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## **A systematic analysis of ICSD-3 diagnostic criteria and proposal for further structured iteration**

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1 SLEEP MEDICINE REVIEW

2 *Theoretical review*

3  
4 **A systematic analysis of ICSD-3 diagnostic criteria and proposal for further structured**  
5 **iteration**

6  
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1 **SUMMARY**

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3 The main objective of this theoretical review is to systematically analyze the type of ICSD-3  
4 diagnostic criteria by labeling each of them in order to propose an overview of the way in  
5 which the diagnostic criteria are organized. Labelling of diagnostic criteria using a rigorous  
6 iterative process of “aggregation” and “generalization” was conducted and inter-rater  
7 reliability calculation (Cohen’s Kappa with three raters) was calculated. 241 criteria from 43  
8 main sleep disorders of the ICSD-3 were labeled into nine types (Clinical manifestation  
9 86.0% of sleep disorders, Objective markers 53.5%, Distress 30.2%, Disability 30.2%,  
10 Duration 30.2%, Frequency 58.1%, Age” in 18.6%, Exclusion condition 81.4% and  
11 Associated condition 34.8%), with a high inter-rater reliability (Cohen’s Kappa=0.85). This  
12 analysis assumes that the structuring of the ICSD-3 diagnostic criteria is based on the  
13 Harmful Dysfunction Analysis (HDA). Some criteria correspond to the dysfunction part of  
14 the HDA while others refer to the harmful part. However, the approach does not seem to be  
15 homogeneous across the nosological classification. The use of a structured definition of sleep  
16 disorder and a framework to organize the ICSD diagnostic criteria is discussed with regard to  
17 the reliability and validity of criteria for diagnosing sleep disorders.

18

19 **KEYWORDS:** Sleep; Harmful dysfunction analysis; Distress; Disability; Classification;  
20 Diagnosis; ICSD-3.

21

1 **Abbreviations**

2

3 AHI apnea hypopnea index

4 APA American Psychiatric Association

5 DSM diagnostic and statistical manual of mental disorder

6 DCSAD diagnostic classification of sleep and arousal disorders

7 DIMS disorders of initiating and maintaining wakefulness

8 DOES disorders of excessive somnolence

9 HDA harmful dysfunction analysis

10 ICSD international classification of sleep disorders

11 ILAE international league against epilepsy

12 MSLT multiple sleep latency test

13 MWT maintenance wakefulness test

14 OSAS obstructive sleep apnea syndrome

15 PLMS periodic limb movement disorder

16 RDoC research domain criteria

17 REM rapid eye movement

18 RLS restless legs syndrome

19 RWA REM sleep without atonia

20

21

22

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# 1 INTRODUCTION

2

3 The third edition of the International Classification of Sleep Disorders (ICSD-3, 3th ed.),  
4 promoted by the *American Academy of Sleep Medicine*, was published in 2014 and  
5 represented an important contribution toward a robust classification in sleep medicine for  
6 both the clinical (“*as a guide in the identification of specific disease states*”) and the scientific  
7 communities (“*in guiding future research agendas which will enhance our knowledge and*  
8 *understanding of the clinical features, pathophysiology and treatment response specific to*  
9 *each disorder*” p.13) [1]. Surprisingly, however, it does not provide a consensual and  
10 structured definition of a sleep disorder. Such a definition would be useful for knowing what  
11 should or should not have gone into the book of sleep disorders, and for organizing the  
12 diagnostic criteria of sleep disorders in a comprehensive structured way. It would also follow  
13 the aims of the ICSD-3 which is “*to define the domain of a given discipline, a factor of*  
14 *particular importance for fields such as sleep medicine which cut across many related*  
15 *specialties*” [1]. Indeed, for sleep disorders, interdisciplinary collaboration is particularly  
16 important, because different professional organizations have attempted to develop a  
17 classification of sleep disorders [2,3] and many medical fields are concerned by them. The  
18 ICSD-3 revision workgroup was based on the collaboration of numerous medical and non-  
19 medical specialties (e.g. pulmonary medicine vs. neurology vs. psychiatry vs. psychology vs.  
20 neurosciences). Moreover, the classification of sleep disorders has been complicated by the  
21 existence of several distinctive nosological classifications that differ markedly. A structured  
22 way for organizing the diagnostic criteria of sleep disorders could thus allow better  
23 collaboration between the different specialties and approaches involved in sleep medicine.  
24 Ideally, the classification of medical disorders should be based on unambiguous etiology  
25 [3,4]. However, there is no identifiable etiology in many chronic disorders, so the diagnostic  
26 criteria are based on clinical, physiological or other features according to a combination of  
27 empirical data, expert opinion and consensus [2,5]. Like many classifications in medicine, the  
28 ICSD-3 is based on diagnostic criteria that provide standardized diagnostic criteria for  
29 distinctive sleep disorders. The ICSD-3 thus presents diagnostic criteria for the identification  
30 of each of the specific sleep disorders included in the manual. While the immediate goal of  
31 including such criteria was to improve reliability by minimizing criterion variance, the  
32 ultimate one was to help clinicians and researchers make valid diagnoses by identifying  
33 underlying sleep dysfunctions and minimizing both false positives and false negatives.

1 However, only a few studies have attempted to empirically establish the reliability and the  
2 validity of the diagnostic criteria of the ICSD-3 [2,6], and no comparison has been made  
3 between the main sleep disorder categories. To maximize reliability, the variability in the  
4 interpretation of the diagnostic criteria between physicians and over time must be minimized.  
5 To maximize validity, the criteria should be related to clear physiological dysfunctions.  
6 Reliability and validity are thus directly dependent on the quality of the diagnostic criteria.  
7 Yet the way in which the diagnostic criteria of disorder are organized in the ICSD-3 lacks  
8 clarity. As recently highlighted in the journal of *Sleep Medicine Review*: “for the  
9 classification of some disorders, such as insomnia and restless legs syndrome (RLS), the  
10 diagnosis is based solely on subjective complaints whereas for others, such as narcolepsy  
11 type 1, it presumes a precise pathophysiology. In others such as obstructive sleep apnea  
12 syndrome (OSAS), diagnosis can be solely defined by findings on ancillary investigations (i.e.  
13 Apnea Hypopnea Index; AHI)” [7]. Therefore, while the ICSD-3 has gone a long way to  
14 achieving a high degree of standardization between disorders and includes information for  
15 each disorder based on the same structured sections, the category “Diagnostic criteria” for  
16 each sleep disorder remains less clear. These definitions of sleep disorders should be  
17 standardized and homogenized in order to improve their scientific reliability and validity and  
18 to improve the clinical management of patients and the outcome of treatment.

19 A structured unified approach to defining the diagnostic criteria for each sleep disorder  
20 should be encouraged. As recommended by Telles-Correia [8], this approach seems  
21 necessary for several reasons: i) to distinguish what is pathological from what is normal; ii) to  
22 know which diagnoses should and should not be included in the classifications; iii) to identify  
23 the conditions which, because of their negative consequences, should implicitly make  
24 physicians react; iv) to separate the areas of responsibility incumbent on the medical system  
25 from those applicable to other societal systems; v) to identify the conditions that justify  
26 appropriate societal recognition of those who are sick; vi) to avoid false positives and related  
27 problems such as overmedicalization, unnecessary labeling, wasted recourses [9]; and vii) to  
28 define the role of Sleep Medicine as a medical specialty. Other medical fields have made the  
29 effort to propose a definition. In psychiatry, for example, a structured definition of mental  
30 disorder has been useful to operationalize the way to determine each category of the  
31 *Diagnostic and Statistical Manual of Mental Disorder (DSM)* by the *American Psychiatric*  
32 *Association (APA)* [10]. In neurology, the same is true for the field of epilepsy for which the  
33 *International League Against Epilepsy (ILAE)* commissioned a task force to propose such a

1 structured definition in order to better organize the classification of epilepsies [11]. Both the  
2 APA and the ILAE have clearly and explicitly discussed the conceptual framework  
3 underpinning these definitions, which is essential to the construction of diagnostic criteria.  
4 The ICSD-3 posited *a hybrid approach* (p.13 of the introduction) [1], without a clear  
5 reference to what was being referred to. Nevertheless, this approach seems to be based on a  
6 classical epistemological approach, which has led to several medical classifications where the  
7 nature of the disorders remained complex, e.g. mental disorders in the DSM-5 classification  
8 and epilepsies in the ILAE classification, but also to much more wide-ranging proposals such  
9 as the International Classification of Diseases (ICD-11) developed by the *World Health*  
10 *Organization* [12]. The hybrid approach is related to the conceptual approach of *Harmful*  
11 *Dysfunction Analysis* (HDA), which has only rarely been applied explicitly in the field of  
12 sleep medicine, except once to our knowledge in a discussion aiming to establish an  
13 international consensus for defining sleep-related bruxism [13]. HDA, which was developed  
14 in 1992 by Wakefield [14] to define which conditions can be considered as disorders or not,  
15 can be very useful in constructing more reliable and valid classifications of medical disorders.  
16 It offers a global vision of the nature of disorders despite their heterogeneity by including  
17 both the concept of dysfunction (e.g. physiological) and the concept of harm (e.g. value).  
18 HDA posits that a disorder is a hybrid concept whereby a physiological dysfunction,  
19 understood as a failure of some feature to perform a naturally selected function, is directly  
20 related with the harm caused to the individual, as evaluated by social values.

