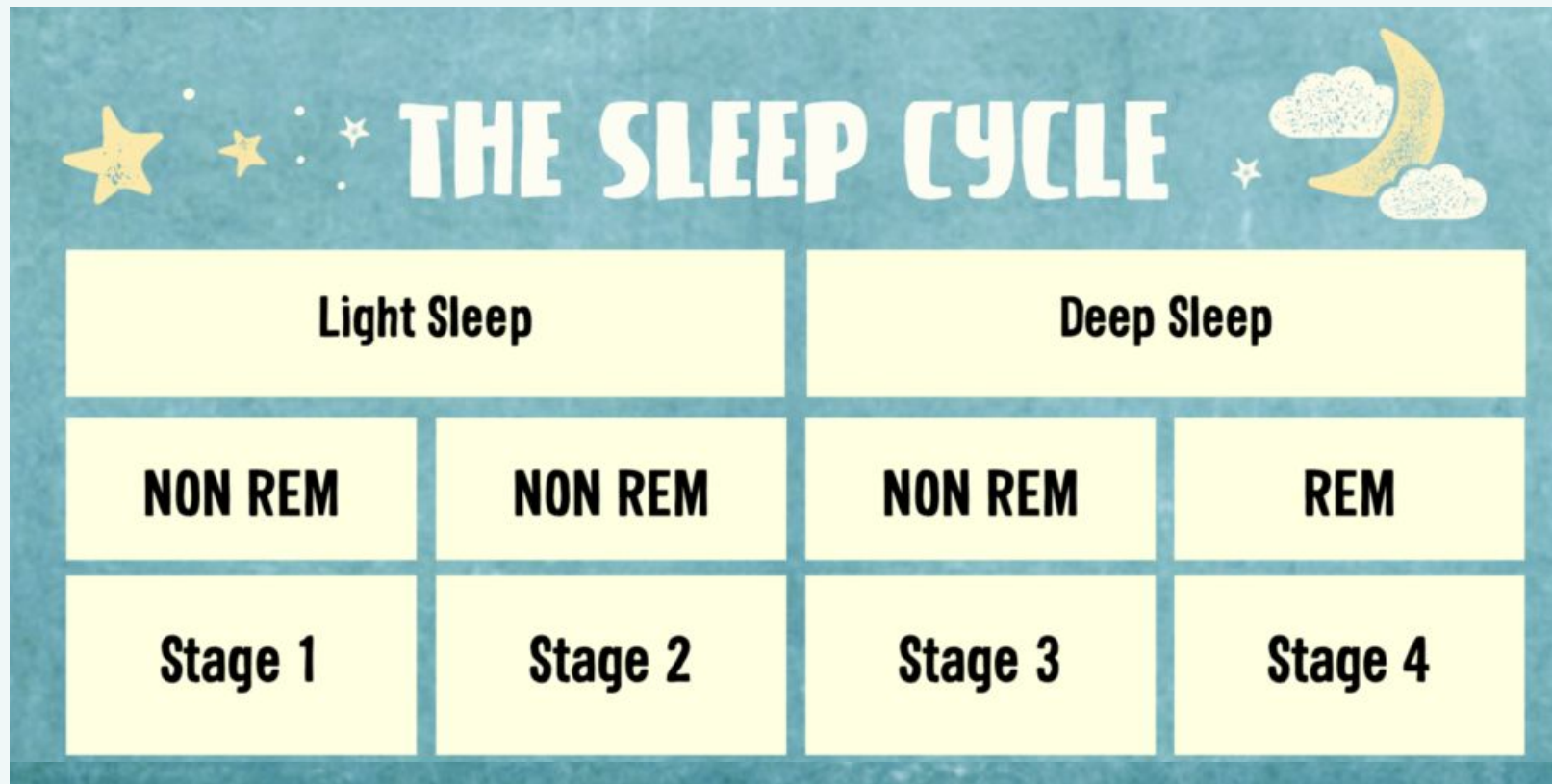
- There are 4 different stages of sleep
- Sleep stages are defined by difference in brain waves
- Brain waves are measured using electroencephalogram (EEG) which measures neuronal activity and ultimately brain activity



