

## B. Assessment of sleep disorders and diagnostic procedures

### 1. Classification of sleep disorders

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#### SUMMARY

In March 2014, the third edition of the International Classification of Sleep Disorders was published by the American Academy of Sleep Medicine, replacing the previous edition. This chapter essentially summarizes the content of the third edition of the International Classification of Sleep Disorders classification, with particular attention to the changes from the previous version, indicating some critical points and emphasizing new concepts and approaches.

#### KEY POINTS

- The International Classification of Sleep Disorders, third edition (ICSD-3) is the current, most advanced classification of sleep disorders devoted to sleep experts.
- The ICSD-3 includes six main clinical divisions: insomnia, sleep-related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias and sleep-related movement disorders.
- A supplementary category has also been included, 'other sleep disorder', in order to assign a code to conditions that might not fit any of the above categories.
- Finally, two appendices are also part of this classification: 'Sleep-related medical and neurological disorders' and 'ICD-10-CM coding for substance induced sleep disorders'.

#### INTRODUCTION

In March 2014, the third edition of the International Classification of Sleep Disorders (ICSD-3) was published by the

American Academy of Sleep Medicine (2014). This new classification replaces the previous edition (ICSD-2; American Academy of Sleep Medicine, 2005), and should be used. In this chapter, important differences between these two

classifications will be highlighted in order to facilitate the transition from one system to the other. However, the general structure of the ICSD-3 parallels that of the second edition and has the same major clinical divisions. A particular mention is reserved for paediatric conditions that are fully merged within each major clinical category, with the exception of obstructive sleep apnoea. Whenever needed, diagnostic criteria variations for the paediatric group are indicated within the general criteria for each condition, and a paragraph on 'Developmental issues' has been added which also contains information on the geriatric group, when appropriate. Also, a comparison is made throughout this chapter with another major classification system, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-V), published by the American Psychiatric Association (2013). It should be considered here that the DSM-V is a classification system to be used by mental health and general medical clinicians who are not experts in sleep medicine; in contrast, the ICSD-3 has been prepared for use by sleep experts. For this reason, in the context of this textbook the ICSD-3 is the reference classification that is discussed primarily in this chapter.

The ICSD-3 includes six main clinical divisions, as described below:

1. Insomnia
2. Sleep-related breathing disorders
3. Central disorders of hypersomnolence
4. Circadian rhythm sleep-wake disorders
5. Parasomnias
6. Sleep-related movement disorders

In addition, another category has been included, called 'Other sleep disorder', with the aim of allowing the clinician to assign a code to conditions that, for different reasons, might not fit any of the above categories. Finally, two appendices report 'Sleep-related medical and neurological disorders' and 'ICD-10-CM coding for substance induced sleep disorders'; these appendices will also be described below.

## INSOMNIA

The list of conditions belonging to this category is much shorter than that published in the ICSD-2, mainly because all diagnoses characterized by a chronic insomnia disorder have been collapsed into a single diagnosis (Chronic insomnia disorder; Table 1). Thus, this chapter now includes the following diagnoses:

1. Chronic insomnia disorder
2. Short-term insomnia disorder
3. Other insomnia disorder
4. Isolated symptoms and normal variants
5. Excessive time in bed
6. Short sleeper

The general definition of insomnia remains basically unchanged with respect to the ICSD-2, being characterized by 'a persistent difficulty with sleep initiation, duration, consolidation, or quality that occurs despite adequate opportunity and circumstances for sleep, and results in some form of daytime impairment'. Thus, insomnia is composed of three

**Table 1** Diagnostic criteria for chronic insomnia (adapted from ICSD-3)

Criteria A–F must be met

- A. The patient reports, or the patient's parent or caregiver observes, one or more of the following:
  1. Difficulty initiating sleep
  2. Difficulty maintaining sleep
  3. Waking up earlier than desired
  4. Resistance to going to bed on appropriate schedule
  5. Difficulty sleeping without parent or caregiver intervention
- B. The patient reports, or the patient's parent or caregiver observes, one or more of the following related to the nighttime sleep difficulty:
  1. Fatigue/malaise
  2. Attention, concentration or memory impairment
  3. Impaired social, family, occupational or academic performance
  4. Mood disturbance/irritability
  5. Daytime sleepiness
  6. Behavioural problems (e.g. hyperactivity, impulsivity, aggression)
  7. Reduced motivation/energy/initiative
  8. Proneness for errors/accidents
  9. Concerns about or dissatisfaction with sleep
- C. The reported sleep/wake complaints cannot be explained purely by inadequate opportunity (i.e. enough time is allotted for sleep) or inadequate circumstances (i.e. the environment is safe, dark, quiet and comfortable) for sleep.
- D. The sleep disturbance and associated daytime symptoms occur at least three times per week
- E. The sleep disturbance and associated daytime symptoms have been present for at least 3 months
- F. The sleep/wake difficulty is not explained more clearly by another sleep disorder

general traits: persistent sleep difficulty, adequate sleep opportunity and associated daytime dysfunction.

As indicated above, the major difference between ICSD-2 and ICSD-3 regarding insomnia is that the contrast between primary and secondary insomnia has been abandoned due to the impossibility to define with certainty the cause/effect relationship between insomnia and the other most often-associated, especially psychiatric, clinical conditions. Insomnia often develops independently from the supposedly primary psychiatric conditions, and may persist when such conditions are treated successfully. Moreover, the ICSD-2 listed several primary insomnia subtypes (psychophysiological insomnia, idiopathic insomnia, inadequate sleep hygiene and paradoxical insomnia) that have been difficult to use in clinical practice, with most patients meeting the diagnostic criteria for two or more of these subtypes. For all these reasons, the new classification includes only one diagnosis encompassing all forms of chronic insomnia. It is not difficult to believe that this choice will cause serious problems, especially for the arrangement of new studies and clinical trials, because if comorbidities are not taken into account a very heterogeneous group of patients will fall within this diagnostic category. At least comorbidities, when present, should always be specified along with the diagnosis of chronic insomnia, and their role in aggravating sleep disruption should be taken into due account.

The grouping of the distinct insomnia phenotypes previously recognized by the ICSD-2 (psychophysiological insomnia, idiopathic insomnia, sleep-state misperception and inadequate sleep hygiene) into a single entity, introduced by the ICSD-3, is in some agreement with the DSM-V approach that states that there is limited evidence to support these distinct phenotypes; consequently, the DSM-V considers the diagnosis of insomnia disorder whether it occurs as an independent condition or in comorbidity with another mental or sleep disorder. Thus, when comorbid insomnia is encountered, the DSM-V indicates that two diagnostic codes should be used but, if insomnia is not sufficiently severe to warrant independent clinical attention, no separate diagnosis is necessary.

Four of the five criteria for short-term insomnia overlap with criteria A, B, C and F of chronic insomnia; only one criterion (D) is specific, and states that 'the sleep disturbance and associated daytime symptoms have been present for <3 months'. Among the features distinguishing short-term insomnia from chronic insomnia, besides the obvious duration of the disorder, the presence of an identifiable cause triggering or precipitating insomnia is common. Insomnia occurring episodically, possibly in connection with particular daytime stressors, can also be classified with this category.

The last category, 'other insomnia disorder', should include patients who complain of the typical insomnia features (persistent sleep difficulty, adequate sleep opportunity and associated daytime dysfunction), but do not meet the full criteria for either chronic insomnia disorder or short-term insomnia disorder.