21 This theoretical review proposes to analyze systematically the type of “ICSD-3 diagnostic  
22 criteria” by labeling each of them for each sleep disorder in order to propose an overview of  
23 the way in which the diagnostic criteria are organized through the distinctive disorders of the  
24 classification. This analysis will enable to make proposals to improve the organization of the  
25 ICSD diagnostic criteria for further iterative developments based on a structured definition of  
26 sleep disorders and on the comprehensive framework of the hybrid approach of HDA. We  
27 hope that the proposal will serve to guide the evolution of the diagnostic criteria for each  
28 sleep disorder based on a structured unified approach to sleep medicine. Recommendations  
29 are made for future research and the development of iterations of the ICSD to improve the  
30 reliability and validity of sleep disorder diagnoses.

31



1 **METHOD**

2

3 **Sampling strategy**

4 All the sleep disorders listed in the ICSD-3 were selected for the analyses after excluding the  
5 following conditions: a) disorders “Unspecified” or “Not otherwise specified”; b) disorders  
6 "Due to Other Conditions" and c) “Isolated symptoms and normal variants”. These criteria  
7 were applied to select only the main sleep disorders.

8

9 **Units of study**

10 All the diagnostic criteria of the selected ICSD-3 sleep disorders (with the exclusion of notes)  
11 were selected.

12

13 **Data extraction and collection**

14 All the diagnostic criteria of the selected ICSD-3 were extracted and processed in a Microsoft  
15 Excel spreadsheet (macOS, Version 15.37)

16

17 **Data analysis**

18 The type of “ICSD-3 diagnostic criteria” was labeled according to a rigorous qualitative  
19 method. Labels were established in order to group each diagnostic criterion into a type of  
20 higher order of abstraction through a process of “aggregation” and “generalization” [15]. For  
21 methodological details, see **Figure 1** and **Annex 4**.

22

23 **Data processing**

24 The diagnostic criteria of the selected ICSD-3 sleep disorders were extracted independently  
25 and labeled into one or more labels in a standard electronic form by three authors (JAM, CG,  
26 RL). The labeling was compared between the three raters to assure the trustworthiness and  
27 credibility of the full diagnostic criteria list. Inter-rater reliability was calculated by means of  
28 Kappa statistics. For methodological details, see **Annex 3**.

29

30 **Data synthesis**

31 The presence of each type of diagnostic criterion was listed according to the selected  
32 diagnoses. The percentage of each type of diagnostic criterion was calculated for each main

- 1 diagnostic category of the ICSD-3, and for all the sleep disorders selected, in order to propose
- 2 an overview of the way in which the diagnostic criteria are organized in the ICSD-3. **Table 1.**
- 3

## 1 RESULTS

2

3 Forty-three diagnoses classified into 6 main diagnostic categories were analyzed (2 insomnia  
4 disorders, 12 sleep-related breathing disorders, 6 central disorders of hypersomnolence, 6  
5 circadian rhythm sleep-wake disorders, 10 parasomnias and 7 sleep-related movement  
6 disorders). Among the 43 diagnoses, 241 single criteria were extracted (from 2 to 18 criteria  
7 per diagnosis) and 284 labels were applied (**Figure 1**). Twenty-nine ICSD diagnostic criteria  
8 (12%) were classified into two (N=18) or more types of label (N=11), most frequent clinical  
9 manifestation and duration and / or frequency.

10

### 11 **Type of diagnostic criteria**

12 Nine labels were consensually determined (**Table 1**). An example of diagnostic criteria  
13 associated with each label is shown in **Annex 4**. The labels “Clinical manifestation” and  
14 “Objective biomarker” found in the introduction of the ICSD-3 were retained.

15 **Supplementary materials** show: i) the list of criteria extracted and labeled for each disorder  
16 by each of the three raters (**Annex 1**), and ii) the consensual attribution of a label for each  
17 ICSD-3 diagnostic criterion (**Annex 2**).

18

### 19 **Inter-rater reliability**

20 Total interrater reliability for all labels and for all sleep disorders was Cohen's Kappa=0.85,  
21 considered as substantial agreement.

22 **Supplementary materials** show: i) the kappa calculated (**Annex 3**); ii) the qualitative details  
23 of the inter-rater reliability (**Annex 4**)

24

### 25 **Main findings**

26 **Table 1** shows the type of label used for each sleep disorder, the percentage of use and  
27 Cohen's Kappa for each label, for each main diagnostic category of the ICSD-3, and for all  
28 the sleep disorders selected. “Clinical manifestation” and “Exclusion” criteria were found in  
29 most sleep disorders (86%), whereas “Age” was found in very few (18.6%). “Objective  
30 marker” was found in around half of sleep disorders, and in all the Sleep-related breathing  
31 disorders. “Distress” and “Disability” were found in around one third of sleep disorders.  
32 “Distress” was found in all the Insomnia disorders and Circadian rhythm sleep wake  
33 disorders, but not in any Sleep-related breathing disorders or Central disorders of

- 1 hypersomnolence. Circadian rhythm sleep wake disorders were the main sleep category
- 2 exhibiting all types of criteria (except age).
- 3

## 1 DISCUSSION

2

3 In this theoretical review article, we provide the first systematic analysis of the ICSD-3  
4 criteria used for the diagnosis of sleep disorders. Using a rigorous iterative process of  
5 “aggregation” and “generalization”, 241 criteria from 43 main sleep disorders of the ICSD-3  
6 were labeled into nine types, with a high inter-rater reliability (Cohen’s Kappa=0.85). The  
7 types of criteria were: “Clinical manifestation”, “Objective marker”, “Distress”, “Disability”,  
8 “Duration”, “Frequency”, “Age”, “Exclusion”, and “Associated condition”. Interestingly, this  
9 overview of the way in which the diagnostic criteria are organized in the ICSD-3 found a  
10 structure that is in line with the conceptual framework of the HDA, a classical hybrid  
11 approach for defining disorder with the interaction of a dysfunction part (i.e. “Clinical  
12 manifestation” and “Objective marker”) and a harmful part (i.e. “Distress” and “Disability”).  
13 Thus, even if the ICSD-3 posited this approach in the introduction without a clear reference  
14 to the HDA [1], the present findings confirm the conceptual foundation of this classification  
15 of sleep disorder in the HDA framework, as is the case for the DSM and the ILAE  
16 nosological classification [11,14]. In line with these results, we can propose a definition of  
17 sleep disorder based on the comprehensive framework of the HAD (**Annex 5, 6, 7**). This  
18 structured definition and the comprehensive framework of the hybrid approach of the HDA  
19 could serve to organize the diagnostic criteria of sleep disorders in a more comprehensive and  
20 structured way, by: i) the definition of a key terminology and its application consistently  
21 across all diagnoses, ii) the enlightenment of our understanding and the identification of any  
22 inconsistency and omissions in the development of these criteria. Such a proposition could  
23 shift sleep medicine from a multidisciplinary approach (i.e. different specialties working side  
24 by side, each with their conceptual framework) to a transdisciplinary approach (i.e. different  
25 specialties sharing the same conceptual framework). Such a common conceptual framework  
26 could be of great interest for studying and validating the diagnoses of sleep disorders [2].  
27 Nevertheless, this systematic analysis of the “ICSD-3 diagnostic criteria” also found a high  
28 level of heterogeneity in the type of criteria used across the different sleep disorders (**Table**  
29 **1**). Thus, although the ICSD-3 uses a conceptual framework based on a hybrid approach, the  
30 latter does not seem to be homogeneous through its nosological classification. This  
31 heterogeneity is particularly manifest for Objective marker and Distress / Disability criteria  
32 that are not used equally for each sleep disorder, and in the differences between the Clinical  
33 manifestation criteria used for almost all sleep disorders. Such heterogeneity could be due to

1 the fact that sleep medicine investigates different types of sleep disorder, which may call  
2 upon different types of ICSD-3 diagnostic criteria. However, the difference is not solely due  
3 to differences in specific diagnostic criteria concerning the specificity of disorders but seems  
4 to be related to the way disorders, and the boundaries between the normal and the  
5 pathological, are conceptualized. Some disorders seem to be based without the use of harmful  
6 criteria (i.e. “Distress” and “Disability”), like “Sleep-related breathing disorders”, for which  
7 the boundaries between the normal and the pathological are defined principally on the  
8 supposed pathophysiological mechanism. The consequences of the disorder in terms of  
9 distress or disability, or more generally in terms of prognosis, seem to be implicitly included  
10 in the diagnostic criteria, as indicated in the section “Onset course and complications” of the  
11 ICSD-3 for these disorders. Other sleep disorders seem to be principally based on value  
12 criteria, like “Insomnia disorders”, for which the boundaries between the normal and the  
13 pathological are defined principally on the supposed consequences of distress or disability. In  
14 this case, the pathophysiological mechanism is discussed only in the section “Pathology and  
15 pathophysiology” of the ICSD-3, without any diagnostic criteria referring to it. For the other  
16 main sleep disorder categories, a mixture of dysfunction and harmful diagnostic criteria is  
17 generally used.

