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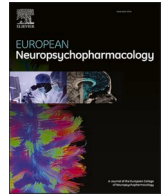
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# Clinical sleep staging for insomnia disorder

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## 1. Introduction

In clinical practice, insomnia disorder (ID) is understood as a dynamic and time-sensitive condition that shapes its presentation, maintenance, and progression. For instance, initial insomnia symptoms often evolve from acute episodes related to stress into chronic patterns through maladaptive sleep habits if not addressed early (e.g., prolonged wakefulness reinforced by anxiety and irregular sleep schedules). Temporal phenotypes – or “clinical stages” – of ID could be defined by successive phases along developmental trajectories (Pillai et al., 2015). However, to our knowledge, there currently exists no theoretical framework to explain these clinical temporal dynamics.

The concept of “clinical staging”, while extensively applied in fields such as oncology and psychiatry (McGorry and Hickie, 2019), remains underexplored in sleep medicine (Friedman et al., 2002). Mirroring the clinical staging framework in oncology represented by the TNM classification (for Tumor, Nodes, Metastasis), which has significantly improved the precision of prognosis and treatment strategies, clinical staging in sleep medicine could aim to delineate successive clinical stages, ordered temporally, to organize personalized care accordingly.

Clinical staging differs from related concepts of subtyping and sleep staging. Firstly, subtyping of sleep disorders (e.g., Blanken et al., 2019; Pillai et al., 2015) focuses on the identification of prognostic or predictive subgroups based on specific markers, such as symptom profiles, comorbidities, or biological indicators. While subtyping defines phenotypes based on static markers, clinical staging instead delineates stages based on the temporal progression of the disorder (Tinland et al.,

2024). Secondly, the term “staging” in sleep medicine traditionally refers to electrophysiological sleep staging based on polysomnography scoring during a single night. However, clinical staging is applied in a phenotypical sense to describe the progression of sleep disorders over time, emphasizing a longitudinal clinical perspective rather than a static categorization of clinical sleep stages.

In this insight, we will characterize the potential of clinical staging for sleep medicine. We will introduce several notions for the future of sleep medicine: a focus on the dynamic nature and phenotyping of insomnia and a particular emphasis on precision sleep medicine (Gauld et al., 2021).

## 2. Characterization of clinical sleep staging

Clinical sleep staging could aim to delineate and predict the evolution of ID along a continuum of increasing severity, where distinct clinical stages can be identified based on symptom progression and impact on functioning. In sleep medicine, this approach could assess severity either horizontally (e.g., extent of disturbances to new symptoms, for instance cognitive, emotional, or behavioral) or vertically (e.g., chronicity and/or worsening of the same symptom over time) (Tinland et al., 2024). Central to clinical sleep staging is the assumption of temporal progression, suggesting that, without appropriate intervention, a sleep disorder could evolve through increasingly severe phases, each marked by greater functional impairment, chronicity, or comorbidity over time (Friedman et al., 2002). Severity and duration of symptoms and markers are generally considered to be closely correlated,

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reflecting a dynamic interplay where positive feedback loops – if left unaddressed – can exacerbate symptom severity over time (McGorry and Hickie, 2019; Tinland et al., 2024). Clinical sleep staging may provide a more accurate assessment of insomnia disorder by incorporating the temporal progression of symptoms, particularly considering insomnia severity as a dynamic indicator to refine the characterization of insomnia disorder. In other words, clinical sleep staging may serve a dual purpose: refining the temporal understanding of insomnia disorder itself while considering insomnia symptoms as an evolving phenotypic marker among other psychopathological ones.

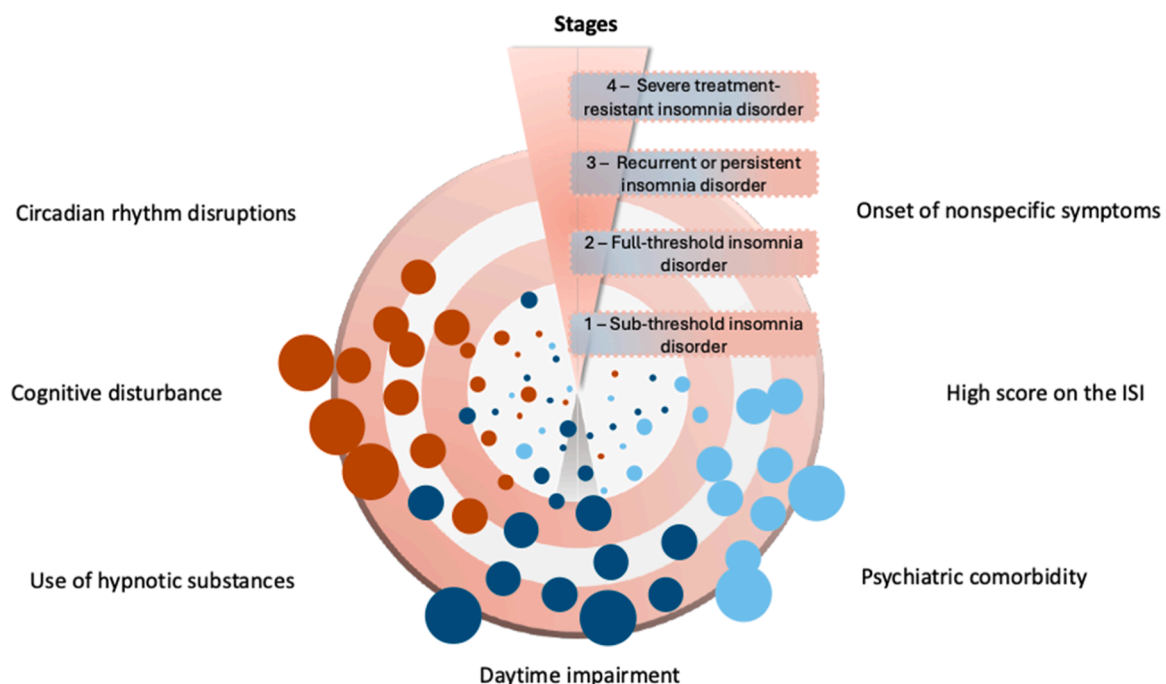
**Fig. 1.** Proposed schematic model for clinical sleep staging of insomnia disorder. The circles represent the clinical stages of insomnia disorder, ranging from clinical stage 1 (“Sub-threshold insomnia disorder”) to clinical stage 4 (“Severe treatment-resistant insomnia disorder”). The bubbles within each clinical stage correspond to symptoms and other clinical elements (e.g., impact on functioning), which are mostly nonspecific (mixed colors) and of low intensity/severity (small circumference) in the early clinical stages, becoming more specific and intense/severe as the disorder progresses to later clinical stages. There is thus an outward increase in severity, symptom distinctiveness (referring to the process where, at the center of the figure, a patient presents with various symptoms of different subtypes, and these subtypes become more specified over the course of the disorder) and, consequently, an outward increase in disability, impact, and/or comorbidity. The specific elements that each clinical stage should encompass in a staging model – such as the score on an insomnia scale, daytime functioning, duration of the disorder, comorbidities, vulnerability factors, chronotype, somnotype, trototype, or circadian flexibility – remain to be defined in future research. This schematic model illustrates the underlying assumption of staging models commonly employed in psychiatry and oncology: more severe symptoms correspond to later clinical stages. For instance, the model reflects a gradation in symptom severity, such as minor circadian misalignment at the center, progressing to severe circadian disruptions (e.g., a complete reversal of the sleep-wake cycle) at the periphery; occasional hypnotic use at the center, escalating to reliance and potential misuse at the periphery; or minimal daytime impairment at the center, with severe functional limitations at the periphery. ISI: Insomnia Severity Index.