'Excessive time in bed' is one of the two proposed isolated symptoms or normal variants, and describes the feature of individuals who may report isolated insomnia features such as difficulties falling asleep or prolonged awakenings during the night, without a complaint of insomnia and no daytime consequences.

The other isolated symptom or normal variant is the category 'short sleeper', which describes individuals who sleep, on average, fewer than 6 h per night, yet have no sleep/wake complaints. In order to consider these individuals to be normal short sleepers, daytime dysfunction should also be ruled out.

## SLEEP-RELATED BREATHING DISORDERS

This section includes several conditions characterized by disordered respiration during sleep: obstructive sleep apnoea (OSA) disorders, central sleep apnoea disorders, sleep-related hypoventilation disorders and sleep-related hypoxaemia disorder. It is expected that more than one of these conditions are often present in the same patient and, in particular, obstructive and central sleep apnoea are often found in combination (Tables 2–5).

**Table 2** Diagnostic criteria for obstructive sleep apnoea, adult (adapted from ICSD-3)

(A and B) or C satisfy the criteria

A. The presence of one or more of the following:

1. The patient complains of sleepiness, non-restorative sleep, fatigue or insomnia symptoms
2. The patient wakes with breath holding, gasping or choking
3. The bed partner or other observer reports habitual snoring, breathing interruptions or both during the patient's sleep
4. The patient has been diagnosed with hypertension, a mood disorder, cognitive dysfunction, coronary artery disease, stroke, congestive heart failure, atrial fibrillation or type 2 diabetes mellitus

B. Polysomnography (PSG) or out-of-centre sleep testing (OCST) demonstrates:

1. Five or more predominantly obstructive respiratory events [obstructive and mixed apnoeas, hypopnoeas or respiratory effort-related arousals (RERAs)] per hour of sleep during a PSG or per hour of monitoring (OCST)

or

C. PSG or OCST demonstrates:

1. Fifteen or more predominantly obstructive respiratory events (apnoeas, hypopnoeas or RERAs) per hour of sleep during a PSG or per hour of monitoring (OCST)

**Table 3** Diagnostic criteria for obstructive sleep apnoea, paediatric (adapted from ICSD-3)

Criteria A and B must be met

A. The presence of one or more of the following:

1. Snoring
2. Laboured, paradoxical or obstructed breathing during the child's sleep
3. Sleepiness, hyperactivity, behavioural problems or learning problems

B. PSG demonstrates one or more of the following:

1. One or more obstructive apnoeas, mixed apnoeas, or hypopnoeas, per hour of sleep
2. A pattern of obstructive hypoventilation, defined as at least 25% of total sleep time with hypercapnia ( $\text{PaCO}_2 > 50$  mm Hg) in association with one or more of the following:
  - (a) Snoring
  - (b) Flattening of the inspiratory nasal pressure waveform
  - (c) Paradoxical thoracoabdominal motion

**Table 4** Diagnostic criteria for central sleep apnoea with Cheyne–Stokes breathing (adapted from ICSD-3)

(A or B) + C + D satisfy the criteria

A. The presence of one or more of the following:

1. Sleepiness
2. Difficulty initiating or maintaining sleep, frequent awakenings or non-restorative sleep
3. Awakening short of breath
4. Snoring
5. Witnessed apnoeas

B. The presence of atrial fibrillation/flutter, congestive heart failure or a neurological disorder

C. PSG (during diagnostic or positive airway pressure titration) shows all of the following:

1. Five or more central apnoeas and/or central hypopnoeas per hour of sleep
2. The total number of central apnoeas and/or central hypopnoeas is  $>50\%$  of the total number of apnoeas and hypopnoeas
3. The pattern of ventilation meets criteria for Cheyne–Stokes breathing.

D. The disorder is not explained more clearly by another current sleep disorder, medication use (e.g. opioids) or substance use disorder

**Table 5** Diagnostic criteria for primary central sleep apnoea (adapted from ICSD-3)

Criteria A–D must be met

A. The presence of at least one of the following:

1. Sleepiness
2. Difficulty initiating or maintaining sleep, frequent awakenings or non-restorative sleep
3. Awakening short of breath
4. Snoring
5. Witnessed apnoeas

B. PSG demonstrates all of the following:

1. Five or more central apnoeas and/or central hypopnoeas per hour of sleep (PSG)
2. The number of central apnoeas and/or central hypopnoeas is  $>50\%$  of the total number of apnoeas and hypopnoeas
3. Absence of CSB

C. There is no evidence of daytime or nocturnal hypoventilation

D. The disorder is not explained more clearly by another current sleep disorder, medical or neurological disorder, medication use or substance use disorder

CSB, Cheyne–Stokes breathing; PSG, polysomnography.

- Sleep-related breathing disorders are classified as follows:
1. Obstructive sleep apnoea disorders
    - (a) Obstructive sleep apnoea, adult
    - (b) Obstructive sleep apnoea, paediatric
  2. Central sleep apnoea syndromes
    - (a) Central sleep apnoea with Cheyne–Stokes breathing
    - (b) Central apnoea due to a medical disorder without Cheyne–Stokes breathing

- (c) Central sleep apnoea due to high-altitude periodic breathing
  - (d) Central sleep apnoea due to a medication or substance
  - (e) Primary central sleep apnoea
  - (f) Primary central sleep apnoea of infancy
  - (g) Primary central sleep apnoea of prematurity
  - (h) Treatment-emergent central sleep apnoea
3. Sleep-related hypoventilation disorders
- (i) Obesity hypoventilation syndrome
  - (j) Congenital central alveolar hypoventilation syndrome
  - (k) Late-onset central hypoventilation with hypothalamic dysfunction
  - (l) Idiopathic central alveolar hypoventilation
  - (m) Sleep-related hypoventilation due to a medication or substance
  - (n) Sleep-related hypoventilation due to a medical disorder
4. Sleep-related hypoxaemia
- (o) Disorder sleep-related hypoxaemia
5. Isolated symptoms and normal variants
- (p) Snoring
  - (q) Catathrenia

The upper airway resistance syndrome (UARS) is included in the diagnosis of Obstructive sleep apnoea, adult because of the common pathophysiology. These criteria overlap greatly with the previous ICSD-2 criteria; however, a novelty can be noted in the possibility to diagnose OSA with portable recorders with a limited set of channels [not including electroencephalography (EEG)] and are called 'out of centre sleep testing' (OCST) devices.

The DSM-V lists only three major diagnoses: obstructive sleep apnoea hypopnoea, central sleep apnoea (idiopathic central sleep apnoea, Cheyne–Stokes breathing and central sleep apnoea comorbid with opioid use) and sleep-related hypoventilation (idiopathic hypoventilation, congenital central alveolar hypoventilation and comorbid sleep-related hypoventilation).

The criteria for paediatric OSA are reported to apply to patients younger than 18 years; however, polysomnography (PSG) is scored following the AASM Manual (Berry *et al.*, 2012), which states that adult diagnostic criteria may be used for patients aged 13–18 years.

The central sleep apnoea syndromes include both primary and secondary disorders; before central sleep apnoea can be defined to be primary (i.e. with unknown cause), all secondary conditions should be excluded.

