

European Sleep Research Society

**Sleep Medicine Textbook
Second Edition**

Editors-in-Chief: Claudio Bassetti, Walter McNicholas, Tiina Paunio, Philippe Peigneux

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Table of Contents

Preface	5
---------	---

A. Physiological basis of sleep

(Section Editors: Roberto Amici, Philippe Peigneux)

1. The neurophysiology and neurobiology of wakefulness and non-rapid eye movement (NREM) sleep	
Antoine Adamantidis, Patrice Fort and Pierre-Hervé Luppi	7
2. The neurophysiology and neurobiology of paradoxical (REM) sleep	
Pierre-Hervé Luppi, Antoine Adamantidis and Patrice Fort	15
3. Adaptation of bodily functions to sleep	
Roberto Amici and Giovanna Zoccoli	27
4. Theories on the functions of sleep	
Róbert Bódizs	41
5. Sleep and psychology (cognitive and emotional processes)	
Péter Simor, Rebeca Sifuentes Ortega and Philippe Peigneux	57
6. Effects of acute and chronic sleep deprivation	
Sebastian C. Holst and Hans-Peter Landolt	67
7. Sleep and dreaming	
Aurélie M. Stephan and Francesca Siclari	81
8. Ageing and sleep: Sleep in all stages of human development	
Sven Leach, Nadja Olini and Reto Huber	95
9. Gender differences in sleep	
Tarja Porkka-Heiskanen, Tarja Saaresranta and Päivi Polo-Kantola	109
10. Circadian biology/Chronobiology	
Christian Cajochen and Corrado Garbazza	123
11. Effects of various pharmacological treatments on sleep	
Hans-Peter Landolt and Esther Werth	135

B. Assessment of sleep disorders and diagnostic procedures

(Section Editors: Thomas Penzel, Marco Zucconi)

1. Classification of sleep disorders	
Marco Zucconi and Raffaele Ferri	151
2. The clinical interview and clinical examination	
Ludger Grote and Francisco Javier Puertas	167
3. Measuring: Monitoring sleep and wakefulness	
Johannes Mathis, Simone de Lacy, Corinne Roth and Elizabeth A. Hill	181
4. Other tests and examinations	
Thomas Penzel and Christoph Schöbel	201
5. Biomarkers for disturbed sleep	
Anna Heidbreder	209

C. Insomnia

(Section Editors: Colin Espie, Dieter Riemann)

1. Nosological classification, definitions, and epidemiology	
Jason G. Ellis	219
2. Pathophysiology	
Kai Spiegelhalder and Chiara Baglioni	237
3. Clinical picture and diagnosis	
Dieter Riemann	245
4. Comorbidities and special populations	
Tiina Paunio	253
5. Treatment	
5.1. Current guidelines	
Dieter Riemann	261
5.2. Cognitive behavioural therapy for insomnia and other psychotherapeutic approaches	
Dimitri Gavriloff, Simon D. Kyle and Colin A. Espie	265
5.3. Pharmacological treatment	
Damien Leger	279
5.4. Evidence-based efficacy of alternative interventions	
Chiara Baglioni	287

D. Sleep-related breathing disorders

(Section Editor: Walter McNicholas)

1. Nosological classification, definitions, and epidemiology
Johan Verbraecken 297
2. Pathophysiology
Winfried J. Randerath 311
3. Clinical picture and diagnosis
Ludger Grote and Stefan Mihaicuta 325
4. Obstructive sleep apnea and comorbidities: A specific focus on cardiometabolic comorbidities
Jean-Louis Pépin, Sébastien Baillieux and Renaud Tamisier 347
5. Treatment
Dirk Pevernagie, Manuel Sastry and Peter van Maanen 357

E. Hypersomnias of central origin

(Section Editors: Claudio Bassetti)

1. Nosological classification, definitions, and epidemiology
Ulf Kallweit and Claudio L. A. Bassetti 379
2. Etio-pathophysiology
Claudio L. A. Bassetti and Gert Jan Lammers 387
3. Clinical picture and diagnosis
Claudio L. A. Bassetti and Gert Jan Lammers 401
4. Treatment
Yves Dauvilliers and Lucie Barateau 413
5. Miscellaneous topics
Emanuela Postiglione and Fabio Pizza 425

F. Circadian rhythm sleep disorders

(Section Editors: Tiina Paunio, Debra Skene)

1. Nosological classification, definitions, and epidemiology
Bjørn Bjorvatn 435
2. Pathophysiology
 - 2.1. Shift work
John Axelsson and Bjørn Bjorvatn 441
 - 2.2. Delayed sleep-wake phase disorder
Cátia Reis and Sabra M. Abbott 449
 - 2.3. Non-24-hour sleep-wake disorder
Debra J. Skene 457
3. Clinical picture and diagnosis
Bjørn Bjorvatn and Ståle Pallesen 461
4. Comorbidities
Carmen M. Schroder, Ülker Kilic Huck, Elisabeth Ruppert and Patrice Bourgin 467
5. Health risks
Ståle Pallesen and Bjørn Bjorvatn 483
6. Treatment
Ülker Kilic Huck, Carmen Schroder and Patrice Bourgin 493