# Sleep stages

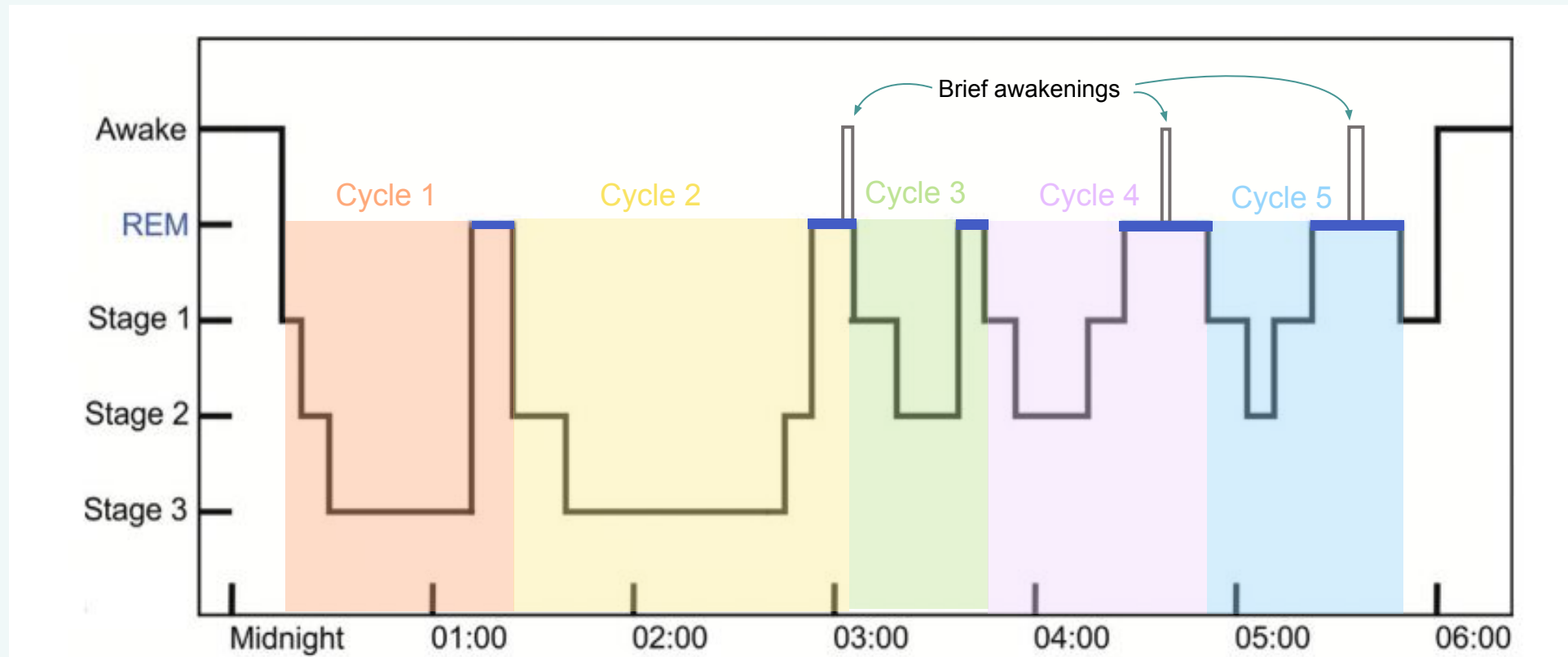
The 4 stages of sleep are:

- 3 stages of non rapid eye movement (NREM) sleep
- 1 stage of rapid eye movement sleep (REM) sleep



# Sleep cycle

- Sleep cycles change throughout the night
- More stage N3 in first half of the night, more REM sleep in the second half of the night



# Why do we sleep?

- The two-process theory of sleep explains that sleep is driven by sleep pressure & circadian rhythm

Sleep pressure is the increasing level of fatigue that comes from the build up of adenosine during the day