Typical Cheyne–Stokes breathing is characterized by a cyclical pattern of crescendo–decrescendo respiration separated by central apnoeas or hypopnoeas. The majority of these patients are affected by congestive heart failure; however, Cheyne–Stokes breathing also occurs consistently in patients with stroke or with other neurological disorders. It is

important to note that structural central nervous system (CNS) abnormalities can also cause non-Cheyne–Stokes central sleep apnoea due to medical or neurological conditions. Finally, central sleep apnoea due to high-altitude periodic breathing is usually associated with acute ascent to high altitude and requires the presence of symptoms such as sleepiness, difficulty initiating or maintaining sleep, frequent awakenings or non-restorative sleep, awakening with shortness of breath or morning headache or witnessed apnoea.

Treatment-emergent central sleep apnoea represents a novelty, because it was not included in the ICSD-2 and should be used with patients with predominantly obstructive events during diagnostic sleep testing, who exhibit central apnoeas or central hypopnoeas on positive airway pressure treatment, as an emergent or persisting pattern, notwithstanding the resolution of the obstructive disorder, which is not explained more clearly by another central sleep apnoea disorder diagnosis.

The general criterion for the diagnosis of sleep-related hypoventilation disorders is the presence of sleep-related hypoventilation, as defined by the AASM Manual (Berry *et al.*, 2012). These disorders are characterized by abnormally elevated arterial carbon dioxide partial pressure (PaCO<sub>2</sub>) during sleep. For the diagnosis of obesity hypoventilation syndrome it is necessary, additionally, to demonstrate daytime hypoventilation, defined as an arterial PaCO<sub>2</sub> >45 mm Hg. In this group of disorders, different adult and paediatric criteria have also been arranged.

Moreover, several changes for the criteria of sleep-related hypoventilation disorders can be noted from the previous ICSD-2 in this new edition. First, obesity hypoventilation syndrome has been given the dignity of a separate disorder because of its prevalence and clinical characteristics. In the ICSD-2, sleep-related hypoventilation/hypoxaemia disorders constituted a single category; in the ICSD-3, disorders characterized by hypoventilation have been separated from disorders characterized only by sleep hypoxaemia (arterial oxygen desaturation) because of the different diagnostic and treatment correlates. The diagnosis of sleep-related hypoxaemia, characterized by periods of significantly reduced oxyhaemoglobin saturation, can be used when sleep-related hypoventilation is either not present or the status is unknown. Many conditions and different aetiologies can cause sleep-related hypoxemia: hypoventilation, ventilation–perfusion mismatch, low partial pressure of oxygen, shunt or a combination of these factors. Many diverse aetiologies can be associated with sleep-related hypoxaemia. While, in the ICSD-2, lower airway obstruction, pulmonary parenchymal and vascular pathology and neuromuscular and chest wall disorders were part of the diagnostic subgroups, in the ICSD-3 these specific pulmonary or neurological disorders should be diagnosed separately and associated with a diagnosis of sleep-related hypoventilation due to medical or neurological condition or sleep-related hypoxaemia.

Snoring is the first isolated symptom/normal variant of the sleep-related breathing disorders chapter of the ICSD-3. This

snoring occurs without episodes of apnoea, hypopnoea, respiratory effort-related arousals (RERAs) or hypoventilation; thus, this type of snoring does not cause symptoms of daytime sleepiness or insomnia in the patient and cannot be diagnosed in individuals' exhibiting symptoms, such as daytime sleepiness, fatigue or other similar symptoms or report of respiratory pauses, without objective measurement of breathing during sleep. In patients with comorbid cardiovascular disease who are at increased risk for OSA, even in the absence of daytime complaints, PSG or OCST is required to effectively rule out OSA.

The second isolated symptom/normal variant is catathrenia, also known as sleep-related groaning. This disorder was among parasomnias in the ICSD-2 but has been moved into the sleep-related breathing disorders section because it is characterized by prolonged expiration, usually during rapid eye movement (REM) [but also non-REM (NREM)] sleep, with a monotonous vocalization resembling groaning, and usually associated polygraphically with prolonged bradypnoea and/or central apnoea starting with the expiratory phase of the respiratory cycle. Generally, these events, differently from the classical central sleep apnoea, are not associated with oxyhaemoglobin desaturation.

## CENTRAL DISORDERS OF HYPERSOMNOLENCE

Daytime sleepiness, i.e. the inability to stay awake and alert during the major episodes of wakefulness during the day, resulting in periods of incoercible sleep or involuntary bouts of drowsiness or sleep, is the primary complaint in the disorders included in this group. In all cases, daytime sleepiness should not be caused by disturbed nocturnal

sleep or disordered circadian rhythms and, when other sleep disorders are present, they need to be treated adequately before a diagnosis in this category can be established. Finally, the term 'hypersomnolence' refers to the symptom of excessive sleepiness, whereas hypersomnia indicates specific disorders, such as idiopathic hypersomnia.

There are subjective (Epworth Sleepiness Scale; ESS) and objective ways (Multiple Sleep Latency Test; MSLT) to assess the severity of daytime sleepiness which can be used as diagnostic tools, provided that they are administered following standard procedures and in subjects belonging to populations in whom the tests have been validated (Chervin, 2000; Mignot *et al.*, 2006). Conversely, the maintenance of wakefulness test, which assesses the ability to remain awake during the daytime in a darkened and quiet environment, is not adequate for diagnostic purposes but is better suited to assess response to treatment. Finally, 24-h continuous sleep recording or actigraphy (for at least 1 week) can be helpful for the diagnosis of idiopathic hypersomnia (Pizza *et al.*, 2013; Tables 6 and 7).

Central disorders of hypersomnolence are classified as follows:

1. Narcolepsy type 1
2. Narcolepsy type 2
3. Idiopathic hypersomnia
4. Kleine–Levin syndrome
5. Hypersomnia due to a medical disorder
6. Hypersomnia due to a medication or substance
7. Hypersomnia associated with a psychiatric disorder
8. Insufficient sleep syndrome
9. Isolated symptoms and normal variants
  - (a) Long sleeper

**Table 6** Diagnostic criteria for narcolepsy types 1 and 2 (adapted from ICSD-3)

Criteria A and B must be met

Narcolepsy type 1

A. The patient has daily periods of irrepressible need to sleep or daytime lapses into sleep occurring for at least 3 months

B. The presence of one or both of the following:

1. Cataplexy (as defined under 'Essential features') and a mean sleep latency of  $\leq 8$  min and two or more sleep-onset REM periods (SOREMPs) on an MSLT performed according to standard techniques. A SOREMP (within 15 min of sleep onset) on the preceding nocturnal polysomnogram may replace one of the SOREMPs on the MSLT
2. CSF hypocretin-1 concentration, measured by immunoreactivity, is either  $\leq 110$  pg mL<sup>-1</sup> or  $< 1/3$  of mean values obtained in normal subjects with the same standardized assay

Criteria A–E must be met

Narcolepsy type 2

A. The patient has daily periods of irrepressible need to sleep or daytime lapses into sleep occurring for at least 3 months

B. A mean sleep latency of  $\leq 8$  min and two or more sleep-onset REM periods (SOREMPs) are found on a MSLT performed according to standard techniques. A SOREMP (within 15 min of sleep onset) on the preceding nocturnal polysomnogram may replace one of the SOREMPs on the MSLT

C. Cataplexy is absent

D. Either CSF hypocretin-1 concentration has not been measured or CSF hypocretin-1 concentration measured by immunoreactivity is either  $> 110$  pg mL<sup>-1</sup> or  $> 1/3$  of mean values obtained in normal subjects with the same standardized assay

E. The hypersomnolence and/or MSLT findings are not explained more clearly by other causes such as insufficient sleep, obstructive sleep apnoea, delayed sleep phase disorder or the effect of medication or substances or their withdrawal

CSF, cerebrospinal fluid; REM, rapid eye movement; MSLT, Multiple Sleep Latency Test.