G. Parasomnias

(Section Editors: Claudio Bassetti, Lino Nobili)

1. Nosological classification, definitions, and epidemiology
Claudio L. A. Bassetti 507
2. Pathophysiology and psychopathology
Lino Nobili and Isabelle Arnulf 515
3. Clinical findings
Joan Santamaria and Valérie Cochen de Cock 531
4. Special populations and comorbidities
Alex Iranzo and Elena Antelmi 543
5. Treatment
Paola Proserpio and Raffaele Manni 555
6. Miscellaneous topics
Ana Rita Peralta, Dario Arnaldi and Dulce Neutel 565

H. Sleep-related movement disorders

(Section Editor: Claudio Bassetti)

1. Nosological classification, definitions, and epidemiology
Federica Provini and Luca Baldelli 577
2. Pathophysiology
Celia Garcia-Malo, Sabela Novo Ponte and Diego Garcia-Borreguero 587
3. Clinical picture and diagnosis
Alex Iranzo and Laura Pérez-Carbonell 599
4. Comorbidities
Silvia Miano, Silvia Riccardi and Mauro Manconi 615
5. Treatment
Diego Garcia-Borreguero, Celia Garcia-Malo, Sabela Novo Ponte and Claudia Trenkwalder 633

I. Paediatric sleep disorders

(Section Editors: Oliviero Bruni, Lino Nobili)

1. Chronic insomnia
Oliviero Bruni, Marco Angriman and Raffaele Ferri 647
2. Specific features of parasomnias
Paola Proserpio and Lino Nobili 665
3. Obstructive sleep apnea
Athanasios G. Kadiris and Maria Pia Villa 673
4. Sleep-related movement disorders
Rosalia Silvestri and Sona Nevsimalova 683
5. Narcolepsy
Giuseppe Plazzi and Francesca Cavalli 697
6. Sleep in neurodevelopmental disorders
Paul Gringras 709

J. Sleep and pulmonology

(Section Editors: Jan Hedner, Walter McNicholas)

1. Overview and pathophysiology
Jan Hedner and Ding Zou 717
2. Obstructive sleep apnea and chronic obstructive pulmonary disease overlap
Walter T. McNicholas 725
3. Sleep-disordered breathing and asthma
Maria R. Bonsignore and Oreste Marrone 735
4. Sleep-disordered breathing and Interstitial Lung Disease (ILD)
Charalampos Mermigkis, Izolde Bouloukaki and Sophia E. Schiza 745
5. Hypoventilation disorders
Victor R. Ramírez Molina, Juan F. Masa Jiménez, Francisco J. Gómez de Terreros Caro and Jaime Corral Peñafiel 757

K. Sleep and internal medicine

(Section Editors: Walter McNicholas, Dirk Pevernagie)

1. Cardiovascular diseases: Heart failure, coronary artery disease, arrhythmias, and hypertension
Shahrokh Javaheri, Luciano F. Drager, Dirk A. Pevernagie and Geraldo Lorenzi-Filho 771
2. Endocrine diseases: Diabetes mellitus, diseases of the thyroid, acromegaly, polycystic ovarian syndrome
Barry Kennedy and Brian D. Kent 789
3. Nocturia
Karel Everaert, An Mariman, Dirk Vogelaers and Dirk Pevernagie 801
4. Cancer
Dimitrios Papadopoulos 811
5. Chronic fatigue and pain syndromes
An Mariman, Dirk Pevernagie, Ignace Hanoulle and Dirk Vogelaers 823
6. Sleep in critically ill patients
Xavier Drouot and Christophe Rault 833

L. Sleep and psychiatry

(Section Editors: Christoph Nissen, Tiina Paunio)

1. Overview	
Tiina Paunio	843
2. Substance use disorders	
Lukas Frase and Christoph Nissen	855
3. Schizophrenia spectrum disorders	
Bryony Sheaves and Daniel Freeman	863
4. Affective disorders	
Christoph Nissen, Elisabeth Hertenstein and Tiina Paunio	879
5. Anxiety disorders	
Elisabeth Hertenstein and Christoph Nissen	891
6. Other psychiatric disorders	
Elisabeth Hertenstein and Christoph Nissen	899

M. Sleep and neurology

(Section Editors: Claudio Bassetti)

1. Overview	
Claudio L. A. Bassetti	905
2. Epilepsy	
Steve A. Gibbs, Frédéric Zubler and Lino Nobili	915
3. Parkinsonian Syndromes	
Panagiotis Bargiotas	929
4. Dementias	
Luigi Ferini-Strambi and Maria Salsone	945
5. Stroke	
Claudio L. A. Bassetti	959
6. Headache	
Ulf Kallweit and Ramin Khatami	971
7. Multiple sclerosis and other autoimmune disorders	
Ulf Kallweit	981
8. Neuromuscular disorders	
Matthias Boentert	991

