PHYSIOLOGY OF SLEEP

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INTRODUCTION

- Sleep is the natural periodic **state of rest for mind and body** with closed eyes characterized by partial or complete loss of consciousness.
- Loss of consciousness leads to decreased response to external stimuli and decreased body movements.
- Depth of sleep is not constant throughout the sleeping period.
- It varies in different stages of sleep.

SLEEP REQUIREMENT

- Sleep requirement is not constant.
- However, average sleep requirement per day at different age groups is:

1. Newborn infants : 18 to 20 hours
2. Growing children : 12 to 14 hours
3. Adults : 7 to 9 hours
4. Old persons : 5 to 7 hours.

PHYSIOLOGICAL CHANGES DURING SLEEP

- During sleep, most of the body functions are reduced to basal level.
- Following are important changes in the body during sleep:

1. PLASMA VOLUME

- Plasma volume decreases by about 10% during sleep.

2. CARDIOVASCULAR SYSTEM

HEART RATE

- During sleep, the heart rate reduces. It varies between 45 and 60 beats per minute.

BLOOD PRESSURE

- Systolic pressure falls to about 90 to 110 mm Hg.
- Lowest level is reached about 4th hour of sleep and remains at this level till a short time before waking up. Then, the pressure commences to rise.
- If sleep is disturbed by exciting dreams, the pressure is elevated above 130 mm Hg.

3. RESPIRATORY SYSTEM

- Rate and force of respiration are decreased.

4. GASTROINTESTINAL TRACT

- Salivary secretion decreases during sleep.
- Gastric secretion is not altered or may be increased slightly.
- Contraction of empty stomach is more vigorous.

5. EXCRETORY SYSTEM

- Formation of urine decreases and specific gravity of urine increases.

6. SWEAT SECRETION

- Sweat secretion increases during sleep.

7. LACRIMAL SECRETION

- Lacrimal secretion decreases during sleep.

8. MUSCLE TONE

- Tone in all the muscles of body except ocular muscles decreases very much during sleep. It is called sleep paralysis.

9. REFLEXES

- Certain reflexes particularly knee jerk, are abolished. **Babinski sign** becomes positive during deep sleep.
- Threshold for most of the reflexes increases.
- Pupils are constricted. Light reflex is retained. Eyeballs move up and down.

10. BRAIN

- Brain is not inactive during sleep.
- There is a characteristic cycle of brain wave activity during sleep with irregular intervals of dreams. Electrical activity in the brain varies with stages of sleep.

TYPES OF SLEEP

- Sleep is of two types:

1. Rapid eye movement sleep or REM sleep
2. Non-rapid eye movement sleep, NREM sleep or non-REM sleep.

1. RAPID EYE MOVEMENT SLEEP – REM SLEEP

- Rapid eye movement sleep is the type of sleep associated with rapid conjugate movements of the eyeballs, which occurs frequently.
- Though the eyeballs move, the sleep is deep. So, it is also called **para- doxical sleep.**
- It occupies about 20% to 30% of sleeping period.
- Functionally, REM sleep is very important because, it plays an important role in consolidation of memory. Dreams occur during this period.

2. NON-RAPID EYE MOVEMENT SLEEP – NREM OR NON-REM SLEEP

- Non-rapid eye movement (NREM) sleep is the type of sleep without the movements of eyeballs.
- It is also called **slow-wave sleep.**
- Dreams do not occur in this type of sleep and it occupies about 70% to 80% of total sleeping period. Non-REM sleep is followed by REM sleep.

- Differences between the two types of sleep are given in Table

Characteristics	REM sleep	Non-REM sleep
1. Rapid eye movement (REM)	Present	Absent
2. Dreams	Present	Absent
3. Muscle twitching	Present	Absent
4. Heart rate	Fluctuating	Stable
5. Blood pressure	Fluctuating	Stable
6. Respiration	Fluctuating	Stable
7. Body temperature	Fluctuating	Stable
8. Neurotransmitter	Noradrenaline	Serotonin

MECHANISM OF SLEEP

- Sleep occurs due to the activity of some **sleep-inducing centers** in brain.
- Stimulation of these centers induces sleep.
- Damage of sleep centers results in sleeplessness or persistent wakefulness called **insomnia.**

SLEEP CENTERS

- Complex pathways between the reticular formation of brainstem, diencephalon and cerebral cortex are involved in the onset and maintenance of sleep.
- However, two centers which induce sleep are located in brainstem:

1. Raphe nucleus
2. Locus ceruleus of pons.

- Recently, many more areas that induce sleep are identified in the brain of animals.
- Inhibition of ascending reticular activating system also results in sleep.