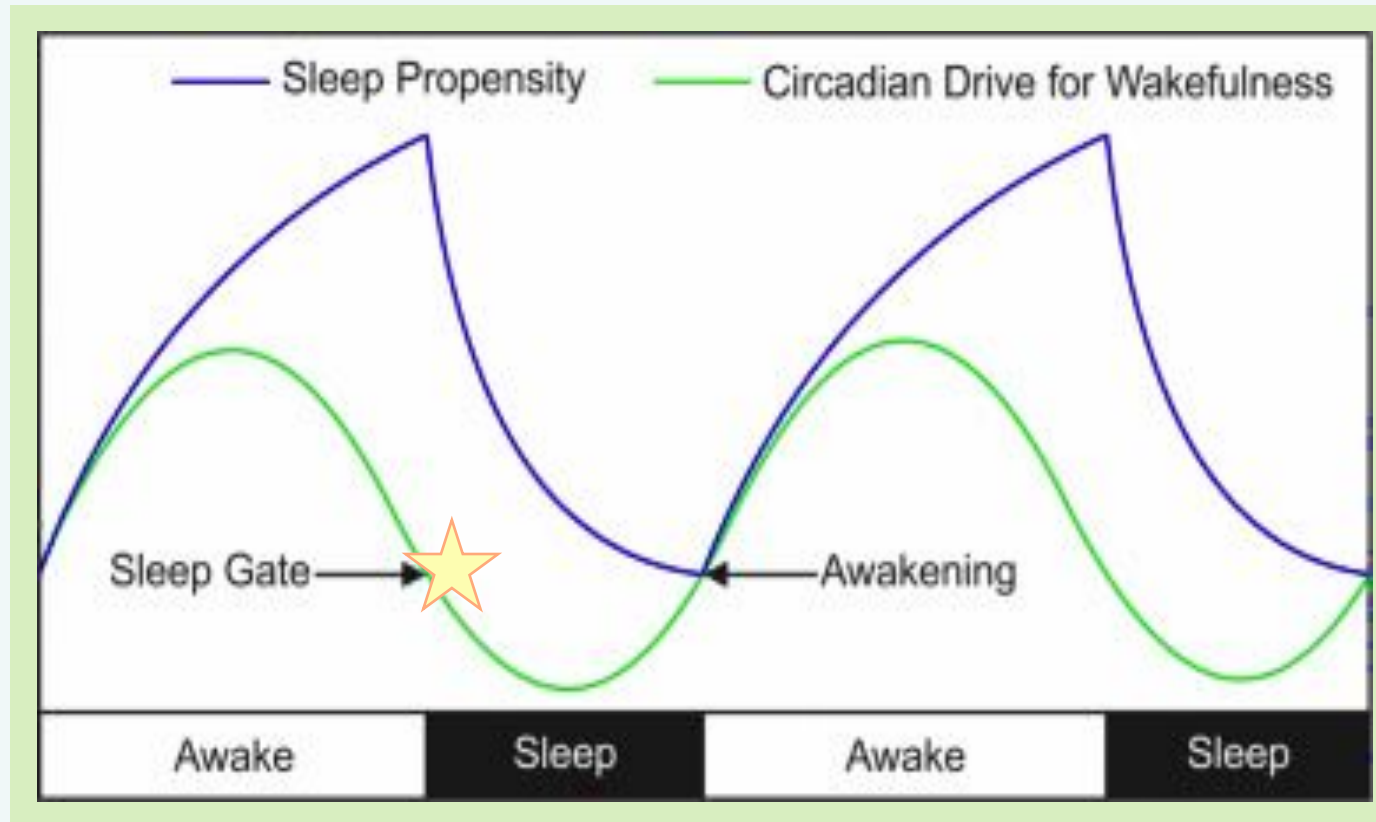


Circadian rhythm is the body's 24h biological clock telling the body when to be awake



# Why do we sleep?

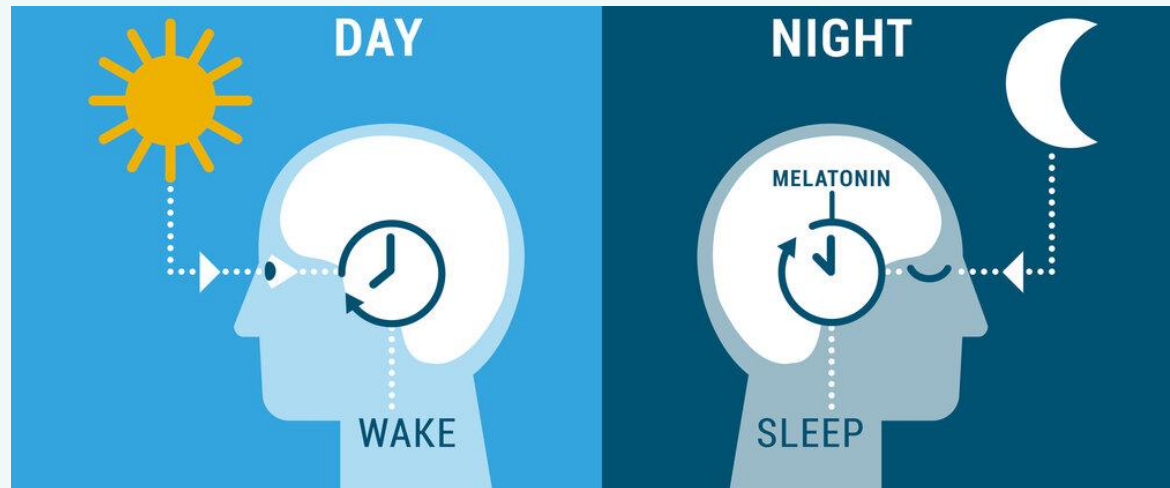
- We usually fall asleep at night because **sleep pressure** is at its highest point, and **circadian rhythm** is at its lowest



# What affects circadian rhythm?

- Circadian rhythm is the body's 24h biological clock
  - the circadian rhythm is controlled by the suprachiasmatic nucleus (SCN)
  - this superchiasmatic nucleus receives light information from the eye

Daylight  
promotes  
wakefulness



At night, the SCN  
tells the pineal  
gland to release  
melatonin

# Melatonin and sleep

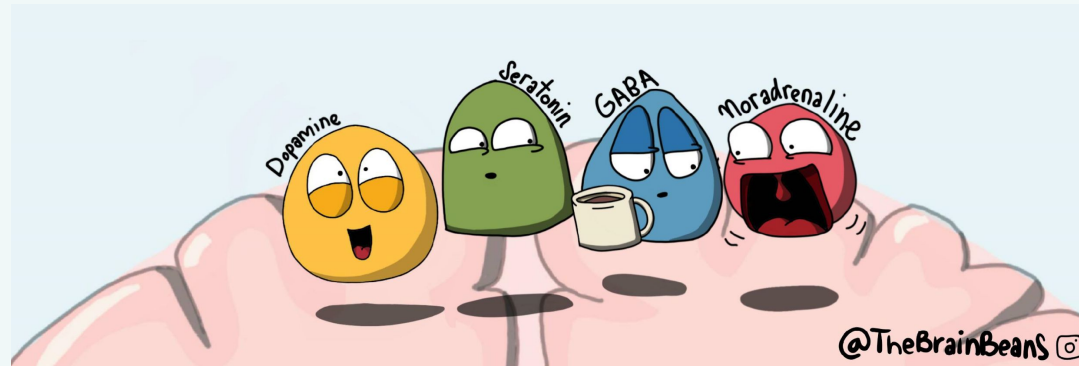
- Melatonin regulates the circadian rhythm by dropping body temperature and decreasing blood pressure
- Blue light (daylight, electronics) inhibits the release of melatonin