18 Therefore, there is a clear need to discuss the role of Clinical manifestation, Objective  
19 marker, Distress and Disability criteria in a nosological sleep disorder classification, and to  
20 propose recommendations for future research and the development of iterations of both ICSD  
21 diagnostic criteria and their organization so that they are reliable and valid for identifying  
22 sleep disorders.

23

## 24 **Proposals for modifying the ICSD diagnostic criteria**

25

### 26 *Clinical manifestation criteria*

27 This systematic analysis found that a clinical manifestation criterion was included for almost  
28 all the main sleep disorders analyzed. Only five diagnoses, i.e. 41.6% of Sleep-related  
29 breathing disorders and one Sleep-related movement disorder (Periodic Limb Movement  
30 disorder), had no Clinical manifestation criterion.

31 This result confirms that the clinical interview is considered as a very “important assessment  
32 component for any sleep disorder” [2] and that “Clinical manifestation” is the type of  
33 criterion that clinicians find the most useful since the ICSD-1 [3]. However, some Clinical

1 manifestation criteria lacked inter-rater reliability, highlighting the fact that it may be difficult  
2 to identify “Clinical manifestation” criteria in the ICSD-3 diagnostic criteria. This could be  
3 due to the term used for Clinical manifestation criteria, which may lack precision or sufficient  
4 specificity [6],

5 Until now, the terminology and choice of Clinical manifestation criterion for a number of  
6 sleep disorders have been based on expert opinions and consensus, which is a classical step in  
7 the development of a classification system [2]. Nevertheless, the following recommendation  
8 could be made for the evolution of the Clinical manifestation criteria of the ICSD in order to  
9 increase the reliability and validity of the diagnostic criteria and to tend toward the  
10 standardization of clinical and research practice:

- 11 - Empirical research should be encouraged in order evaluate the reliability (i.e. inter-  
12 rater agreement on identification of a clinical manifestation), validity (i.e. relation of  
13 the clinical manifestation with the pathophysiological mechanism) and practicality  
14 (i.e. efficiency of the clinical manifestation with regard to the clinical reasoning  
15 process) of clinical manifestation criteria. This issue has received little attention until  
16 now. Authors have investigated the reliability and validity of the diagnostic criteria of  
17 Insomnia disorders [6]. Others have investigated the inter-observer reliability of the  
18 diagnostic criteria for Parasomnia [16], specifically for Disorder of arousal [17] and  
19 REM sleep behavior disorder [18], and Narcolepsy [19]. In this line, Clinical  
20 manifestation criteria that combine very different clinical manifestations in the same  
21 criteria, as is the case for Obstructive sleep apnea disorders, criterion A.1 “the patient  
22 complains of sleepiness, nonrestorative sleep, fatigue, insomnia symptoms”, should  
23 be avoided in order to increase the reliability, validity and practicability of diagnostic  
24 criteria.
- 25 - A consensual terminology of sleep manifestations in sleep medicine should be  
26 developed. For example, for Parasomnias, subjective experiences and behavior during  
27 sleep, or for Central disorders of hypersomnolence (excessive daytime sleepiness,  
28 excessive need for sleep, sleep attack) should be described with a more precise, well  
29 defined and specific clinical terminology [7,20]. Interestingly, the ILAE developed a  
30 specific task force for the classification and definition of “ictal semiology” [21]. A  
31 similar initiative could be launched to develop a “Sleep semiology task force”, in  
32 order to avoid the pitfalls of the undefined terms in the Clinical manifestation criteria,

1 and to reduce the variability in how clinical manifestations are defined in the sleep  
2 literature.

- 3 - A standardized clinical interview based on the ICSD diagnostic criteria and on a  
4 consensual terminology of sleep manifestations should be developed in order to assess  
5 clinical manifestations more systematically. Moreover, as many clinical  
6 manifestations occur during sleep, these standardized clinical interviews should  
7 include the bed partner.

### 9 *Objective marker criteria*

10 This systematic analysis found that “Objective marker” criteria were included for half of the  
11 sleep disorders analyzed, with large discrepancies between the main diagnostic categories  
12 (from 0% for Insomnia disorders or 10% for Parasomnias, to 83.3% for Circadian rhythm  
13 sleep wake disorders and 100% for Sleep-related breathing disorders). PSG diagnostic criteria  
14 were found in only (12/43) 27.9% of the main sleep disorders analyzed. Cardio-respiratory  
15 objective measures were systematically found for each “Sleep-related breathing disorder”, in  
16 contrast to “Insomnia disorders”, which did not have any Objective marker criterion. For the  
17 “Circadian rhythm sleep wake disorders” main category, “sleep log” and “whenever possible,  
18 actigraphy monitoring” are indicated. There was also discrepancy in the use of Objective  
19 marker criteria for disorders listed in the same main sleep disorder category. In “Central  
20 disorders of hypersomnolence”, the criterion “mean sleep latency” or “24-hour  
21 polysomnographic monitoring” were explicitly indicated for “Narcolepsy type 1 and type 2”  
22 and “Idiopathic hypersomnia” but not for the other Central disorders of hypersomnolence  
23 [7,22]. For “Parasomnias”, such Objective markers exist for REM sleep behavior disorder  
24 (i.e. REM sleep without atonia) [23], but are lacking for other parasomnias, often  
25 characterized only by subjective experiences such as nightmares or sleep-related  
26 hallucinations. Lastly, only one diagnosis listed in the main category “Sleep-related  
27 movement disorders” (i.e. PLM disorder) has an Objective marker, while other disorders such  
28 as Sleep-related bruxism or Sleep-related rhythmic movement disorders do not. Nevertheless,  
29 they can also be objectively quantified with well-defined criteria from the AASM scoring  
30 manual [24]. For example, masseter muscle activity, as an Objective marker of sleep-related  
31 bruxism, is “ideally recorded” in the ICSD-3.

32 Thus, in the present systematic analysis, many disorders did not require an objective marker  
33 (obtained by a PSG or other electrophysiological techniques). Yet an objective marker is



1 crucial to increase the reliability and validity of sleep disorder diagnoses and to obtain a more  
2 robust classification. Thus, the following recommendation could be made for the evolution of  
3 the Objective marker criteria in the ICSD:

- 4 - Empirical research should be encouraged to evaluate the relationship of the Objective  
5 marker with a sleep dysfunction or a physiological dysfunction occurring during sleep  
6 (like decrease in CSF hypocretine-1 concentration in narcolepsy type 1, PHOX2B  
7 mutation in Congenital Central Alveolar Hypoventilation Syndrome, or loss of  
8 physiological atonia during REM sleep in REM sleep behavior disorder). To be  
9 included in the future revisions of the ICSD, Objective markers developed for the  
10 diagnosis of sleep disorders should not only have good performance but should also  
11 be clearly related to a physiological dysfunction that reflects the pathophysiology of  
12 the disease. If such a requirement appears to be met for the new polysomnographic  
13 diagnostic criteria for Disorders of arousal [20], further studies are needed to validate  
14 such criteria for Sleep-related bruxism [25] or for the newly proposed diagnostic  
15 category Trauma-associated sleep disorder [26]. The current state of knowledge  
16 indicates that objective markers are not possible for all sleep disorders, although  
17 research should be encouraged for all of them.
- 18 - Sleep function should continue to be investigated to better define what normal sleep is  
19 compared to pathological sleep. Two approaches should be encouraged [27]: an  
20 evolutionary approach to sleep functioning, and a homeostatic and integrative  
21 approach to it [28–31]. In this line, a large population normative sleep data base  
22 should be developed, taking into account the evolution of sleep parameters with age  
23 [31,32].
- 24 - A sleep task force for sleep disorder classification (for the ICSD-3 manual) should  
25 collaborate with a task force involved in PSG techniques and scoring (for the AASM  
26 scoring manual), in order to investigate ways to rigorously operationalize Objective  
27 markers so as to obtain reliable, valid, practical and specific markers of sleep  
28 pathophysiology.

### 29 ***Distress / Disability criteria***

31 This systematic analysis found that distress / disability criteria were included in around half  
32 of the sleep disorders analyzed. These Distress and Disability criteria can be related to the  
33 “clinical significance” proposed in the ICSD-3 introduction. However, the use of “distress” or

1 “disability” criteria is formulated in several ways across the sleep disorders analyzed (as  
2 shown in **Table 1**) and the exact term “clinically significant” was found in only (8/43) 18.6%  
3 of the Distress and / or Disability criteria (for Circadian rhythm sleep wake disorders,  
4 Recurrent isolated sleep paralysis, and Nightmare disorder). Moreover, the use of such  
5 criteria can vary considerably across a main sleep disorder category of the ICSD-3. For  
6 example, in the “Sleep-related breathing disorders” main category, “Disability” was found  
7 only for Obstructive sleep apnea disorder in children and for Late-Onset Central  
8 Hypoventilation with Hypothalamic Dysfunction; and for the “Central hypersomnolence  
9 disorder” main category only for Kleine-Levin Syndrome and for Insufficient Sleep  
10 Syndrome. For the “Parasomnias” main category, “Distress” and / or “Disability” were found  
11 for half of the parasomnia disorders. In contrast, the “Circadian rhythm sleep wake disorders”  
12 main category is homogenous, as distress or disability were found for all disorders.