APPLIED PHYSIOLOGY – SLEEP DISORDERS

1. INSOMNIA

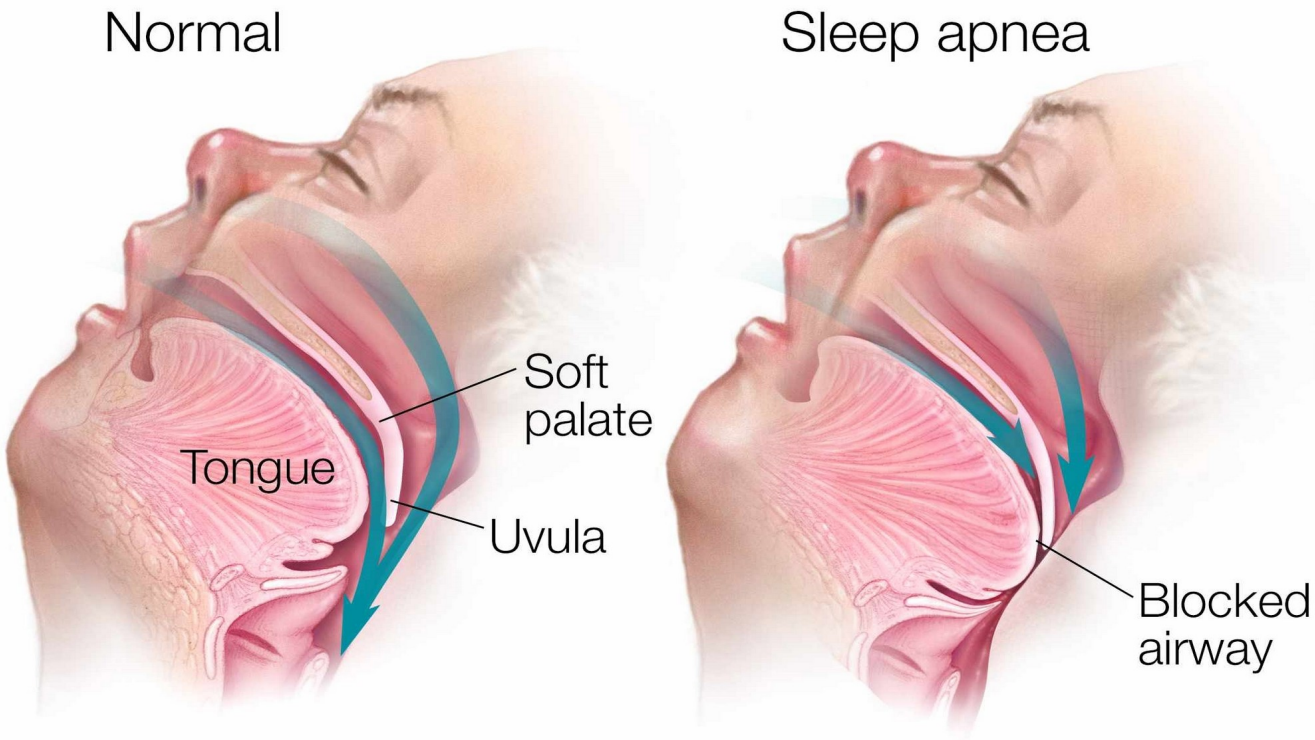
- Insomnia is the inability to sleep or abnormal wakefulness.
- It is the most common sleep disorder.
- It occurs due to systemic illness or mental conditions such as psychiatric problems, alcoholic addiction and drug addiction.

2. HYPERSOMNIA

- Hypersomnia is the excess sleep or excess need to sleep.
- It occurs because of lesion in the floor of the third ventricle, brain tumors, encephalitis, chronic bronchitis and disease of muscles.
- Hypersomnia also occurs in endocrine disorders such as myxedema and diabetes insipidus.