**Table 7** Diagnostic criteria for idiopathic hypersomnia (adapted from ICSD-3)

Criteria A–F must be met

- A. The patient has daily periods of irrepressible need to sleep or daytime lapses into sleep occurring for at least 3 months
- B. Cataplexy is absent
- C. An MSLT performed according to standard techniques shows fewer than two sleep onset REM periods or no sleep onset REM periods if the REM latency on the preceding polysomnogram was  $\leq 15$  min
- D. The presence of at least one of the following:
  1. The MSLT shows a mean sleep latency of  $\leq 8$  min
  2. Total 24-h sleep time is  $\geq 660$  min (typically 12–14 h) on 24-h polysomnographic monitoring (performed after correction of chronic sleep deprivation), or by wrist actigraphy in the patient has daily periods of irrepressible need to sleep or daytime lapses into sleep occurring for at least three associations with a sleep log (averaged over at least 7 days with unrestricted sleep)
- E. Insufficient sleep syndrome is ruled out (if deemed necessary, by lack of improvement of sleepiness after an adequate trial of increased nocturnal time in bed, preferably confirmed by at least a week of wrist actigraphy)
- F. The hypersomnolence and/or MSLT findings are not explained more clearly by another sleep disorder, other medical or psychiatric disorder or use of drugs or medications

REM, rapid eye movement; MLST, Multiple Sleep Latency Test.

The major novelty of this new classification is the subdivision of narcolepsy into narcolepsy types 1 and 2, thus abandoning the previous diagnoses of narcolepsy with and without cataplexy. In the ICSD-3 the hypocretin (orexin) absence plays a major discriminating role between these two categories. It is also specified that it is not obligatory to dose hypocretin in the cerebrospinal fluid. Basically, these changes allow patients without cataplexy but with deficient hypocretin to be classified together with those with cataplexy. Another important change from the ICSD-2 is represented by the need of one single sleep-onset REM period (SOREMP) on an MSLT, provided that a SOREMP is recorded (within 15 min of sleep onset) on the preceding nocturnal PSG; otherwise, the two SOREMPs rule is maintained.

For the DSM-V, only one major category is reported under the term 'narcolepsy', encompassing some subtypes in which one of the criteria needed for the major diagnosis can be missing (narcolepsy without cataplexy but with hypocretin deficiency, narcolepsy with cataplexy but without hypocretin deficiency, autosomal dominant cerebellar ataxia, deafness and narcolepsy, autosomal dominant narcolepsy, obesity and type 2 diabetes, narcolepsy secondary to another medical condition).

The diagnosis of idiopathic hypersomnia is reserved for individuals who show an objective excessive daytime sleepiness without cataplexy, and with no more than one SOREMP on MSLT and preceding polysomnogram combined; excessive daytime sleepiness should not be explained by another disorder. Moreover, differently from the previous version, ICSD-3 does not list subtypes for this condition, because it was felt that there is insufficient evidence that the two previous subtypes (with short or long nocturnal sleep) represent two distinct subcategories of this somewhat heterogeneous group of patients.

The DSM-V reports a hypersomnolence disorder that should only be used when hypersomnolence is not explained more clearly and does not occur exclusively during the

course of another sleep disorder, is not attributable to the effects of a substance, and is not adequately explained by co-existing mental and medical disorders. Nevertheless, three types of specifiers are indicated: (a) if it occurs with another disorder (mental, including substance use disorders; medical or another sleep disorder); (b) duration (acute, <1 month; subacute, 1–3 months; persistent, >3 months) and (c) severity (mild, 1–2 days per week, moderate, 3–4 days per week; severe, 5–7 days per week).

Kleine–Levin syndrome is a recurrent severe hypersomnia characterized by relapsing–remitting episodes during which cognitive, psychiatric and behavioural disturbances are also evident. In the ICSD-3, the historic term 'Kleine–Levin syndrome' has returned to be preferred in place of the recurrent hypersomnia, because this condition is somewhat homogeneous if not stereotyped. The criteria for its diagnosis have changed very little and the ICSD-2 menstrual-related hypersomnia appears now only as a subtype of the Kleine–Levin syndrome.

The other categories of this group are essentially the same as in the ICSD-2, with the addition of long sleeper, listed as an isolated symptom or normal variant.

## CIRCADIAN RHYTHM SLEEP–WAKE DISORDERS

Circadian rhythm sleep–wake disorders share a common criterion that the disorder is caused by alterations of the circadian time-keeping system, its entrainment mechanisms or a misalignment of the endogenous circadian rhythm and the external environment (Table 8).

The following circadian rhythm sleep–wake disorders are listed in the ICSD-3:

1. Delayed sleep–wake phase disorder
2. Advanced sleep–wake phase disorder
3. Irregular sleep–wake rhythm disorder

**Table 8** General criteria for circadian rhythm sleep–wake disorder (adapted from ICSD-3)

Criteria A–C must be met

- A. A chronic or recurrent pattern of sleep–wake rhythm disruption due primarily to alteration of the endogenous circadian timing system or misalignment between the endogenous circadian rhythm and the sleep–wake schedule desired or required by an individual's physical environment or social/work schedules
- B. The circadian rhythm disruption leads to insomnia symptoms, excessive sleepiness or both
- C. The sleep and wake disturbances cause clinically significant distress or impairment in mental, physical, social, occupational, educational or other important areas of functioning

- 4. Non-24-h sleep–wake rhythm disorder
- 5. Shift work disorder
- 6. Jet lag disorder
- 7. Circadian sleep–wake disorder not otherwise specified (NOS)

The diagnosis of these disorders is based essentially, besides the careful collection of the clinical history, on sleep logs and actigraphic recordings which should last for at least 7 days, and preferably for 14 days in order to include working and non-working days. Important additional information can be obtained by means of morningness/eveningness questionnaires on the individual circadian chronotype; moreover, physiological measures of endogenous circadian timing (salivary or plasma dim light melatonin onset and urinary 6-sulphatoxymelatonin) are also available, which can provide precious information.

Habitual delayed sleep–wake timing characterizes delayed sleep–wake phase disorder; the delay is usually longer than 2 h, with difficulty falling asleep at a socially acceptable time. This results in a reduction of sleep duration on school or work nights which appears to be insufficient. Sleep is reported to be of normal duration if the subject is not awakened by external stimuli, such as an alarm clock. However, difficulty arising at a socially acceptable wake time (for school or work) is reported. Predisposing/precipitating factors for this disorder are: evening chronotype, adolescent age, polymorphism in the circadian clock gene *hPer3*, decreased exposure to light in the morning or increased exposure to bright light late in the evening, changes in work and social schedules, travel across time zones and shift work.