13 Clinically significant meant that the clinical manifestations are related to significant distress  
14 or disability, which should help to establish the threshold for the diagnosis of a sleep disorder  
15 in situations in which the sleep manifestation (Clinical manifestation or Objective marker)  
16 per se is not sufficient to establish the boundaries between the normal and the pathological.  
17 This point is clearly indicated in the notes for Sleep-related rhythmic movement disorder:  
18 *“when there are no clinical consequences of the rhythmic movements, the rhythmic*  
19 *movements are simply noted but the term rhythmic movement disorder is not employed”* [1].

20 However, “clinical significance” has been largely discussed in the literature on diagnostic  
21 criteria and raises some important issues [33,34]: i) it could be unclear whether “distress” and  
22 “disability” refer only to the intrinsic consequence of sleep disturbances (e.g., the intrinsic  
23 discomfort of snoring, or the presence of cardiovascular consequences of sleep disturbances)  
24 or also to distress or disability about having sleep disturbances (e.g., being upset about the  
25 consequence of snoring on the sleep partner, or about the risk of the cardiovascular  
26 consequences of sleep disturbances); ii) it could be unclear what the relation is between  
27 clinical significance and the underlying physiological dysfunction in the organism, i.e. the  
28 very way in which a condition may be considered pathological. Such a nuance could be very  
29 theoretical and difficult to disentangle in routine clinical practice. Thus, the following  
30 recommendation could be made for the evolution of the Distress / Disability criteria of the  
31 ICSD:

- 32 - A consensual clinical terminology of sleep Distress and Disability should be  
33 developed. In the first Diagnostic Classification of Sleep and Arousal Disorders

1 (DCSAD) proposed by the “*Association of Sleep Disorders Centers*” and the  
2 “*Association for the Psychophysiological Study of Sleep*” published in *Sleep* in 1979  
3 [35], Sleep-related distress and disability were grouped together under the terms :  
4 DIMS for “*Disorders of initiating and maintaining wakefulness*” and DOES for  
5 “*disorders of excessive somnolence*”. Such terms could be viewed as a simplistic  
6 categorization and should be more detailed. Nevertheless, it could be the first step in  
7 developing such a terminology to better identify and classify distress and disability  
8 related to sleep disorders. Indeed, such an approach is encouraged by a sleep clinician  
9 [3] because it matched with the clinician’s experience of how their patients presented  
10 (e.g. with complaints of insomnia, hypersomnolence or unusual behavior during  
11 sleep), and with the ability of the clinician to differentiate the normal and the  
12 pathological based on the significance of these manifestations.

- 13 - Empirical research should be encouraged to evaluate the relationship between the  
14 Distress / Disability and their underlying pathophysiological mechanisms. Indeed, the  
15 HDA framework supposes that both distress and disability, which are inherent in  
16 sleep disturbances and the consequences of the dysfunction, are relevant to its status  
17 as a disorder – otherwise, marked distress or disability about having a non-disordered  
18 condition may lead to a false positive diagnosis [9]. Indeed, ‘harmful’ is to be  
19 considered as an adjective that conveys a value judgment about the dysfunctional  
20 component of a disorder. This relationship between dysfunction and harmful was  
21 underlined by Spitzer when citing Wakefield's words from a personal communication  
22 in 1988 concerning Insomnia disorder [34]. In particular, to establish the relationship  
23 between the harmful and the dysfunction within a disorder, it is important to specify  
24 that the harmful is not the only consequence of inadequate environmental  
25 circumstances for sleep. Interestingly, the concept of DIMS and DOES in the DCSAD  
26 was a first attempt to emphasize the required relationship between Distress /  
27 Disability and a pathophysiological mechanism.
- 28 - A sleep task force for sleep disorder classification should attempt to rigorously  
29 operationalize Sleep-related distress and disability, in order to avoid false positives.  
30 Such criteria of harmful could be clinically related but could also involve an  
31 Objective marker. For example, concerning somnolence, many studies have been  
32 conducted with the Maintenance Wakefulness Test (MWT) [36]. Indeed, unlike the  
33 Multiple Sleep Latency Test (MSLT), which is an objective test of sleep dysfunction

1 measuring the tendency to fall asleep, the MWT can be considered strictly speaking as  
2 an objective test of wakefulness-related harm. Even if further research is needed, the  
3 aim is indeed to correlate the degree of sleepiness and the ability to maintain  
4 wakefulness (related to the function sleep) with safety and the putative occupational  
5 risks for the individual and for society in “real life” circumstances, and according to  
6 social norms. Such an approach could be encouraged for other objective tests of sleep-  
7 specific distress or disability.

### 9 **Proposals for organizing the ICSD diagnostic criteria**

10 To reduce the heterogeneity in the type of criteria used across the different sleep disorders  
11 and to better implement the conceptual framework based on a “hybrid approach” as  
12 introduced in the ICSD-3, a framework for organizing the ICSD diagnostic criteria could be  
13 proposed in order i) to highlight the way sleep disorders are conceptualized in the nosological  
14 classification, ii) to integrate the different sleep disorders and types of diagnostic criteria  
15 specific to the characteristics of each sleep disorder.

16 Importantly, we analyzed only the main sleep disorders of the ICSD-3, i.e. 43 sleep disorders  
17 out of the 67 (65 %) that are included in the ICSD-3. These sleep disorders should be  
18 reintegrated in the proposed framework for ICSD diagnostic criteria. Our systematic  
19 conceptual analysis of the main ICSD-3 sleep disorders and the comprehensive framework of  
20 the hybrid approach of HAD (**Annex 7**) suggests considering “Clinical manifestation”,  
21 “Objective marker”, and “Distress / Disability” as the central core of the diagnostic criteria  
22 for sleep disorders. Other type of ICSD diagnostic criteria should be incorporated with regard  
23 to these central core criteria (**Table 2**). Thus, the following recommendations could be made  
24 for re-organizing the ICSD diagnostic criteria:

- 25 - “Clinical manifestation”, “Objective marker”, and “Distress / Disability” diagnostic  
26 criteria should be systematically discussed for each sleep disorder. This does not  
27 mean that these types of diagnostic criteria should be present systematically for each  
28 sleep disorder. Some of these criteria could be sufficiently related to  
29 pathophysiological mechanisms and to harmful consequence to not require other  
30 criteria. For example, for Narcolepsy type 1, the Objective marker “CSF hypocretin-  
31 1” of the ICSD-3 criteria may not be present, because the clinical manifestation  
32 “cataplexy” is strongly associated with the pathophysiological mechanisms of  
33 Hypocretin-1 deficiency. For REM sleep behavior disorder, the Distress / Disability

1 criteria might not be necessary, because the objective marker “REM sleep without  
2 atonia” is epidemiologically strongly associated with future Distress or Disability  
3 related to Parkinson disease. Nevertheless, these three types of diagnostic criteria  
4 offer the opportunity systematically to discuss and structure the central core of a sleep  
5 disorder in light of the conceptual framework of the HDA and the structured  
6 definition of sleep disorder proposed (**Annex 7**).

- 7 - The other types of criteria of the ICSD-3 (“Duration”, “Frequency”, “Age”,  
8 “Exclusion”, “Associated condition”) could be considered as specific criteria of sleep  
9 disorders. In line with the recent proposition for Hypersomnolence disorders [7], three  
10 other criteria could be added: “Level of certainty criteria”, “Level of severity criteria”,  
11 “Subtype criteria”. These three criteria are not present in the current ICSD-3. Despite  
12 the fact that they require further research to be added in the evolution of the ICSD  
13 diagnosis criteria, an expert consensus has highlighted their interest for classifying  
14 disorders [7].

- Level of certainty would make it possible to indicate the degree of association  
15 of the sleep condition identified with a sleep dysfunction [7]. For example,  
16 hypocretin deficiency is a useful criterion for separating Narcolepsy type 1  
17 from Narcolepsy type 2 in ICSD-3 [7].

- Level of severity would indicate the quantification of the clinical  
19 manifestation, the dysfunction or the Distress / Disability, as proposed in the  
20 first version of the ICSD in addition to the diagnostic criteria [37]. However,  
21 our systematic analysis found a lack of precision concerning the degree of  
22 severity in the ICSD-3 diagnostic criteria. The term “difficulty” found in three  
23 Clinical manifestation criteria, as well as the summary term “sleep  
24 disturbance” for Insomnia disorders, or the term “irrepressible need to sleep”  
25 for Central disorders of hypersomnolence are just some examples of the lack  
26 of detail in the way the general population formulates complaints [38,39]. This  
27 imprecision can leave to a wide variability of interpretation of the Clinical  
28 manifestation diagnostic criteria. Interestingly, the analysis of Buysse et al. on  
29 clinicians’ use of the ICSD-1 found a very low useful rating for severity  
30 criteria of the ICSD-1. This may reflect “disagreements with the specific  
31 method for rating severity, difficulty with applying the severity criteria, or a  
32 lack of relevance to clinical decision making” [3]. Thus, they suggest that  
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1 “future revisions of the ICSD [first version] will need to re-examine severity  
2 ratings to ensure that they are anchored to treatment or outcome data and that  
3 they are sufficiently “user-friendly” for clinical practice”. This criterion was  
4 removed from the ICSD-2 [40] and the ICSD-3 [1]. We suggest re-examining  
5 this omission in the future revision of the ICSD.