# Neurotransmitters and sleep

- Neurotransmitters: chemical messengers released from neurons at synapses that “talk” to neighboring cells
- There are six key neurotransmitters that impact sleep:
  - dopamine
  - histamine
  - norepinephrine
  - acetylcholine
  - serotonin
  - orexin
- These neuromodulators all promote wakefulness



# GABA

- Gamma aminobutyric acid (GABA) is the key inhibitory neurotransmitter in the brain
- It is thought GABA inhibits the wakefulness neurotransmitter system
- GABA binding to GABA receptors promotes sleep



## 2. Sleep & neurodevelopmental differences

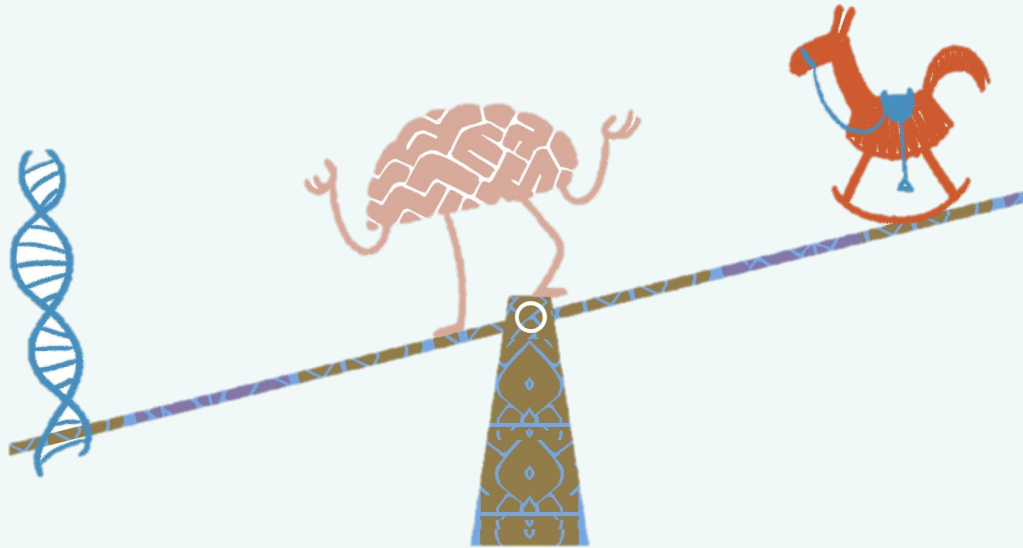
# Prevalence of sleep disorders

- 40-80% children with NDDs have sleep problems compared to 25-40% in children who are neurotypical
- Sleep problems are one most burdensome challenges for both children and families
- In the provincial survey 78% had sleep difficulties



# Cause

- Sleep difficulties and NDDs have many causes
  - genetics
  - environment
  - abnormal melatonin production
  - seizures
  - ADHD
  - medications
  - sleep hygiene



# Sleep and NDDs

- Most common difficulties from provincial survey:
  - wakes up multiple times 57%
  - takes a long time to fall asleep 52%
  - wakes very early 45%
- Sleep issues increase challenging daytime behaviours and emotional regulation
  - important to treat sleep

### 3. What can go wrong with sleep?

# What can go wrong?

- Primary sleep disorders from International Classification of Sleep Disorders (ICSD-3):
  - insomnia
  - parasomnia
  - circadian rhythm sleep disorder
  - sleep related breathing disorders
  - sleep related movement disorders





# What is insomnia?

- Definition:
  - bedtime resistance
  - difficulty initiating sleep
  - difficulty maintaining sleep
  - frequent night wakening's
  - waking too early
  - not enough sleep
  - poor sleep quality
    - all of these can occur despite the opportunity to sleep
- Insomnia can be primary or secondary
  - primary - not a result of another condition - ie. ADHD, anxiety
  - secondary – something else is causing the insomnia – ie. ADHD, anxiety, restless leg syndrome



# Parasomnias

- Definition: unwanted physical experiences during sleep or during sleep arousal
- Includes:
  - night terrors
    - child can scream loudly, sweat, usually confused, difficult to wake them, can't remember event, quickly fall back asleep
  - sleepwalking
  - sleep talking
  - nocturnal enuresis
    - bed wetting during sleep 2 or more times per week in children over 5
  - sleep paralysis
  - nightmares



# Circadian rhythm sleep disorder

- Changes in circadian rhythm (body's biological clock) resulting in circadian rhythm to not match outside environment
  - desire to fall asleep does not match typical nighttime sleeping
  - difficulty in starting sleep
- Different from insomnia because with circadian rhythm sleep disorder, once fallen asleep the sleep architecture is normal