In the advanced sleep–wake phase disorder an habitual advance of the major sleep episode is present, with sleep onset and offset occurring typically at least 2 h before the required or desired times. Usually, these patients report early morning or maintenance insomnia and excessive sleepiness in the evening. The disorder occurs more frequently in older individuals, who generally present an increased morningness. Although familiarity is evident in some patients, definite genes implicated in this condition are not known. Advanced sleep–wake phase disorder has also been observed in children with neurodevelopmental disorders (autism spectrum disorders and Smith–Magenis syndrome) with abnormal melatonin secretion profiles.

The irregular sleep–wake rhythm disorder is defined as a chronic or recurring lack of a clearly defined circadian rhythm

of sleep and wake. This temporal disorganization of the sleep–wake pattern, with variable sleep and wake episodes throughout the 24-h cycle, can cause insomnia, or excessive sleepiness, or both. This disorder is often seen in old-age neurodegenerative disorders (Alzheimer's disease, Parkinson's disease, Huntington's disease, etc.) but also in children with neurodevelopmental disorders. In institutionalized elderly individuals this disorder can be favoured by poor sleep hygiene and insufficient exposure to synchronizing agents (light, activity and social schedules).

In the non-24-h sleep–wake disorder (or free-running disorder), which was called non-entrained circadian rhythm sleep disorder in the ICSD-2, the individual circadian pacemaker is not entrained to a 24-h light/dark cycle and causes symptoms of insomnia or excessive sleepiness, depending on the timing of the attempts to sleep in relation to the circadian rhythm of sleep and wake propensity. This disorder is common in totally blind individuals, while in non-blind patients some environmental conditions can favour its appearance, especially insufficient or time-inappropriate exposure to circadian entraining agents (light). Also, delayed sleep–wake phase disorder may predispose and it has been reported that non-24-h sleep–wake disorder has developed after chronotherapy in adults as a consequence of traumatic brain injury.

Shift work disorder is reported by individuals working hours corresponding to their usual sleep episode (at least in part), and is characterized by complaints of insomnia or excessive sleepiness. Night shifts, early morning shifts and rotating shifts are associated frequently with shift work disorder, causing a reduction of total sleep time (typically 1–4 h) followed by the perception of unrefreshing and unsatisfactory sleep. Impaired work performance and reduced alertness are also reported, which may be associated with reduced safety at work and on the commute to and from work. The disorder usually lasts only for the duration of the shift-work schedule, but in some individuals may persist after discontinuation of the shift work. Several individual features may predispose, precipitate or aggravate this disorder, such as chronotype, presence of other sleep disorders (sleep apnoea) and social pressures.

Jet lag disorder arises from a temporary mismatch between the timing of the endogenous circadian sleep and wake cycle and that of the sleep and wake pattern required

by the time zone. After a time zone change, because of a flight, travellers suffer from disturbed sleep, sleepiness/fatigue and impaired daytime functioning. Symptoms can vary in severity and duration, depending on the number of time zones travelled, the ability to sleep in flight, exposure to light or other environmental clues, individual tolerance to circadian misalignment and travel direction. Travelling eastward requires advancing circadian rhythms and causes more adjustment problems than westward travel.

Finally, individuals meeting the general diagnostic criteria for circadian rhythm sleep–wake disorders but do not meet the specific criteria for one of the circadian rhythm sleep–wake disorders listed above must be assigned the diagnosis of circadian sleep–wake disorder not otherwise specified (NOS). This diagnosis includes patients with alterations in circadian sleep–wake patterns due to underlying medical, neurological and psychiatric disorders; thus, the two ICSD-2 categories of circadian rhythm sleep disorders due to a medical condition and to drug or substance (alcohol) use have been suppressed in the ICSD-3 and merged into this heterogeneous group.

The circadian rhythm sleep–wake disorders listed by the DSM-V largely overlap those included in the ICSD-3; the jet-lag disorder is not present in this classification.

## PARASOMNIAS

Parasomnias are disorders characterized by the occurrence of complex motor or behavioural events or experiences at sleep onset, within sleep or during arousal from sleep. Parasomnias may occur during any sleep stage: NREM, REM or during transitions to and from sleep. During parasomnia events abnormal sleep-related complex movements, behaviours, emotions, perceptions, dreams and autonomic nervous system activity may occur which are

potentially harmful and can cause injuries (also to the bed partner), sleep disruption, adverse health consequences and undesirable psychosocial effects.

In the ICSD-3 the concept of parasomnias as a result of sleep state dissociation is emphasized and corroborated by recent research showing that combinations of one or more of these states (wake, NREM and REM sleep) occur and may result in unstable states of altered consciousness manifesting as parasomnias. Moreover, the categories of parasomnias have been revised and merged differently from the ICSD-2. There are 10 core categories of parasomnias listed in the ICSD-3. Only one of the core categories, REM sleep behaviour disorder (RBD), requires video PSG documentation as one of the essential diagnostic criteria. However, for most of the other parasomnias, polysomnographic monitoring can provide corroborative documentation in support of the clinical diagnosis (Table 9 and 10).

The following parasomnia categories are listed in the ICSD-3:

1. NREM-related parasomnias
  - (a) Disorders of arousal (from NREM sleep)
  - (b) Confusional arousals
  - (c) Sleepwalking
  - (d) Sleep terrors
  - (e) Sleep-related eating disorder
2. REM-related parasomnias
  - (a) REM sleep behaviour disorder
  - (b) Recurrent isolated sleep paralysis
  - (c) Nightmare disorder
3. Other parasomnias
  - (a) Exploding head syndrome
  - (b) Sleep-related hallucinations

**Table 9** General diagnostic criteria for disorders of arousal (adapted from ICSD-3)

Criteria A–E must be met

- A. Recurrent episodes of incomplete awakening from sleep
- B. Inappropriate or absent responsiveness to efforts of others to intervene or redirect the person during the episode
- C. Limited (e.g. a single visual scene) or no associated cognition or dream imagery
- D. Partial or complete amnesia for the episode
- E. The disturbance is not explained more clearly by another sleep disorder, mental disorder, medical condition, medication or substance use

**Table 10** Diagnostic criteria for sleep-related eating disorder (adapted from ICSD-3)

Criteria A–D must be met

- A. Recurrent episodes of dysfunctional eating that occur after an arousal during the main sleep period
- B. The presence of at least one of the following in association with the recurrent episodes of involuntary eating:
  1. Consumption of peculiar forms or combinations of food or inedible or toxic substances
  2. Sleep-related injurious or potentially injurious behaviours performed while in pursuit of food or while cooking food
  3. Adverse health consequences from recurrent nocturnal eating
- C. There is partial or complete loss of conscious awareness during the eating episode, with subsequent impaired recall
- D. The disturbance is not explained more clearly by another sleep disorder, mental disorder, medical disorder, medication or substance use

- (c) Sleep enuresis
- (d) Parasomnia due to a medical disorder
- (e) Parasomnia due to a medication or substance
- (f) Parasomnia, unspecified