- 6 - Lastly, subtype criteria would make it possible to include all specific and  
7 relevant criteria for a sleep disorder that need to be clearly indicated with  
8 regard to the clinical or pathophysiological purpose. Such an approach offers  
9 the opportunity to include ICSD iteration in the precision medicine paradigm  
10 [41], in order to clarify the relationships between specific sleep disorders and  
11 pathophysiological mechanisms, as proposed by Eckert for OSAS [28], and  
12 between prognosis and therapeutic outcome, as proposed by Zinchuk for  
13 OSAS [29]. This would make it possible to create a dynamic modifiable  
14 framework over time that ensures validity through the implementation of data  
15 from Evidence-Based Medicine without reducing the importance of having a  
16 solid stable clinical framework over time that possesses central core criteria  
17 that ensure that practitioners from different disciplines share the same  
18 understanding of disorders.

- 19 - The sleep disorders not included in our systematic analysis (1. “Unspecified” or “Not  
20 otherwise specified” disorders; 2. disorders "Due to Other Conditions" and 3.  
21 “Isolated symptoms and normal variants”) could be included in the proposed  
22 framework. With such a framework, the organization of the criteria for “Sleep Wake  
23 Phase Disorder” and for “Disorders of arousal”, with general criteria for these main  
24 sleep disorder categories, and specific diagnostic criteria for sleep disorders of the  
25 main category, could be generalized to the entire classification. This offers the  
26 opportunity to include “unspecified and not otherwise specified” sleep disorder within  
27 the criteria concerning the level of certainty, “due to other condition” sleep disorder  
28 within the association criteria, and “isolated symptoms” and “normal variant” within  
29 the severity criteria. Moreover, age (i.e. Child, Adult, Elderly) would be taken into  
30 account for each sleep disorder as a specifier, whereas in fact it sometimes serves as a  
31 diagnostic criterion and at others as a sleep disorder category (e.g. “Obstructive sleep  
32 apnea, pediatric”). It should be considered as an important improvement for the future  
33 evolution of the ICSD diagnostic criteria.

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## **Limitations**

There are several limitations to the methodology proposed herein.

First, the systematic analysis focuses on main sleep disorders but excludes others. The latter were excluded since they provide no useful diagnostic criteria for addressing the aims of this study. Nevertheless, in view of consensual development and evidence from empirical studies, diagnostic criteria are needed for these sleep disorder categories and could subsequently be included.

Second, it should be noted that the proposed diagnostic criteria analysis (**Table 1**) and the framework for organizing the ICSD diagnostic criteria (**Table 2**), based on the structured definition of sleep disorders (**Annex 7**), reflect only the consensus of the authors. However, the methodology is rigorous and was adapted from the standards for reporting qualitative research for the labeling for ICSD-3 diagnostic criteria [42,43] (**Annex 8**) and from the steps defined by Edinger and Morin for the definition of sleep disorders [2]. Moreover, the analysis and proposals were supervised by a philosopher (EG) specialized in medical classification and a neuroscientist (GD) specialized in the link between physiological and sociological data in order to ensure the theoretical coherence of the process. Nevertheless, future refinements will be needed. Data-driven analysis based on bioinformatics methodologies, and in particular text-mining techniques [22] which enable the extraction of unknown knowledge from the number of criteria of a classification, or ontological analysis which makes it possible to create a structured representation of a set of objects (e.g. diagnostic criteria), their characteristics (e.g. label) and their relationship, could be used in further research to better understand the structure of the classification. Comments and criticism from all stakeholders are now needed, as was the case for the DSM criteria [10]. A separate expert panel could be appointed to review and incorporate the public comments to reinforce the iterative process outlined in this paper (Figure 1 & Annex 6). Discrepancies across different sleep disorders diagnostic systems (ICSD, DSM, and ICD) should also be analyzed and the current efforts concerning the DSM revision and the development of a separate sleep disorders chapter in the ICD-11 (which very closely parallels the ICSD) have to be reinforced. Moreover, studies should be conducted to attempt to establish empirically how often the correct application of the mooted diagnostic criteria are truly applicable in sleep medicine and result in a more reliable and valid diagnosis of an individual as having a sleep disorder [2].

1 Lastly, the structured organization of sleep disorder criteria proposed herein is not intended to  
2 limit the clinical assessment of patients with sleep disorder or the scope of research into  
3 better defining and delineating sleep disorders. Alternative approaches might prove to be  
4 preferable. Moreover, the organization of classification is in continuous development, like the  
5 organization of the successive ICSD versions [1,37,40,44]. For example, the first revised  
6 version of the ICSD [44] included the notion of “Minimal criteria” necessary for a diagnosis.  
7 Such a set of criteria was removed from the second version, which indicated “only one set of  
8 criteria” that have to be entirely present [40]. Here, we propose the term “central core  
9 criteria” which is in line with the HDA framework, keeping in mind that a conceptual  
10 framework is preferable than no framework at all. In addition, the proposal does not solve  
11 some issues like the following: i) the problem related to the lumping versus splitting  
12 controversy for sleep disorders [22,45]; ii) the problem of matching between phenotypes and  
13 treatments to use a classification to optimize a therapeutic response in line with the future of  
14 precision medicine in sleep [46]. Work should now focus on establishing a model of  
15 precision medicine that optimizes the categorization of patient groups in relation to clearly  
16 defined phenotypes for the purpose of medical classification [28,29,31].

17

## 18 **Conclusion**

19 As stated by Edinger and Morin: “*Clinicians as well as researchers would benefit from the*  
20 *ongoing evolution of sleep disorder classification schemes toward a unitary system*” [2]. To  
21 promote collaborative multicenter studies, to add more Objective marker criteria to the  
22 current official diagnostic definitions and to develop clinical practice guidelines,  
23 multidisciplinary research approaches and evidence-based medical care, we need to be more  
24 explicit in the way sleep disorders are defined. As Demazeux [47] claims, “*The common*  
25 *belief [of Boorse, like Wakefield] is that science and conceptual clarity can clear up a*  
26 *number of contentious issues*”. Thus, we hope that such a definition of sleep disorders and the  
27 ensuing comprehensive framework will be useful to better justify the evolution of the  
28 diagnostic criteria for each sleep disorder based on a structured and unified approach to sleep  
29 medicine.

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1 **Practice points:**

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1. 241 criteria from 43 main sleep disorders of the ICSD-3 were labeled into nine types, with a high inter-rater reliability (Cohen’s Kappa=0.85).
2. The label “Clinical manifestation” was present in 86.0% (N = 37/43) of the sleep disorders analyzed, “Objective markers” in 53.5% (N = 23), “Distress” in 30.2% (N = 16), “Disability” in 30.2 % (N = 16), “Duration” in 30.2% (N = 16), “Frequency” in 58.1% (N = 25), “Age” in 18.6% (N = 8), “Exclusion condition” in 81.4% (N = 35) and “Associated condition” in 34.8% (N = 15).
3. The diagnostic criteria are organized in the ICSD-3 in line with a hybrid approach (called Harmful Dysfunction Analysis) for defining disorder as the interaction between factual (i.e. “Clinical manifestation” and “Objective marker”) and value (i.e. “Distress” and “Disability”) criteria.
4. The hybrid approach of the ICSD-3 is not homogenous across sleep disorders of the ICSD-3.
5. “Clinical manifestation” criteria are used for almost all sleep disorders but may lack precision or sufficient specificity, leading to a reduction of inter-rater reliability.
6. “Objective marker” criteria are used for half of the sleep disorders analyzed, and PSG diagnostic criteria were found in only (12/43) 27.9 %.
7. Use of “Distress” or “Disability” criteria is formulated in a very heterogeneous way across the sleep disorders analyzed.
8. A structured definition of sleep disorders could provide a useful framework to homogenize the way in which diagnostic criteria across sleep disorders are organized.

1 **Research agenda**

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3 Future research should:

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5 1. Evaluate the reliability, validity and practicality of the different “Clinical  
6 manifestation” criteria.

7 2. Develop a consensual terminology of sleep manifestation in sleep medicine and a  
8 standardized clinical interview to capture it.

9 3. Evaluate the relationship of an “Objective marker” with a sleep dysfunction or a  
10 physiological dysfunction occurring during sleep.

11 4. Seek to develop a large population normative sleep data base, taking into account the  
12 evolution of sleep parameters with age.

13 5. Investigate the way to rigorously operationalize “Sleep-related harmful”, in order to  
14 better take into account the specific consequences of sleep disturbances on “Distress”  
15 and “Disability”.

16 6. Propose an international working group in order to discuss the proposal as a  
17 conceptual framework for the evolution of ICSD diagnostic criteria.

18 7. Propose an international working group in order to carefully homogenize the structure  
19 and the terminology of ICSD diagnostic criteria across sleep disorders.

20 8. Use data-driven analysis based on bioinformatics methodologies or ontological  
21 analysis to better build the structure of the ICSD diagnostic criteria.

22 9. Promote links between sleep disorder classification, ICSD diagnostic criteria and new  
23 methods of stratification made possible by the advent of precision medicine models.