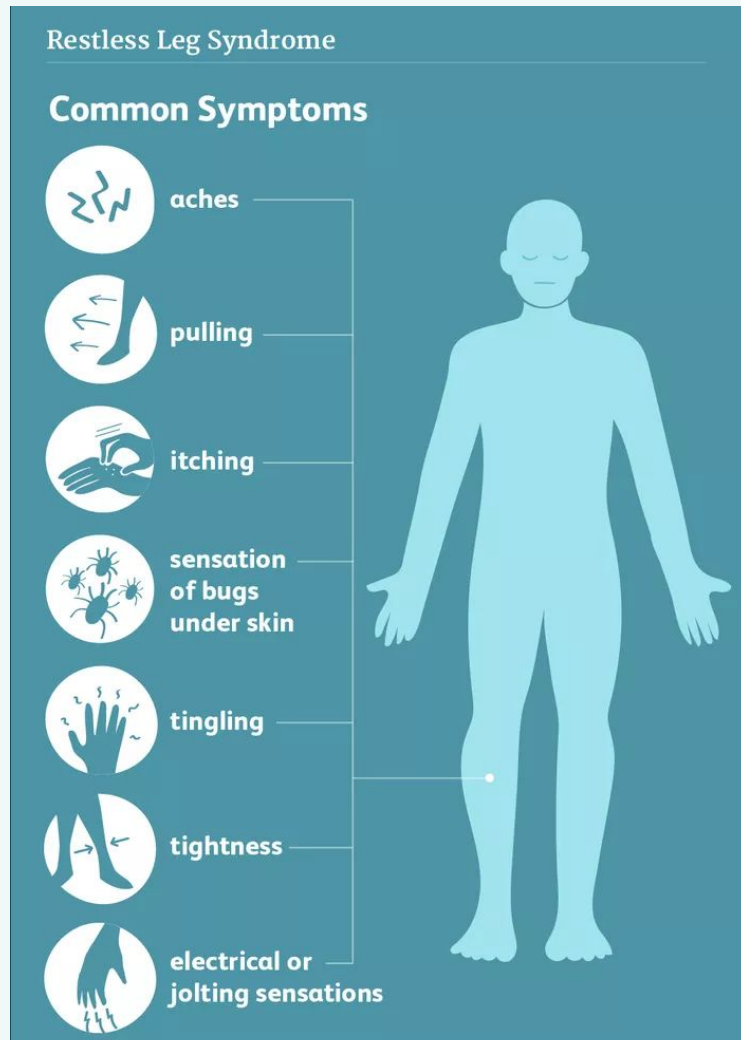


# Sleep related breathing disorders

- Apnea: breathing is interrupted during sleep decreasing or stopping airflow
- Central sleep apnea – reoccurring loss of drive to breath
- Obstructive sleep apnea – airway is blocked which causes more effort to breath since the body isn't getting enough oxygen
  - snoring, mouth breathing, noisy breathing
  - sleep disruptions
  - daytime sleepiness
  - inattention, learning problems, behavioural problems
  - decrease blood oxygen saturation
- Investigations differentiate between type of sleep apnea with polysomnography (sleep study), overnight oximetry



# Sleep related movement disorders



- Periodic limb movement disorder
  - repeated limb jerking
- Restless leg syndrome
  - inherited (if parent has, child will likely have)
  - urge to move the legs due to uncomfortable sensations
  - symptoms worse with inactivity or at night
  - associated with periodic limb movement disorder
  - associated with iron deficiency
- Myoclonic jerk
  - muscle jerking when falling asleep (stage N1 sleep)

## 4. How to take a sleep history

# Sleep history: BEARS method

- Pediatric screening questions to identify sleep issues

**B**edtime problems

**E**xcessive daytime sleepiness

**A**wakenings during the night

**R**egularity and duration of sleep

**S**nororing



# Why use the BEARS method?

- Reveals significantly more sleep problems and more specific information about the sleep problems
- Leads to sleep investigations and plans

	Pre-BEARS (%)	BEARS (%)	P value
General sleep	87.7	98.5	<0.001
Bedtime issues	7.7	93.3	<0.001
Excessive day sleepiness	5.6	93.9	<0.001
Awakenings at night	29.2	91.3	<0.001
Regularity/duration	31.5	65.3	<0.001
Snoring	7.2	92.8	<0.001
Parasomnias	3.1	7.7	0.035



# BEARS questions

## Bedtime problems

- Does your child have any problems going to bed?
- Falling asleep?

## Excessive daytime sleepiness

- Does your child seem over tired or sleepy during the day?

## Awakenings during the night

- Does your child wake up a lot at night?
- Trouble getting back to sleep?

## Regularity and duration of sleep

- Does your child have a regular bedtime and wake time?

## Snoring

- Does your child snore a lot or have difficulty breathing at night?