#### 4. Isolated symptoms and normal variants

- (a) Sleep talking

There are significant differences in clinical and descriptive characteristics of the main features of the disorders of arousals from the ICSD-2. The main clinical features of the different forms have been merged in one single chapter, stressing the differences but also the common findings, and the possibility that the more complex (sleepwalking) may start with the simplest (confusional arousal) form. In this respect, the ICSD-3 is a little more similar to the concept behind the DSM-V classification of these disorders that groups them together into the NREM arousal disorders category (which does not include confusional arousals). At the end of the chapter the essential diagnostic criteria for each single category are mentioned. Moreover, it is emphasized that some clinical and physiopathological subtypes actually exist, such as sleep-related abnormal sexual behaviours, classified primarily as confusional arousals in that they typically occur without any behaviours outside the bed (or chosen sleeping accommodation), but have also been associated less commonly with sleepwalking. Sleep-related abnormal sexual behaviours often have major interpersonal, clinical and occasionally criminal consequences. The set of abnormal sexual behaviours during disordered arousals includes different behaviours followed by morning amnesia. The preponderance of patients have also been diagnosed with a NREM sleep parasomnia, most often confusional arousals alone, but on occasion with sleepwalking, sleep-related driving or sleep-related eating disorder. OSA is another recognized precipitant of sleep-related abnormal sexual behaviours. A major emphasis on the possible different onset or course of lifelong behaviours has been given: disorders of arousal most often occur initially in childhood and decrease in occurrence steadily until young adulthood. However, they may occur for the first time in adulthood or reappear after many asymptomatic years, often related to stress, sleep deprivation or development of another sleep disorder. From the objective finding and video PSG viewpoints, the ICSD-3 stresses the absence of pathognomonic characteristics of EEG or PSG features, but underlines some 'microstructural' modifications, as slow wave sleep can be perturbed and dysregulated with increase in fragmentation, in delta power and in slow wave activity, across all NREM sleep cycles. Moreover, the differential diagnosis with some form of sleep-related epilepsy (i.e. nocturnal frontal or temporal lobe epilepsy) remains a puzzle which has not yet been completely resolved.

Sleep-related eating disorder (SRED) consists of recurrent episodes of involuntary eating and drinking during arousals from sleep, associated with diminished levels of conscious-

ness and subsequent recall, with problematic consequences. The ICSD-3 stresses the relationship with arousals disorders (in fact, differently from the ICSD-2, it is listed among the disorders of arousals): partial level of consciousness during the episodes, incomplete or absent recall, consumption of peculiar forms or combinations of food or of inedible or toxic substances, sleep-related injury, adverse health consequences and various metabolic problems. As it is associated with and shares some common features with nocturnal sleepwalking, SRED might be considered as a possible 'sleepwalking variant disorder'. Conversely, the possibility that the episodes, spontaneous or precipitated by drugs or medication (medication-induced SRED), occur during sleep states is not frequent; on video PSG, eating episodes occur mainly within 1 min after awakening from stages N2 or N3 and are associated frequently with other sleep disorders, such as parasomnias, movement or respiratory disorders during sleep. This raises the question of the distinction of SRED from night eating syndrome (NES), which is characterized by excessive eating between dinner and bedtime and during full awakenings during the sleep period, and from daytime eating disorders (bulimia nervosa, anorexia nervosa), although the two conditions may be comorbid. The extent of overlap and divergence between SRED and NES needs to be clarified further.

RBD is characterized by abnormal behaviours emerging during REM sleep that may cause injury or sleep disruption. RBD is also associated with electromyograph (EMG) abnormalities during REM sleep. The EMG demonstrates an excess of muscle tone during REM sleep, and/or an excess of phasic EMG twitch activity during REM sleep. From the clinical subtypes viewpoint, the ICSD-3 also takes into consideration, besides the parasomnia overlap disorder and the status dissociatus, the dream enactment ('oneirism') that can be a core feature of a pathological condition called agrypnia excitata that is characterized by generalized motor overactivity, impaired ability to initiate and maintain sleep (with 'wakeful dreaming'), loss of slow wave sleep and marked motor and autonomic sympathetic activation. Agrypnia excitata is found with such diverse conditions as delirium tremens, Morvan syndrome, fatal familial insomnia and Mulvihill-Smith syndrome. Thus, agrypnia excitata manifests as both a severe parasomnia and a severe insomnia. Some new underlying features are stressed by the classification: smoking, head injury, pesticide exposure and farming are significant risk factors; medications, particularly the antidepressants venlafaxine, serotonin-specific reuptake inhibitors, mirtazapine and other antidepressant agents (but not bupropion) are increasingly recognized precipitating factors, as well as beta-blockers, anticholinesterase inhibitors and selegiline; psychiatric disorders involving depression (that require antidepressant pharmacotherapy) may comprise a predisposing factor, particularly in adults younger than 50 years, as well as post-traumatic stress disorder. A significantly increased positive family history of dream enactment in RBD patients raises the possibility of a genetic contribution to RBD.

One important emergent new finding, underlined in the ICSD-3, is the relationship with neurodegenerative disorders: delayed emergence of a neurodegenerative disorder [Parkinson disease (PD), multiple system atrophy (MSA) and dementia with Lewy bodies (DLB)], often more than a decade after the onset of idiopathic RBD, is very common. Two recently reported series found conversion rates of >80% from idiopathic RBD to parkinsonism/dementia (Iranzo *et al.*, 2013; Schenck *et al.*, 2013). Conversely, RBD is present in >90% of reported cases of MSA, in approximately 50% of reported cases of DLB, and in up to 46% of reported patients with PD.

Regarding pathophysiology, the ICSD-3 suggests a selective association between RBD and synucleinopathies, a set of neurodegenerative disorders that share a common pathological lesion composed of aggregates of insoluble  $\alpha$ -synuclein protein in selectively vulnerable populations of neurons and glial cells. The major synucleinopathies include PD, DLB and MSA. Moreover, especially in children but also in adults, RBD can be strongly linked with narcolepsy (almost always narcolepsy type 1), representing another form of REM sleep motor-behaviour dyscontrol. RBD associated with narcolepsy is now considered to be a distinct phenotype of RBD, characterized by lack of sex predominance, less complex and more elementary movements and less violent behaviour in REM sleep, earlier age of onset and hypocretin deficiency (that is characteristic of narcolepsy type 1).

Apparently, for this diagnosis, PSG is mandatory; however, it should be noted that the note reported in Table 11 practically allows the 'provisional' diagnosis of this condition, even in the absence of any recording. It is not clear if this 'provisional' diagnosis would allow treatment or inclusion in research protocols of these patients. Another note indicates that REM sleep without atonia (RWA) should be assessed following the rules set by the AASM Manual (Berry *et al.*, 2012); however, these rules specify how to score single epochs of REM sleep as 'tonic' or 'phasic', but do not provide quantitative cut-offs to define when a PSG recording contains sufficient 'sustained muscle activity in REM sleep in the chin EMG' nor 'excessive transient muscle activity during REM in the chin or limb EMG'. Thus, the real value of PSG-confirmed RWA following these rules is highly ques-

tionable and, basically, remains a matter of subjective 'clinical judgement'. It should also be noted that the method indicated in the objective findings as a reliable tool to score RWA (Frauscher *et al.*, 2012), but not indicated in the diagnostic criteria, needs the recording of the flexor digitorum superficialis muscles which are not included in the AASM Manual (Berry *et al.*, 2012) rules, while other reliable methods using only the chin EMG, and thus complying with the above Manual, have been omitted (Ferri *et al.*, 2010; Montplaisir *et al.*, 2010) but can be used, especially if the flexor digitorum superficialis muscles EMG signals are not available.

The diagnosis of REM sleep behaviour disorder is virtually the same in the ICSD-2 and the DSM-V, but for the ICSD-3 the demonstration of RWA is mandatory; without it, only a provisional diagnosis can be formulated.