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1 **Conflict of interest**

2 The authors declare that there is no conflict of interest.

3

4 **Funding**

5 None

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## 1 REFERENCES

- 2 [1] American Academy of Sleep Medicine. International classification of sleep disorders. 2014.
- 3 [2] \*Morin CM, Edinger JD. Sleep Disorders Classification and Diagnosis. Oxford University  
4 Press, USA; 2012.
- 5 [3] \*Buysse DJ, Young T, Edinger JD, Carroll J, Kotagal S. Clinicians' use of the International  
6 Classification of Sleep Disorders: results of a national survey. *Sleep* 2003;26:48–51.
- 7 [4] Kleitman N. Sleep and Wakefulness. University of Chicago Press; 1963.
- 8 [5] Zachar P, Kendler KS. The Philosophy of Nosology. *Annual Review of Clinical Psychology*  
9 2017;13:49–71. <https://doi.org/10.1146/annurev-clinpsy-032816-045020>.
- 10 [6] Edinger JD, Wyatt JK, Stepanski EJ, Olsen MK, Stechuchak KM, Carney CE, et al. Testing  
11 the reliability and validity of DSM-IV-TR and ICSD-2 insomnia diagnoses. Results of a multitrait-  
12 multimethod analysis. *Arch Gen Psychiatry* 2011;68:992–1002.  
13 <https://doi.org/10.1001/archgenpsychiatry.2011.64>.
- 14 [7] \*Lammers GJ, Bassetti CLA, Dolenc-Groselj L, Jennum PJ, Kallweit U, Khatami R, et al.  
15 Diagnosis of central disorders of hypersomnolence: A reappraisal by European experts. *Sleep*  
16 *Medicine Reviews* 2020:101306. <https://doi.org/10.1016/j.smr.2020.101306>.
- 17 [8] Telles-Correia D. Mental disorder: Are we moving away from distress and disability? *J Eval*  
18 *Clin Pract* 2018;24:973–7. <https://doi.org/10.1111/jep.12871>.
- 19 [9] \*Cooper RV. Avoiding false positives: zones of rarity, the threshold problem, and the DSM  
20 clinical significance criterion. *Can J Psychiatry* 2013;58:606–11.  
21 <https://doi.org/10.1177/070674371305801105>.
- 22 [10] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders  
23 (DSM-5®). American Psychiatric Pub; 2013.
- 24 [11] Fisher RS, Boas W van E, Blume W, Elger C, Genton P, Lee P, et al. Epileptic Seizures and  
25 Epilepsy: Definitions Proposed by the International League Against Epilepsy (ILAE) and the  
26 International Bureau for Epilepsy (IBE). *Epilepsia* 2005;46:470–2. <https://doi.org/10.1111/j.0013-9580.2005.66104.x>.
- 27 [12] World Health Organization. International classification of diseases for mortality and  
28 morbidity statistics (11th Revision). Retrieved from <https://icd.who.int/browse11/l-m/en>; 2018.
- 29 [13] Raphael KG, Santiago V, Lobbezoo F. Is bruxism a disorder or a behaviour? Rethinking the  
30 international consensus on defining and grading of bruxism. *Journal of Oral Rehabilitation*  
31 2016;43:791–8. <https://doi.org/10.1111/joor.12413>.
- 32 [14] \*Wakefield JC. Disorder as harmful dysfunction: A conceptual critique of DSM-III-R's  
33 definition of mental disorder. *Psychological Review* 1992;99:232–47. <https://doi.org/10.1037/0033-295X.99.2.232>.
- 34 [15] Smith JM, Smith DCP. Database abstractions: aggregation and generalization. *ACM Trans*  
35 *Database Syst* 1977;2:105–133. <https://doi.org/10.1145/320544.320546>.
- 36 [16] Vignatelli L, Bisulli F, Zaniboni A, Naldi I, Fares JE, Provini F, et al. Interobserver reliability  
37 of ICSD-R minimal diagnostic criteria for the parasomnias. *J Neurol* 2005;252:712–7.  
38 <https://doi.org/10.1007/s00415-005-0723-1>.
- 39 [17] Loddo G, Vignatelli L, Zenesini C, Lusa F, Sambati L, Baldelli L, et al. Interobserver  
40 reliability of ICSD-3 diagnostic criteria for disorders of arousal in adults. *Sleep and Breathing*  
41 2019;23:1309–1314. <https://doi.org/10.1007/s11325-019-01937-w>.
- 42 [18] Bologna, Geneva, Parma, and Pisa Universities group for the study of REM Sleep Behaviour  
43 Disorders in Parkinson's Disease. Interobserver reliability of ICSD-R criteria for REM sleep  
44 behaviour disorder. *J Sleep Res* 2003;12:255–7. <https://doi.org/10.1046/j.1365-2869.2003.00359.x>.
- 45 [19] Vignatelli L, Plazzi G, Bassein L, Barbato A, De Vincentiis A, Lugaresi E, et al. ICSD

1 diagnostic criteria for narcolepsy: interobserver reliability. *International Classification of Sleep*  
2 *Disorders*. *Sleep* 2002;25:193–6. <https://doi.org/10.1093/sleep/25.2.193>.

3 [20] Lopez R, Shen Y, Chenini S, Rassu AL, Evangelista E, Barateau L, et al. Diagnostic criteria  
4 for disorders of arousal: A video-polysomnographic assessment. *Annals of Neurology* 2018;83:341–  
5 51. <https://doi.org/10.1002/ana.25153>.

6 [21] Blume WT, Lüders HO, Mizrahi E, Tassinari C, Boas WVE, Engel J. Glossary of Descriptive  
7 Terminology for Ictal Semiology: Report of the ILAE Task Force on Classification and Terminology.  
8 *Epilepsia* 2001;42:1212–8. <https://doi.org/10.1046/j.1528-1157.2001.22001.x>.

9 [22] Gauld C, Ouazzani K, Micoulaud-Franchi J-A. Commentary on Lammers et al. “Diagnosis of  
10 central disorders of hypersomnolence: A reappraisal by European experts”: From clinic to clinic via  
11 ontology and semantic analysis on a bullet point path. *Sleep Med Rev* 2020;52:101328.  
12 <https://doi.org/10.1016/j.smr.2020.101328>.

13 [23] Montplaisir J, Gagnon J-F, Fantini ML, Postuma RB, Dauvilliers Y, Desautels A, et al.  
14 Polysomnographic diagnosis of idiopathic REM sleep behavior disorder. *Movement Disorders*  
15 2010;25:2044–51. <https://doi.org/10.1002/mds.23257>.

16 [24] American Academic of Sleep Medicine. *AASM Manual for the Scoring of Sleep and*  
17 *Associated Events*. vol. 7. 2015.

18 [25] Lobbezoo F, Ahlberg J, Raphael KG, Wetselaar P, Glaros AG, Kato T, et al. International  
19 consensus on the assessment of bruxism: Report of a work in progress. *Journal of Oral Rehabilitation*  
20 2018;45:837–844. <https://doi.org/10.1111/joor.12663>.

21 [26] Mysliwiec V, Brock MS, Creamer JL, O’Reilly BM, Germain A, Roth BJ. Trauma associated  
22 sleep disorder: A parasomnia induced by trauma. *Sleep Medicine Reviews* 2018;37:94–104.  
23 <https://doi.org/10.1016/j.smr.2017.01.004>.

24 [27] Giroux É. *Après Canguilhem : définir la santé et la maladie*. Presses Universitaires de France;  
25 2010.

26 [28] \*Eckert DJ. Phenotypic approaches to obstructive sleep apnoea - New pathways for targeted  
27 therapy. *Sleep Med Rev* 2018;37:45–59. <https://doi.org/10.1016/j.smr.2016.12.003>.

28 [29] \*Zinchuk AV, Gentry MJ, Concato J, Yaggi HK. Phenotypes in obstructive sleep apnea: A  
29 definition, examples and evolution of approaches. *Sleep Med Rev* 2017;35:113–23.  
30 <https://doi.org/10.1016/j.smr.2016.10.002>.

31 [30] Jullian-Desayes I, Joyeux-Faure M, Tamisier R, Launois S, Borel A-L, Levy P, et al. Impact  
32 of obstructive sleep apnea treatment by continuous positive airway pressure on cardiometabolic  
33 biomarkers: a systematic review from sham CPAP randomized controlled trials. *Sleep Med Rev*  
34 2015;21:23–38. <https://doi.org/10.1016/j.smr.2014.07.004>.

35 [31] Lim DC, Mazzotti DR, Sutherland K, Mindel JW, Kim J, Cistulli PA, et al. Reinventing  
36 polysomnography in the age of precision medicine. *Sleep Medicine Reviews* 2020;52:101313.  
37 <https://doi.org/10.1016/j.smr.2020.101313>.

38 [32] Franco P, Putois B, Guyon A, Raoux A, Papadopoulou M, Guignard-Perret A, et al. Sleep  
39 during development: Sex and gender differences. *Sleep Medicine Reviews* 2020;51:101276.  
40 <https://doi.org/10.1016/j.smr.2020.101276>.

41 [33] \*Bolton D. Overdiagnosis Problems in the DSM-IV and the New DSM-5: Can They Be  
42 Resolved by the Distress—Impairment Criterion? *Can J Psychiatry* 2013;58:612–7.  
43 <https://doi.org/10.1177/070674371305801106>.