N. Sleep and geriatrics

(Section Editor: Claudio Bassetti)

1. Sleep in the elderly	
Adrien Lorette, Ulrich Hemmeter, Francesca Siclari and Armin von Gunten	1003
2. Sleep disorders in the elderly	
Dirk Schwerthöffer and Hans Förstl	1013

O. Societal, economic, organizational, and research aspects

(Section Editors: Torbjörn Åkerstedt, Philippe Peigneux)

1. Demographic and socioeconomic aspects of sleep disorders	
Poul Jennum and Jakob Kjellberg	1021
2. Forensic aspects of sleep medicine	
Thomas Penzel and Christian Veauthier	1029
3. Organization of Sleep Medicine Centres	
Fabio Cirignotta, Susanna Mondini and Zoran Đogaš	1039
4. Training initiatives in sleep medicine	
Zoran Đogaš and Sophia E. Schiza	1049
5. Research design and quantitative methods	
Peter Achermann, Leila Tarokh and Philippe Peigneux	1055
6. Shift work, sleep, and sleepiness	
Torbjörn Åkerstedt	1071

List of Index Words

1079

Author Index

1105

Abbreviations

1107

PREFACE

Seven years have passed since the first edition of the European Sleep Research Society (ESRS) Textbook on Sleep Medicine was published in 2014 with the primary aim of providing the knowledge base to prepare for the ESRS Certifying Examination in Somnology. The Society also hoped that the book would be of interest to all practitioners in sleep medicine and science, and has been highly pleased with the reception and success of this textbook, which has become established as a major reference work in the field of Sleep Medicine. With the growth and development of sleep medicine and science across all major clinical specialties, the interest in sleep disorders of a broad range of clinical practitioners has increased, which indicates the need for an updated and expanded second edition.

The first edition focused primarily on sleep and sleep-related disorders, and the second edition updates the major advances that have occurred in these topics over the intervening years. In addition, the second edition is significantly expanded to include the impact of sleep on major body systems and related disorders. The textbook provides a comprehensive basis and knowledge of sleep medicine, serviceable across all countries with a particular emphasis on European practices in sleep medicine. The book follows the format of the 'Sleep medicine catalogue of knowledge and skills - Revision' published in the *Journal of Sleep Research* (Penzel et al., 2021), the official publication of the ESRS. This Catalogue was jointly developed by the ESRS Board and the Sleep Medicine Committee of the ESRS, in cooperation with members of the Assembly of National Sleep Societies (ANSS), a constituent body of the ESRS. The Catalogue is intended to be the basis for sleep medicine education, for sleep medicine courses and for sleep medicine examinations, servicing not only physicians with a medical speciality degree, but also PhD and MSc health professionals such as clinical psychologists and scientists, technologists and nurses, all of whom are involved professionally in sleep medicine.

The Textbook presents state-of-the-art knowledge over 15 sections that parallel the domains defined in the Catalogue, comprising physiology, pathology, diagnosis and treatment procedures, major sleep disorders such as insomnia, parasomnias and sleep-related

breathing disorders, in addition to the impact of sleep on system-based disorders such as Neurology and Pneumology. The structured content provides a basis for the development of specific teaching modules, and the collection of European Credit Transfer and Accumulation System (ECTS) points in the framework of standard education study programmes conducted at the European level, which could be implemented in cooperation with teaching institutions or with other expert societies that have special interests in the sleep medicine domain, such as Neurology, Psychiatry and Pneumology.

Recognized sleep experts have written all the chapters, which have been subjected to peer-review evaluation by the editors with the assistance of external reviewers. The four Editors-in-Chief sincerely thank all the Authors, Section Editors and Reviewers for their outstanding contribution to this important Society product. We also warmly thank Mrs Brigitte Knobl for her enthusiastic and highly professional support in the development of this book as ESRS Editorial Manager. We hope that the Textbook will serve future students of newly developed integrated sleep medicine curricula, and support the continuous medical education of sleep experts all over Europe and worldwide. We trust that this textbook will attract new students and fellows in the exciting fields of sleep medicine and sleep research, and ultimately benefit the many patients suffering from sleep disorders.

Professor Claudio Bassetti (ESRS President 2008–2012), Professor Walter McNicholas (ESRS President 2016–2020), Professor Tiina Paunio (ESRS Clinical Vice-President 2016–2020, Education Committee Chair 2014–), Professor Philippe Peigneux (ESRS President 2012–2016).

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REFERENCE

Penzel, T., Pevernagie, D., Bassetti, C., Peigneux, P., Paunio, T., McNicholas, W. T., Dogas, Z., Grote, L., Rodenbeck, A., Cirignotta, F., d'Ortho, M. P., Nobili, L., Paiva, T., Pollmacher, T., Riemann, D., Zucconi, M., Hill, E. A., Arnardottir, E. S., & Parrino, L. (2021). Sleep medicine catalogue of knowledge and skills - Revision. *Journal of Sleep Research*, 30(3), e13394.