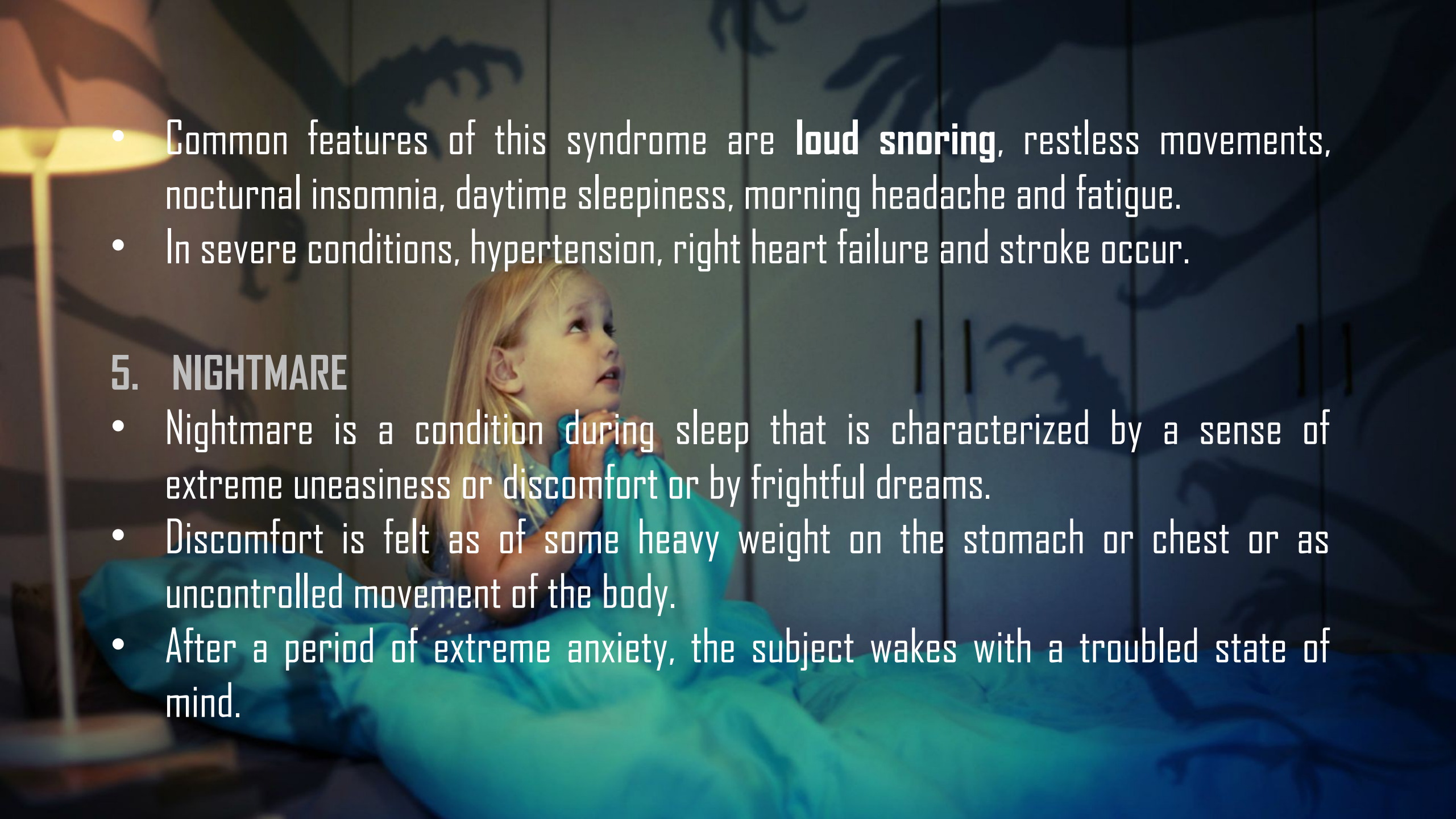
3. NARCOLEPSY AND CATAPLEXY

- Narcolepsy is the sudden attack of **uncontrollable sleep.**
- Cataplexy is sudden **outburst of emotion.**
- Both the diseases are due to hypothalamic disorders.