# Other questions

- Pre sleep activities (screen time, mealtimes)
- Bedtime routine (including consistency)
- Physical activity
- Parental response to nighttime waking's
- Movements during sleep
  
- Medication history
- Family history of sleep difficulties
- Other medical problems: gastroesophageal reflux, constipation, pain

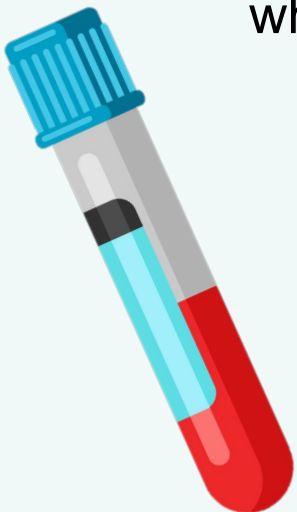
## 5. Assessments

# Assessments

- Blood test
- Sleep diary
- Actigraphy
- Sleep doctor
- Polysomnography/sleep study
- Better Nights, Better Days study

# Blood test

- Brain iron deficiency plays role in restless leg syndrome and periodic limb movement disorder
- Morning fasting serum iron, ferritin levels, TIBC, %TSAT, CRP
  - ferritin is a protein that stores iron in our cells
  - caution: ferritin is an acute phase reactant meaning ferritin levels can be elevated when there is inflammation



# Sleep diary

- <https://keltymentalhealth.ca/collection/sleep-diaries> - has 3 fillable sample sleep diaries

	Example	Monday	Tuesday
Today's date (to fill out in the morning) DD/MM/AAAA	04/07/2020		
<b>SLEEP DURATION</b>			
1. Bedtime [HH : MM]:	22:15		
2. Sleep time (when you tried to fall asleep) [HH : MM]:	23:00		
3. Time it took to fall asleep [en min]:	15		
4. Number of awakenings during the night (excluding your final awakening):	2 times		
5. Total duration of these awakenings [en min]:	10		
6. A. Time of final awakening [HH : MM]:	06:35		
B. Time spent in bed trying to sleep after your final awakening? [en min]:	0		
C. Did you wake up earlier than you planned? [Yes/No]	Yes		
D. If yes, how much earlier? [en min]:	30		
7. Time out of bed today [HH : MM]:	06:45		
8. Total sleep duration: (Time spent in bed) – (time to fall asleep) – (total duration of awakenings) Example : (7 hrs 35 min) – (15 min) – (10 min) = 7 hrs 10 min [HH : MM]	07:10		

# Actigraphy



- Worn on wrist or ankle for 3-14 days
- Measures amount and frequency of limb movement
- Algorithm applied to data to estimate sleep and wake patterns

Pros	Cons
Actigraphy can be done at home (polysomnography requires hospital)	Doesn't replace electromyography (measures muscle movement) for diagnosis of periodic limb movement disorder
Data collected over multiple nights (polysomnography one night)	Doesn't replace polysomnography
Useful in assessment of insomnia and circadian rhythm sleep disorder	