## SLEEP-RELATED MOVEMENT DISORDERS

The basic features of sleep-related movement disorders are relatively simple, often stereotyped movements that occur during sleep or at its onset. Even if limb movements that patients with restless legs syndrome (RLS) use to reduce leg discomfort during wakefulness, especially at evening/night, are not stereotypical, during sleep the great majority of these patients make periodic limb movements (PLMs) which are usually simple, somewhat stereotyped, and repetitive (Tables 12–14). Disturbed night sleep or daytime sleepiness/fatigue are needed for a diagnosis of a sleep-related movement disorder. PLMs can occur during sleep (PLMS) or wakefulness (PLMW); however, if they are not accompanied by any complaint or sleep objective disturbance they do not constitute a disorder, but their presence should only be noted. Similarly, the simple presence of rhythmic movements, without complaints or sleep disturbance, cannot support the diagnosis of a sleep-related rhythmic movement disorder.

Although the diagnosis of sleep-related movement disorders can be based only on clinical data, such as in RLS, video PSG may be an important examination to define other entities in this group, such as sleep-related rhythmic movement disorders.

**Table 11** Diagnostic criteria for REM sleep behaviour disorder (adapted from ICSD-3)

Criteria A–D must be met

- A. Repeated episodes of sleep related vocalization and/or complex motor behaviours
- B. These behaviours are documented by polysomnography to occur during REM sleep or, based on clinical history of dream enactment, are presumed to occur during REM sleep
- C. Polysomnographic recording demonstrates REM sleep without atonia (RWA)
- D. The disturbance is not explained more clearly by another sleep disorder, mental disorder, medication, or substance use

On occasion, there may be patients with a typical clinical history of RBD with dream-enacting behaviours, who also exhibit typical rapid eye movement (REM) sleep behaviour disorder (RBD) behaviours during video polysomnography (PSG), but do not demonstrate sufficient RWA, based on the current evidence-based data, to satisfy the PSG criteria for diagnosing RBD. In such patients, RBD may be provisionally diagnosed, based on clinical judgement. The same rule applies when videoPSG is not readily available.

**Table 12** Diagnostic criteria for restless legs syndrome (RLS; adapted from ICSD-3)

Criteria A–C must be met

A. An urge to move the legs, usually accompanied by or thought to be caused by uncomfortable and unpleasant sensations in the legs.

These symptoms must:

1. Begin or worsen during periods of rest or inactivity such as lying down or sitting;
2. Be partially or totally relieved by movement, such as walking or stretching, at least as long as the activity continues; and
3. Occur exclusively or predominantly in the evening or night rather than during the day

B. The above features are not solely accounted for as symptoms of another medical or a behavioural condition (e.g. leg cramps, positional discomfort, myalgia, venous stasis, leg oedema, arthritis, habitual foot-tapping)

C. The symptoms of RLS cause concern, distress, sleep disturbance or impairment in mental, physical, social, occupational, educational, behavioural or other important areas of functioning

**Table 13** Diagnostic criteria for periodic limb movement disorder (PLMS; adapted from ICSD-3)

Criteria A–D must be met

A. Polysomnography demonstrates PLMS, as defined in the latest version of the American Academy of Sleep Medicine (AASM) Manual for the Scoring of Sleep and Associated Events

B. The frequency is  $>5\text{ h}^{-1}$  in children or  $>15\text{ h}^{-1}$  in adults

C. The PLMS cause clinically significant sleep disturbance or impairment in mental, physical, social, occupational, educational, behavioural or other important areas of functioning

D. The PLMS and the symptoms are not explained more clearly by another current sleep disorder, medical or neurological disorder or mental disorder (e.g. PLMS occurring with apnoeas or hypopnoeas should not be scored)

Data suggest a partial overlap of PLMS Index values between symptomatic and asymptomatic individuals, emphasizing the importance of clinical context over an absolute cutoff value.

**Table 14** Diagnostic criteria for sleep-related bruxism (adapted from ICSD-3)

Criteria A and B must be met

A. The presence of regular or frequent tooth grinding sounds occurring during sleep

B. The presence of one or more of the following clinical signs:

1. Abnormal tooth wear consistent with above reports of tooth grinding during sleep
2. Transient morning jaw muscle pain or fatigue; and/or temporal headache; and/or jaw locking upon awakening consistent with above reports of tooth grinding during sleep

Sleep-related movement disorders are listed below:

1. Restless legs syndrome
2. Periodic limb movement disorder
3. Sleep-related leg cramps
4. Sleep-related bruxism
5. Sleep-related rhythmic movement disorder
6. Benign sleep myoclonus of infancy
7. Propriospinal myoclonus at sleep onset
8. Sleep-related movement disorder due to a medical disorder
9. Sleep-related movement disorder due to a medication or substance
10. Sleep-related movement disorder, unspecified
11. Isolated symptoms and normal variants
  - (a) Excessive fragmentary myoclonus
  - (b) Hypnagogic foot tremor and alternating leg muscle activation
  - (c) Sleep starts (hypnic jerks)

RLS is a sensorimotor disorder characterized by an urge to move the limbs, often accompanied by other uncomfortable sensations sometimes difficult or impossible to

describe. A variable but significant proportion of RLS patients also report arm sensations. RLS sensations become worse with rest, are relieved by movement and occur in the evening or at night, with a clear circadian distribution of symptoms (at least in the first years of the disease). RLS is defined as clinically significant when its symptoms cause distress, sleep disturbance or impairment of function. No specific criteria are indicated for paediatric RLS; however, one note specifies that, for children experiencing uncomfortable and unpleasant sensations in the legs, 'the description of these symptoms should be in the child's own words'. Also the presence of RLS in first-degree relatives represents an important factor to be taken into account for the diagnosis of paediatric RLS.

Supportive data for the diagnosis of RLS are the presence of PLMS and/or PLMW, positive family history of RLS and prompt response of symptoms and PLMS to dopaminergic therapy (Manconi *et al.*, 2007). PLMS are associated frequently with arousals from sleep and are accompanied by significant rises in heart rate and blood pressure (Pennestri *et al.*, 2007); however, these events are not connected by a cause/effect relationship (Ferri *et al.*, 2013; Manconi *et al.*,

2012). The ICSD-3 does not mention 'symptomatic' or 'secondary' RLS but indicates a series of predisposing (positive family history, some genetic variants, female sex) and precipitating factors: iron deficiency, some drugs, pregnancy, chronic renal failure and prolonged immobility.

The main feature of PLMD is the occurrence of PLMS accompanied by clinical sleep disturbance or fatigue that cannot be accounted for by another primary sleep disorder or other aetiology. Consequently, PLMD cannot be diagnosed in the context of RLS, narcolepsy, untreated obstructive sleep apnoea or REM sleep behaviour disorder because it is known that PLMS are a common finding in these conditions which, *per se*, justify more effectively the sleep complaint and, in particular, the diagnosis of RLS takes precedence over that of PLMD even when PLMS appear to be particularly disturbing the sleep structure.

The diagnosis of PLMD should be made in the context of clinical history of sleep onset and/or maintenance problems, or unrefreshing sleep attributable to the PLMS. Excessive daytime sleepiness has been reported in individuals with PLMS which has not been confirmed by subjective (ESS) or objective (MSLT) measures.