### 3. Clinical implications of sleep staging

Current clinical approaches of ID do not provide a consistent framework for delineating successive clinical stages (Blanken et al., 2019; Riemann et al., 2022). By viewing conditions as evolving along a continuum, clinical sleep staging would allow interventions to be tailored based on the developmental course of symptoms and other clinical markers.

**Early clinical stages.** Identifying early clinical stages in ID is essential, as it allows detection of subtle shifts in sleep rhythms, patterns, and habits that may accumulate, attract new disturbances, or intensify over time (Scott et al., 2013). However, early clinical stage identification remains challenging due to the nonspecific nature of subclinical symptoms and the difficulty in distinguishing transient disruptions from the onset of pathological processes. Accurately identifying markers of these early clinical stages would allow for more precise targeting of interventions like cognitive-behavioral therapy, which tend to be more effective and less invasive at this stage. In the context of early clinical stages, treatments with limited evidence, such as valerian, might still hold value if they offer subjective improvements in sleep quality without significant adverse effects (Valente et al., 2024). Further research is necessary to clarify the roles of such minimally supported interventions at each stage of insomnia (Murru and Sommerhoff, 2024), allowing for a more nuanced and targeted application of therapies that corresponds to a specific clinical (early) stage.

**Targeted interventions.** Clinical sleep staging in ID might allow for the implementation of stage-specific interventions that could be progressively adapted according to the characteristics of each clinical stage, aligning with a stepped-care approach (McGorry and Hickie, 2019; Riemann et al., 2022). For instance, the management of advanced-stage insomnia might require a combination of pharmacological treatments and more intensive behavioral therapies compared to earlier stages of the disorder (Baglioni et al., 2023). Stage-appropriate treatments could prevent progression and the onset of related conditions such as depression, and evaluating the impact of these interventions can be achieved by tracking changes in severity over time (Scott et al., 2013). Moreover, as sleep research advances, the integration of mechanistic and statistical biomarkers into these clinical stages could further refine



**Fig. 1.** Presents a provisional schematic staging model as an example of what such a framework might entail, though it requires further development and validation.

staging models. Finally, digital tools for insomnia, including digital cognitive behavioral therapy for insomnia (dCBT-I) and other interventions (Lee et al., 2023; Van Assche et al., 2022), may offer the scalability and personalization needed to address insomnia's diverse presentations across its clinical stages. By integrating these interventions with digital phenotyping (Wadle and Ebner-Priemer, 2023), researchers and clinicians may increasingly adapt insomnia treatments in a way that reflects each patient's unique symptom trajectory and risk profile.

**Organizational implications.** Incidentally, staging psychiatric policies have already contributed to institutional reorganizations. For instance, several countries have developed specific “headspace” centers aimed at proactively engaging individuals in the early stages of ID, providing them with an accessible first point of contact with the medical system. Similarly, for less severe cases – particularly in child and adolescent psychiatry – a public health approach in sleep medicine could involve the establishment of dedicated reception areas staffed by individuals with lived experience of sleep disorders.

#### 4. Conclusion

Borrowed from oncology and applied in psychiatry (Tinland et al., 2024), a clinical sleep staging model could optimize sleep health trajectories for individuals with ID. However, new challenges may arise: could a single transdiagnostic clinical staging model capture insomnia's heterogeneity? How can early ID stages be distinguished from normative variations without reliable biomarkers? Finally, how should multimorbidity be addressed, given frequent co-occurring conditions like comorbid insomnia and sleep apnea (COMISA)?

Addressing these questions will help refine clinical staging models, paving the way for more precise, stage-specific interventions for ID.

#### Declaration of competing interest

The author reports no conflict of interest.

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