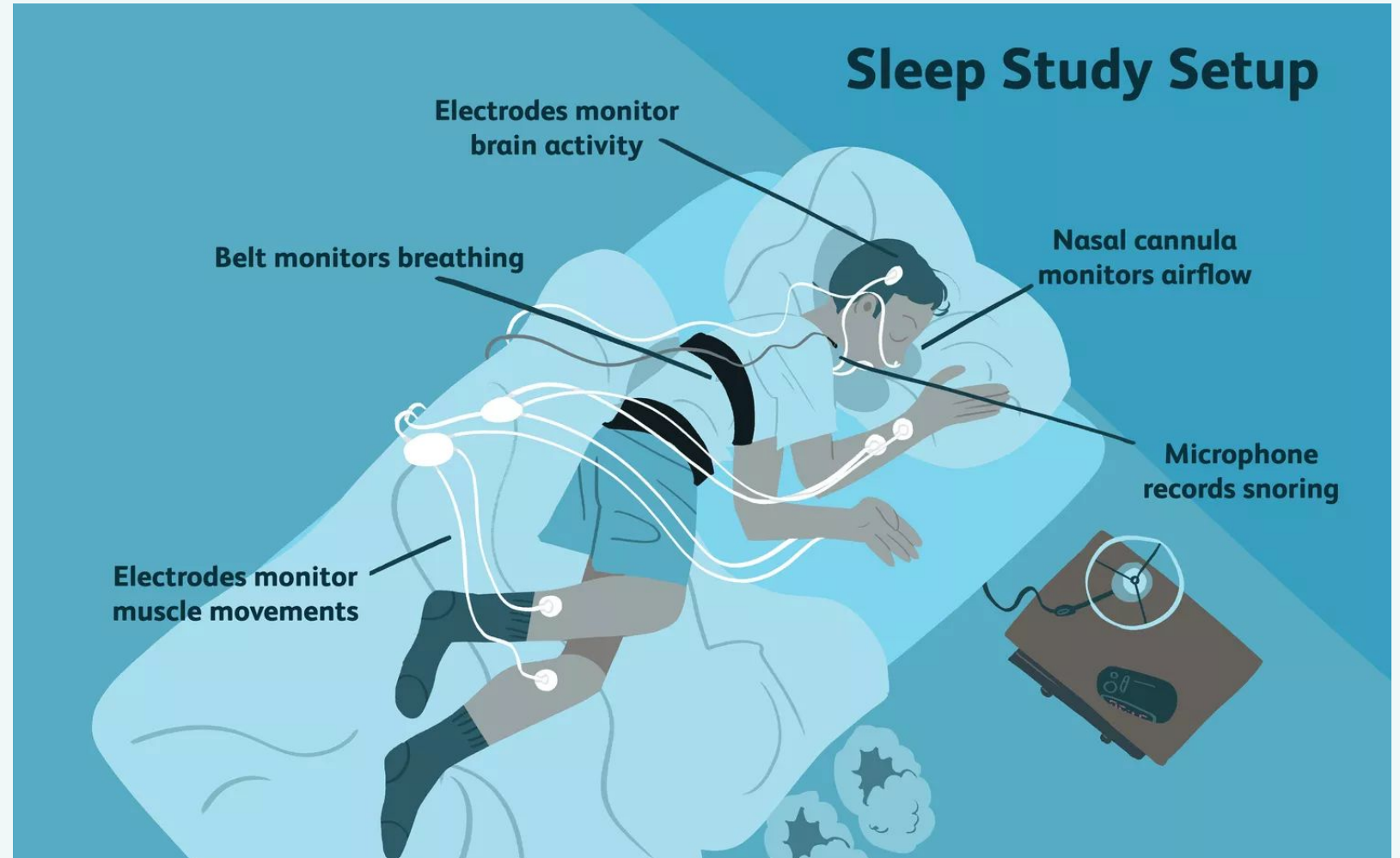
# Sleep doctor

- A doctor specialized in sleep, sleep disorders, and sleep health
- A sleep doctor can have background in different medical specialties (ie. pediatrics, neurology, respirology) giving different approaches and ideas
- Dr. Osman Ipsiroglu
- Sleep clinic at BC Children's



# Polysomnography (PSG)

- PSG is a sleep study investigating:
  - sleep related breathing disorders
  - parasomnias
  - sleep related seizure disorders
  - restless leg syndrome
- Can only happen at BC Children's Hospital



# Better Nights, Better Days study

- eHealth, evidenced based intervention for children with NDDs who experience difficulties with sleep
- Five interactive and automated core sessions
- Psychoeducation and behavioural strategies
- <https://ndd.betternightsbetterdays.ca/>



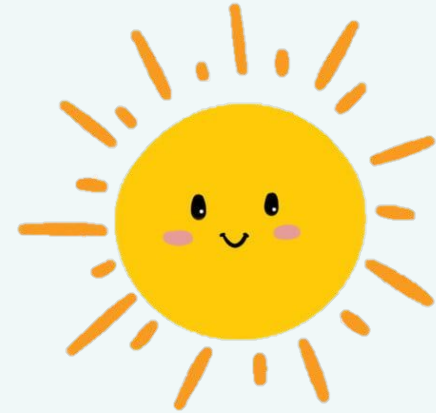
## 6. Behavioural strategies

# Behavioural strategies

- Behavioural strategies work
  - sleep hygiene education
    - through Cognitive Behavioural Therapy (CBT) for families, self education, health care professional
  - setting goals specific to child's sleep challenges to create change
- Behavioural interventions result in improved total sleep time, sleep onset, sleep efficiency
- These strategies are not for everyone

# During the day

- Plenty of natural light and exercise
  - play games such as wheelbarrow walking, crab walking, seat scoots, tug of war
  - carry heavy objects (like groceries, backpack filled with heavy items)
  - pull or push a wagon or cart filled with heavy weights
  - squeeze objects that provide resistance (a balloon filled with flour or corn starch, a stress ball, play dough, silly putty)



# Before bed

- Activities your child finds relaxing 30-60 minutes before bed
- Might involve movement, touch, sound, vision smell or taste:
  - rocking and swinging
  - massaging
  - sorting crayons
  - unraveling rope
  - listening to music
  - calming scents - lavender, peppermint, heliotropin
  - eating a light snack
  - wearing a weighted vest
  - chewing gum, vinyl tubing or crunchy/chewy foods
  - keeping lights down low



# Bedtime routine

- Create a bedtime routine
- Make it visual with picture or schedule boards



- This website has some sample visual routine printouts:
  - <https://www.autismspeaks.org/sites/default/files/2018-09/Sleep%20Quick%20Tips.pdf>



# Bedroom environment



- Comfortable bedtime clothing and fabrics your child likes
- Arrange blankets to provide right amount of pressure
  - weighted blanket, sleeping bag, large blanket, large stuffed animals, body pillows
- White noise such as a fan or noise blocking curtains may help
- Ideal temperature 18.3 C (65F)
- Sanitation - wash bedlinens every two weeks, vacuum carpet regularly to reduce dust mites and allergens
- Light – avoid screens at night if possible (seens may also be calming)
  - nightshift setting on phones/tablets/computers – makes screen orange
- Night lights may be calming



Singh & Zimmerman, 2015

Williams Buckley et al., 2020

Weighted Blanket Benefits | Sleep Foundation

Bedroom Environment: What Elements Are Important? | Sleep



# Important behavioural changes

1. Consistent bedtime routine: anything that is repeatable
2. Consistent sleeping environment: at bedtime and during the night

## 7. Treatment – Medications

# Melatonin

- Indication: insomnia, sleep disturbances
- Mechanism of action: regulates sleep-wake cycle, promotes sleep, and inhibits wakefulness signals
- Half life (how long for body to eliminate half): 40 minutes
- Side effects: daytime sleepiness, headache, nausea, increased enuresis