For the neurophysiological correlates of PLMS in PLMD, the same considerations made above can also be made in the context of RLS; in particular, PLMS in PLMD exhibit the same features of high periodicity and gradually decreasing night-time distribution of those recorded in RLS. These additional parameters (besides PLMS index) have been shown to be able to differentiate PLMS in several conditions such as RLS/PLMD, narcolepsy, RBD and obstructive sleep apnoea (Ferri, 2012; Manconi *et al.*, 2014).

As they often involve primarily the lower limbs (the calf or small muscle of the foot), sleep-related leg cramps should be carefully distinguished from RLS because they are characterized by painful sensations accompanying abrupt and intense involuntary contractions of muscles with spasms and hardness.

Differently from the conditions described above, bruxism is characterized by a cranial muscle involvement, with clenching or grinding of the teeth and/or by bracing or thrusting of the mandible. This section only defines bruxism occurring during sleep when jaw muscle contractions often occur in a repetitive pattern, assuming the appearance of the so-called rhythmic masticatory muscle activity (RMMA). Two EMG types are recognized: phasic (series of short repetitive contractions) or tonic (isolated sustained jaw clenching). Typically, sleep bruxism is characterized by tooth-grinding sounds and results in abnormal tooth wear, tooth pain, jaw muscle pain and temporal headache. Severe forms of sleep-related bruxism are also accompanied by sleep disruption.

More complex repetitive, stereotyped and rhythmic movements, involving large muscle groups and occurring during drowsiness or sleep, characterize sleep-related rhythmic movement disorder (RMD). RMD is observed most often in infants and children, occasionally in adults, and different

subtypes can be recognized: body rocking, head banging or a combination of both, head rolling, body rolling, leg banging and leg rolling. Rhythmic, sometimes loud, sound emission can accompany RMD.

The five sleep-related movement disorders described above were also present in the ICSD-2, together with three other, less specific diagnoses (sleep-related movement disorder due to a medical disorder; sleep-related movement disorder due to a medication or substance and sleep-related movement disorder, unspecified). In the ICSD-3, the benign sleep myoclonus of infancy and propriospinal myoclonus at sleep onset, which were formerly included in the list of 'isolated symptoms, apparently normal variants and unresolved issues', have been listed among the definite disorders, while excessive fragmentary myoclonus, hypnagogic foot tremor and alternating leg muscle activation and sleep starts (hypnic jerks) have been included in the 'isolated symptoms and normal variants' subheading of the sleep-related movement disorders section.

The DSM-V only reports criteria for the diagnosis of RLS and does not list any other sleep movement disorder; such criteria are very similar to those of the ICSD-3 and also include some statements about frequency and duration of symptoms.

## OTHER SLEEP DISORDERS

Sleep disorders that cannot be classified elsewhere in the International Classification of Sleep Disorders are listed in Appendices A and B. There is no significant difference between the second and third editions of ICSD. The only significant disorder described is environmental sleep disorder. This diagnosis is employed infrequently in the clinical setting, and significant controversy exists regarding whether environmentally induced sleep disturbance represents a clinical disorder *per se*. The condition is characterized typically by complaints of sleep initiation and/or maintenance that are the direct result of an environmental factor. If the clinician determines that an environmental factor is the primary cause of a sleep disturbance, a diagnosis of 'other sleep disorder' may be employed. Unlike insomnia disorder, the environmental sleep disorder is dependent upon the presence of the environmental factor. In the absence of the stimulus, sleep is normal.

## SLEEP-RELATED MEDICAL AND NEUROLOGICAL DISORDERS

The ICSD-3 lists in its appendix A the following conditions:

1. Fatal familial insomnia
2. Sleep-related epilepsy
3. Sleep-related headaches
4. Sleep-related laryngospasm
5. Sleep-related gastroesophageal reflux
6. Sleep-related myocardial ischaemia

With respect to the previous classification, the ICSD-3 has deleted fibromyalgia while the other disorders, which may have a unique presentation during the sleep period or may occur exclusively in association with sleep, pertain to this chapter. Some new findings are described for fatal familial insomnia (FFI): the genetic picture, the belonging to prion diseases and some pathophysiological aspects such as the clinical picture of sporadic and familial forms, as well as some new research showing that both familial and sporadic fatal insomnia have been transmitted to transgenic animals by intracerebral inoculation of brain homogenates.

Also regarding sleep-related epilepsy, some new findings are reported on video PSG analysis of nocturnal frontal lobe epilepsy. Nocturnal frontal lobe seizures involve a large neuronal network, and some of their clinical expressions are possible consequences of disinhibition of innate motor patterns produced by the central pattern generators. Reports derived from stereo-EEG studies seem to show that, in some cases, the seizures (in particular nocturnal wanderings) may arise from temporal or insular regions (rather than frontal regions) with a secondary spread to the cingulate regions. They may sometimes mimic parasomnias, again raising the issue of the differential diagnosis between some motor seizures and arousal disorders during sleep.

Episodic laryngeal dysfunction causing stridor, difficulty or interruption of airflow and awakening from sleep with fear and panic characterize sleep-related laryngospasm. Stridor may be prolonged and may be confused with the snoring noise. Sometimes a sign of multi-system atrophy, a neurodegenerative illness, sleep-related laryngospasm may be provoked by gastroesophageal reflux or some other local causes. The importance of video–audio PSG recording is emphasized, mainly for the differential diagnosis.

Sleep-related gastroesophageal reflux (GER) is as common as the diurnal form and is related to arousals and awakening from sleep; periodic limb movements and apnoea can trigger transient sphincter relaxations and consequently GER events. Because refluxate clearance requires an arousal, medications decreasing the arousal response (including benzodiazepines and zolpidem) may prolong refluxate clearance and increase the risk of aspiration during sleep. Sleep-related GER is more likely to occur during the first 2 h of sleep. Furthermore, in studies using combined oesophageal pH monitoring with actigraphy, acid reflux events occur primarily during the recumbent-awake period, versus the recumbent-asleep period. Reflux events are more likely to occur in the right side down and supine positions than in the left side down position.

### ICD-10-CM CODING FOR SUBSTANCE INDUCED SLEEP DISORDERS

This appendix of the ICSD-3 reports a detailed table of specific ICD-10-CM codes for sleep disorders induced by alcohol, opioids, sedatives, cocaine, other stimulants and other psychoactive substances. No sleep-specific codes are

available for cannabis, hallucinogens, nicotine and inhalants, for which an ‘unspecified’ or ‘other’ code should be used.

### CONCLUSION

This chapter has essentially resumed the content of the ICSD-3 classification, with particular attention on the changes from the previous version (ICSD-2). It should be remarked that, even if this classification is termed ‘international’, it reflects the effort of a national scientific society and the contribution of non-American scientists and societies has been definitely minor. A formal true international classification of sleep disorders is not available.

In this context, it should also be considered that sleep disorders are also classified in other systems, such as the DSM-V (American Psychiatric Association, 2013), and some differences have also been highlighted in this chapter with respect to this classification. Additionally, specific criteria can be used for some diseases that can be set by different scientific societies; as an example, in 2012 the International RLS Study Group published different criteria for the diagnosis of RLS (<http://irls.org/diagnostic-criteria/>; Allen *et al.*, 2014) which can be used and are the expression of an international scientific society.

Thus, even if the criteria summarized in this chapter are the most often-used rules by the sleep medicine scientific community, they are not intended to be absolute dogmas and different criteria can be used matching more clearly the clinical research purposes of the different contexts.

### CONFLICTS OF INTEREST

No conflicts of interest declared.

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