44 [34] \*Spitzer RL, Wakefield JC. DSM-IV diagnostic criterion for clinical significance: does it help  
45 solve the false positives problem? *Am J Psychiatry* 1999;156:1856–64.  
46 <https://doi.org/10.1176/ajp.156.12.1856>.

47 [35] Diagnostic classification of sleep and arousal disorders. 1979 first edition. Association of  
48 Sleep Disorders Centers and the Association for the Psychophysiological Study of Sleep. *Sleep*

1 1979;2:1–154.

2 [36] Littner MR, Kushida C, Wise M, G. Davila D, Morgenthaler T, Lee-Chiong T, et al. Practice  
3 Parameters for Clinical Use of the Multiple Sleep Latency Test and the Maintenance of Wakefulness  
4 Test. *Sleep* 2005;28:113–21. <https://doi.org/10.1093/sleep/28.1.113>.

5 [37] American Academy of Sleep Medicine. *International Classification of Sleep Disorders, First  
6 Edition*. 1990.

7 [38] Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn.  
8 *Sleep Medicine Reviews* 2002;6:97–111. <https://doi.org/10.1053/smr.2002.0186>.

9 [39] Ohayon MM. Epidemiology of Excessive Daytime Sleepiness. *Sleep Medicine Clinics*  
10 2006;1:9–16. <https://doi.org/10.1016/j.jsmc.2005.11.004>.

11 [40] American Academy of Sleep Medicine. *International Classification of Sleep Disorders,  
12 Second Edition*. 2005.

13 [41] Gauld C, Darrason M, Dumas G, Micoulaud-Franchi J-A. Personalized Medicine for OSAS  
14 in a Nutshell: Conceptual Clarification for Integration. *CHEST* 2020.

15 [42] Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research  
16 (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care* 2007;19:349–  
17 57. <https://doi.org/10.1093/intqhc/mzm042>.

18 [43] O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for Reporting  
19 Qualitative Research: A Synthesis of Recommendations. *Academic Medicine* 2014;89:1245–1251.  
20 <https://doi.org/10.1097/ACM.0000000000000388>.

21 [44] American Academy of Sleep Medicine. *International classification of sleep disorders, First  
22 Edition Revised*. 1997.

23 [45] Hauri PJ. A Cluster Analysis of Insomnia. *Sleep* 1983;6:326–38.  
24 <https://doi.org/10.1093/sleep/6.4.326>.

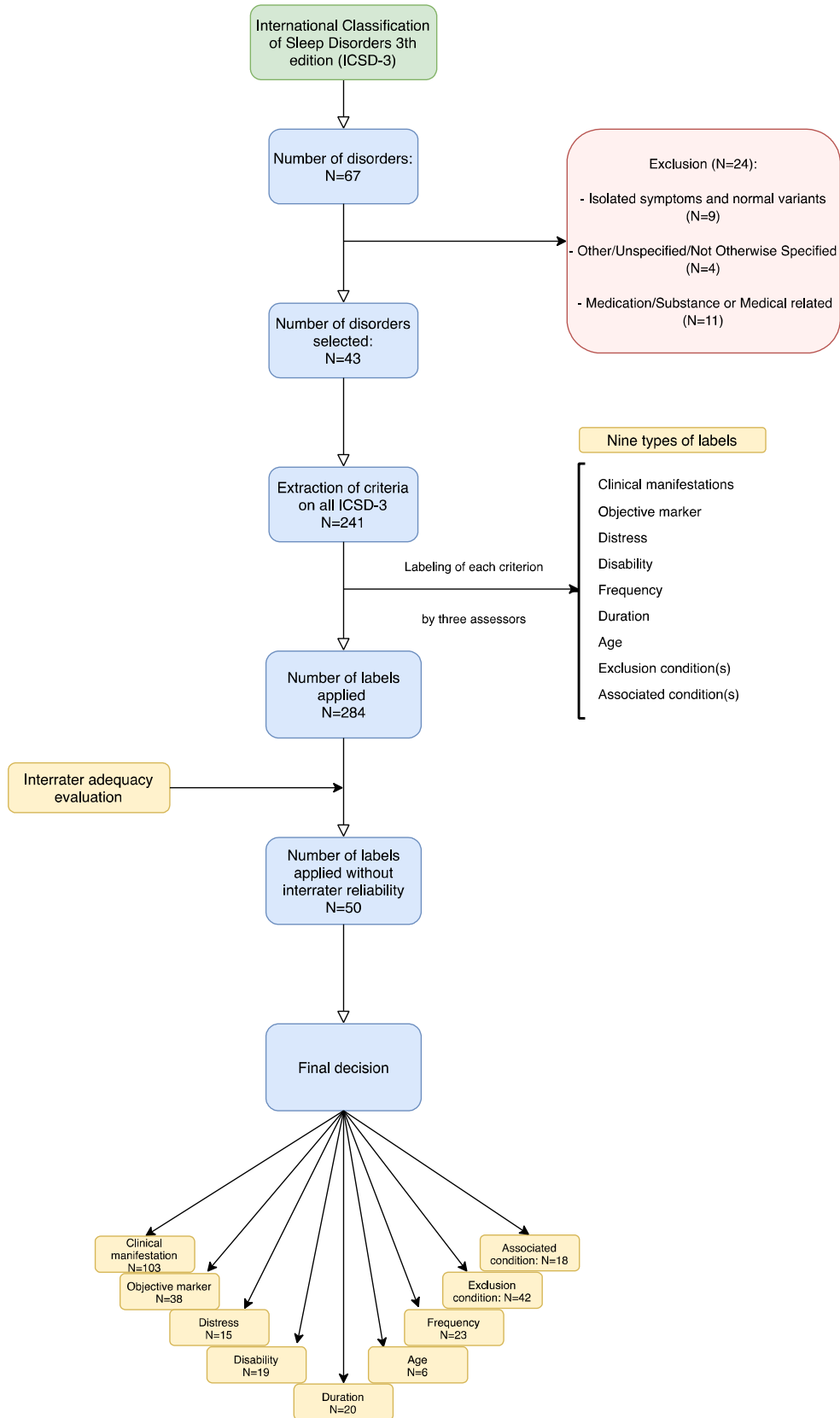
25 [46] Strollo PJ, Badr MS, Coppola MP, Fleishman SA, Jacobowitz O, Kushida CA. The Future  
26 of Sleep Medicine. *Sleep* 2011;34:1613–9. <https://doi.org/10.5665/sleep.1410>.

27 [47] Demazeux S. The Function Debate and the Concept of Mental Disorder. In: Huneman P,  
28 Lambert G, Silberstein M, editors. *Classification, Disease and Evidence: New Essays in the  
29 Philosophy of Medicine*, Dordrecht: Springer Netherlands; 2015, p. 63–91.  
30 [https://doi.org/10.1007/978-94-017-8887-8\\_4](https://doi.org/10.1007/978-94-017-8887-8_4).

31

1 **Figure 1.**

2 Flowchart of ICSD-3 diagnostic criteria extraction and labeling.



1 **Table 1.**

2 Type of ICSD-3 diagnostic criteria for 43 sleep disorders. For detailed tables, see Annex 1 and  
 3 2. The “✓” sign indicates that the type of label is included in the diagnostic criteria and the “.”  
 4 sign indicates that it is not included.

5

		Type of label									
Main sleep disorder categories	Sleep disorders	NUMBER OF CRITERIA	CLINICAL	OBJECTIVE MARKER	DISTRESS	DISABILITY	DURATION	FREQUENCY	AGE	EXCLUSION	ASSOCIATED
INSOMNIA DISORDERS (N=2)	Chronic Insomnia Disorder	18	✓	.	✓	✓	✓	✓	.	✓	.
	Short-Term Insomnia Disorder	17	✓	.	✓	✓	✓	.	.	✓	.
	Percentage use of label		100 %	0.0 %	100 %	100 %	100 %	50.0 %	0.0 %	100 %	0.0 %
	Cohen’s Kappa		0.39	.	0.03	0.62	1.00	1.00	.	1.00	.
SLEEP-RELATED BREATHING DISORDERS (N=12)	Obstructive Sleep Apnea, Adult	6	✓	✓	.	.	.	.	✓ <sup>1</sup>	.	✓
	Obstructive Sleep Apnea, Pediatric	8	✓	✓	.	✓	.	.	✓ <sup>1</sup>	.	.
	Central Sleep Apnea with Cheyne-Stokes Breathing	10	✓	✓	.	.	.	.	.	✓	✓
	Central Sleep Apnea Due to High Altitude Periodic Breathing	7	✓	✓	.	.	.	.	.	✓	✓
	Primary Central Sleep Apnea	10	✓	✓	.	.	.	.	.	✓	.
	Primary Central Sleep Apnea of Infancy	5	✓	✓	.	.	.	.	✓	✓	.
	Primary Central Sleep Apnea of Prematurity	5	✓	✓	.	.	.	.	✓	✓	.
	Obesity Hypoventilation Syndrome	3	.	✓	.	.	.	.	.	✓	✓
	Congenital Central Alveolar Hypoventilation Syndrome	2	.	✓	.	.	.	.	.	.	.
	Late-Onset Central Hypoventilation with Hypothalamic Dysfunction	8	.	✓	.	✓	.	.	✓	✓	✓
	Idiopathic Central Alveolar Hypoventilation.	2	.	✓	.	.	.	.	.	✓	.
	Sleep-related Hypoxemia	3	.	✓	.	.	.	.	.	✓	.
	Percentage		58.3 %	100 %	0.0 %	16.6 %	0.0 %	0.0 %	33.3 %	75.0 %	33.3 %
Cohen’s Kappa		0.89	1.00	.	0.49	.	.	0.87	1.00	0.78	
CENTRAL DISORDERS OF	Narcolepsy Type 1	3	✓	✓	.	.	✓	✓	.	.	.
	Narcolepsy Type 2	5	✓	✓	.	.	✓	✓	.	✓	.
	Idiopathic hypersomnia	7	✓	✓	.	.	✓	✓	.	✓	.
	Kleine-Levin Syndrome	8	✓	.	.	✓	✓	✓	.	✓	✓