# Melatonin

- Starting dose: 1-3 mg 30-60 minutes before bedtime (take when brush teeth)
  - How to titrate up: increase dose if sleep not improving
  - Target dose: titrate to effect
  - Max dose: 5 mg
- 
- Melatonin is a natural health product
    - not regulated by Health Canada, amount of melatonin can vary
    - if doesn't work try a different brand

# Melatonin long term safety

- Nightly extended-release melatonin at 2, 5, 10 mg for 104 weeks (2 years) followed 2 weeks of placebo
- Results:
  - significant improvement of sleep
  - no changes from expected growth, pubertal status, no concerning side effects and no withdrawal

# Iron

- Indication: serum ferritin below 50 ng/mL
- Mechanism of action: iron is needed in the brain for dopamine production (an important neurotransmitter)
- Side effects: nausea, abdominal pain, constipation, diarrhea, dark stool
- Starting dose: 1-2 mg/kg/day elemental iron
- How to titrate up: titrate until side effects
- Target dose: 3-6 mg Fe/kg/dose by mouth once a day (or split into two or 3 doses per day)
- Max dose: 6 mg elemental iron/kg/day

# Iron types

Mineral/elemental iron			Polysaccharide iron	Heme iron
Ferrous gluconate	Ferrous sulfate	Ferrous fumarate	Polysaccharide iron	Heme iron polypeptide (from bovine hemoglobin)
Tablet: 300 mg (35mg Fe)	Tablet: 300 mg (60 mg Fe)  Syrup: 30 mg/mL (6 mg Fe/mL)  Drops: 75 mg/mL (15 mg Fe/mL)	Capsule: 300 mg (100 mg Fe)  Liquid: 60 mg/ml (20 mg Fe/mL)	Capsule: 150 mg (150 mg Fe)  Powder 15mg Fe in quarter teaspoon	Tablet 11 mg (11 mg Fe)



Moe et al., 2019  
Allen et al., 2018  
Powers et al., 2017  
CW Online Formulary

# Iron absorption

- Elemental iron is absorbed in the small intestine by a transporter
- For best absorption give on empty stomach with water or juice
  - don't give with dairy, antacids, proton pump inhibitors, or calcium containing products
  - they interfere with iron absorption
- To limit gastrointestinal discomfort, start with low dose and gradually increase after 5 days
  - can take initially with a snack and shift to taking between meals





# Gabapentin

- Indication: insomnia, restless leg syndrome, prolonged sleep onset
- Mechanism of action: increases stage N3 sleep, increases sleep efficacy, decreases spontaneous arousal, may increase GABA production
- Side effects: drowsiness, poor coordination, dizziness, weight gain, blurry vision, upset stomach, vomiting
- Starting dose: 3-5 mg/kg 30-45 minutes before bed
- How to titrate up: 3-5 mg/kg every 3-7 days as tolerated
- Target dose: 6-15 mg/kg (up to 35 mg/kg/24 hr)
- Max dose: < 12 years old: 50 mg/kg/24 hr,  
> 12 years old: 2400 mg/24 hr

# Clonidine

- Indication: insomnia, behavioural challenges for children with NDDs
- Mechanism of action: alpha 2 agonist, unknown mechanism for how impacts sleep
- Side effects: pallor, tiredness, low blood pressure, slow heart rate (these side effects are rare)
- Starting dose: 1 ug/kg for younger children at bedtime
- How to titrate up: 1 ug/kg increments every 1-2 weeks
- Target dose 2.5 ug/kg/day
- Max dose: 10 ug/kg/day or 0.4 mg/day

# Trazodone

- Indication: insomnia
- Mechanism of action: serotonin antagonist and reuptake inhibitor (SARI)
- Side effects: dry mouth, nausea, vomiting, drowsiness, dizziness, headache. Rare side effect priapism (prolonged painful erection lasting over 4 hours).
- Starting dose: 25 mg (1-2 mg/kg)
- How to titrate up: 12.5-25 mg increments every 2 weeks as tolerated
- Target dose: 25-50 mg (1-3 mg/kg)
- Max dose: 100 mg

# Summary

- We fall asleep when sleep pressure is at its highest point, and circadian rhythm is at its lowest
- Sleeping challenges are common - up to 80% of children and youth with NDDs have sleep difficulties
- Sleep is treatable!
  - Behavioural strategies: consistent bedtime routine, consistent sleeping environment
  - Medications for sleep: melatonin, iron, gabapentin, clonidine, trazadone

# Resources

- <https://keltymentalhealth.ca/collection/sleep-diaries> - Has 3 sample sleep diaries
- <https://sleeponitcanada.ca/> – resource for general sleep info
- <https://www.autismspeaks.org/sleep> – 7 sleep hygiene tips, and other sleep resources including:
  - [https://www.autismspeaks.org/sites/default/files/SC\\_ATN%20Sleep%20Topic%20Flyer\\_083120\\_v5.pdf](https://www.autismspeaks.org/sites/default/files/SC_ATN%20Sleep%20Topic%20Flyer_083120_v5.pdf) - Tips for implementing sleep strategies
  - <https://www.autismspeaks.org/sites/default/files/2018-09/Sleep%20Quick%20Tips.pdf> - Quick tips and visual routine for kids with limited verbal communication

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# Questions?

- Questions will be answered at the 1-hour live Q&A
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