4. SLEEP APNEA SYNDROME

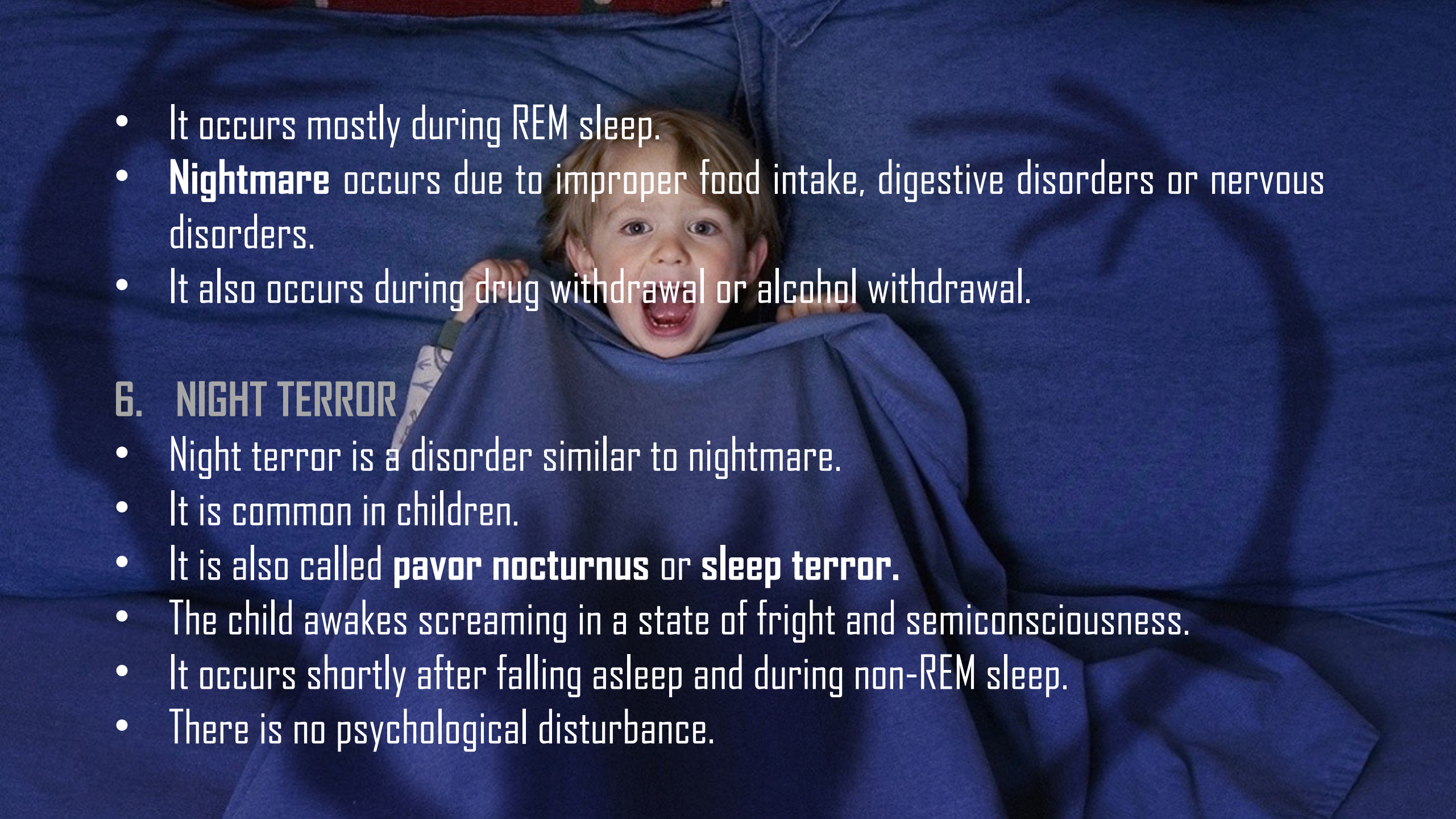
- Sleep apnea is the temporary stoppage of breathing repeatedly during sleep.
- Sleep apnea syndrome is the disorder that involves fluctuations in the rate and force of respiration during REM sleep with short apneic episode.
- When breathing stops, the resultant hypercapnia and hypoxia stimulate respiration.
- Sleep apnea syndrome occurs in **obesity,** myxedema, enlargement of tonsil and lesion in brainstem.



- Common features of this syndrome are **loud snoring**, restless movements, nocturnal insomnia, daytime sleepiness, morning headache and fatigue.
- In severe conditions, hypertension, right heart failure and stroke occur.

5. NIGHTMARE

- Nightmare is a condition during sleep that is characterized by a sense of extreme uneasiness or discomfort or by frightful dreams.
- Discomfort is felt as of some heavy weight on the stomach or chest or as uncontrolled movement of the body.
- After a period of extreme anxiety, the subject wakes with a troubled state of mind.



- It occurs mostly during REM sleep.
- **Nightmare** occurs due to improper food intake, digestive disorders or nervous disorders.
- It also occurs during drug withdrawal or alcohol withdrawal.

6. NIGHT TERROR

- Night terror is a disorder similar to nightmare.
- It is common in children.
- It is also called **pavor nocturnus** or **sleep terror.**
- The child awakes screaming in a state of fright and semiconsciousness.
- It occurs shortly after falling asleep and during non-REM sleep.
- There is no psychological disturbance.

7. SOMNAMBULISM

- Somnambulism is getting up from bed and walking in the state of sleep.
- It is also called **walking during sleep** or **sleep walking** (somnus = sleep; ambulare = to walk).
- It varies from just sitting up in the bed to walking around with eyes open and performing some major complex task.
- The episode lasts for few minutes to half an hour. It occurs during non-REM sleep.
- In children, it is associated with bedwetting or night terror without any psychological disturbance. However, in adults it is associated with psychoneurosis.

8. NOCTURNAL ENURESIS

- Nocturnal enuresis is the involuntary voiding of urine at bed.
- It is also called or **bedwetting.** It is common in children.

9. MOVEMENT DISORDERS DURING SLEEP

- Movement disorders occur immediately after falling asleep.
- **Sleep start** or **hypnic jerk** is the common movement disorder during sleep.
- It is characterized by sudden jerks of arms or legs.
- Sleep start is a physiological form of clonus.
- Other movement disorders are teeth grinding (bruxism), banging the head and restless moment of arms or legs.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