HYPERSONN OLENCE (N=6)	Hypersomnia Associated with a Psychiatric Disorder	3	✓	.	.	.	✓	✓	.	✓	✓
	Insufficient Sleep Syndrome	6	✓	✓	.	✓	✓	✓	✓	✓	✓
	Percentage use of label		100 %	66.7 %	0.0 %	33.3 %	100 %	100 %	16.7 %	83.3 %	50.0 %
	Cohen's Kappa		0.91	0.95	.	0.48	1.00	1.00	1.00	0.91	0.82
CIRCADIAN RHYTHM SLEEP WAKE DISORDERS (N=6)	Delayed Sleep-Wake Phase Disorder	5	✓	✓	✓	✓	✓	✓	.	✓	✓
	Advanced Sleep-Wake Phase Disorder	5	✓	✓	✓	✓ <sup>2</sup>	✓	✓	.	✓	✓
	Irregular Sleep-Wake Rhythm Disorder	4	✓	✓	✓ <sup>2</sup>	✓ <sup>2</sup>	✓	✓	.	✓	✓ <sup>2</sup>
	Non-24-Hour Sleep-Wake Rhythm Disorder	4	✓	✓	✓ <sup>2</sup>	✓ <sup>2</sup>	✓	✓ <sup>2</sup>	.	✓	✓ <sup>2</sup>
	Shift Work Disorder	4	✓	✓	✓ <sup>2</sup>	✓ <sup>2</sup>	✓	✓ <sup>2</sup>	.	✓	✓
	Jet Lag Disorder	3	✓	.	✓ <sup>2</sup>	✓	✓	✓ <sup>2</sup>	.	✓	✓
	Percentage use of label		100 %	83.3 %	100 %	100 %	100 %	100 %	0.0 %	100 %	100 %
	Cohen's Kappa		0.95	1.00	0.79	1.00	1.00	1.00	.	1.00	1.00
PARASOMNIA S (N=10)	Confusional Arousals	2	✓	.	.	.	.	✓ <sup>3</sup>	.	✓	.
	Sleepwalking	1	✓	.	.	.	.	✓ <sup>3</sup>	.	✓ <sup>3</sup>	.
	Sleep Terrors	2	✓	.	.	.	.	✓ <sup>3</sup>	.	✓ <sup>3</sup>	.
	Sleep-related Eating Disorder	6	✓	.	✓	.	.	✓	.	✓	.
	REM Sleep Behavior Disorder	4	✓	✓	.	.	.	✓	.	✓	.
	Recurrent Isolated Sleep Paralysis	4	✓	.	✓	.	✓	✓	.	✓	.
	Nightmare Disorder	11	✓	.	✓	✓	.	✓	.	.	.
	Exploding Head Syndrome	3	✓	.	.	.	.	.	.	✓	.
	Sleep-related Hallucinations	3	✓	.	.	.	.	✓	.	✓	.
	Sleep Enuresis	4	✓	.	.	.	✓	✓	✓	.	✓
	Percentage use of label		100	10%	30%	10%	20%	90%	10%	80%	10%
Cohen's Kappa		0.78	0.79	0.54	0.92	0.65	1.00	1.00	0.95	0.49	
SLEEP- RELATED MOVEMENT DISORDERS (N=7)	Restless Legs Syndrome	6	✓	.	✓	✓	.	.	.	✓	.
	Periodic Limb Movement Disorder	4	.	✓	✓	✓	.	.	.	✓	.
	Sleep-related Leg Cramps	3	✓	.	✓	.	.	.	.	.	.
	Sleep-related Bruxism	3	✓	.	✓	.	.	✓	.	.	.
	Sleep-related Rhythmic Movement Disorder	6	✓	.	✓	✓	.	✓	.	✓	.
	Benign Sleep Myoclonus of Infancy	5	✓	.	.	.	.	✓	✓	✓	.
	Propriospinal Myoclonus at Sleep Onset	5	✓	.	.	.	.	.	.	✓	.
	Percentage use of label		85.7 %	14.3 %	71.4 %	42.9 %	0% %	42.9 %	14.3 %	71.4 %	0% %
Cohen's Kappa		0.62	0.85	0.69	0.89	.	1.00	1.00	1.00	.	
TOTAL (N=43)	Percentage use of label		<b>86.0</b> % (N=37)	<b>53.5</b> % (N=23)	<b>30.2</b> % (N=16)	<b>30.2</b> % (N=16)	<b>30.2</b> % (N=16)	<b>58.1</b> % (N=25)	<b>18.6</b> % (N=8)	<b>81.4</b> % (N=35)	<b>34.8</b> % (N=15)
	Cohen's Kappa		<b>0.78</b>	<b>0.96</b>	<b>0.48</b>	<b>0.78</b>	<b>0.95</b>	<b>1.00</b>	<b>0.95</b>	<b>0.97</b>	<b>0.75</b>

1 <sup>1</sup> Age criterion is mentioned in the title (Adult, Pediatric)

- 1 <sup>2</sup> Part of the general diagnostic criteria for Circadian Rhythm Sleep Wake Disorders (3 criteria)
- 2 <sup>3</sup> Part of the general diagnostic criteria for Disorders of Arousal (5 criteria)
- 3
- 4
- 5
- 6

1 **Table 2.**

2 Proposed organization of diagnostic criteria for future research and iterations development of  
 3 ICSD.

4

	<b>Criteria</b>	<b>Definition</b>	<b>Questions for furthers researches</b>
Central Core Diagnostic criteria	Clinical manifestation	A clinical manifestation unit of analysis associated with the sleep condition	<ul style="list-style-type: none"> <li>• Are there reliable and valid symptoms or signs of the sleep disorder?</li> </ul>
	Objective marker	An objective measure associated with the sleep condition	<ul style="list-style-type: none"> <li>• Are there reliable and valid objective markers of the sleep disorder?</li> </ul>
	Distress	A specification of a clinically significant personal physical or mental suffering or pain associated with the sleep condition	<ul style="list-style-type: none"> <li>• Is there a distress consequence of the sleep condition?</li> </ul>
	Disability	An inability to assume social, occupational, or other important areas of functioning (i.e. familial, professional, educational, etc.) associated with the sleep condition	<ul style="list-style-type: none"> <li>• Is there a disability consequence of the sleep condition?</li> </ul>
Specific criteria	Duration	A specification of a minimal or maximal duration related to the natural course of the sleep condition	<ul style="list-style-type: none"> <li>• Is a minimum or maximal duration of clinical manifestations required for a reliable and valid diagnosis?</li> </ul>
	Frequency	A specification of the recurrence of the condition that specifies a minimal frequency	<ul style="list-style-type: none"> <li>• Is a minimum frequency of clinical manifestations required for a reliable and valid diagnosis?</li> </ul>
	Age	A specification of the age category in which the other diagnostic criteria should be applied	<ul style="list-style-type: none"> <li>• Is there a specific age (children, adult, elderly) for clinical manifestation, objective marker, distress or disability?</li> </ul>
	Exclusion	A specification of the fact that the condition cannot be better explained by another disorder or substance use and/or that the disorder could not be diagnosed in the presence of another condition	<ul style="list-style-type: none"> <li>• One or more condition(s) must be absent?</li> </ul>
	Associated condition	A criterion that requires the presence of another condition	<ul style="list-style-type: none"> <li>• One or more condition(s) must be present?</li> <li>• Which condition is associated with the sleep disorder?</li> </ul>

			<ul style="list-style-type: none"> <li>• Which degree of causal relation of the condition is associated with the sleep disorder?</li> </ul>
	Subtypes	A clinical manifestation or an objective marker associated with a subtype sleep condition	<ul style="list-style-type: none"> <li>• Are there reliable and valid clinical manifestations or objective markers of a subtype sleep disorder?</li> </ul>
	Level of certainty	A clinical manifestation or an objective marker associated with a level of certainty	<ul style="list-style-type: none"> <li>• Is the sleep disorder definite or probable?</li> </ul>
	Level of severity	A clinical manifestation, an objective marker, a distress, a disability, a duration, a frequency, associated with a level of severity	<ul style="list-style-type: none"> <li>• How severe is the sleep disorder?</li> <li>• Is the sleep condition a “normal variant” or an “isolated symptom”?</li> </ul>

1