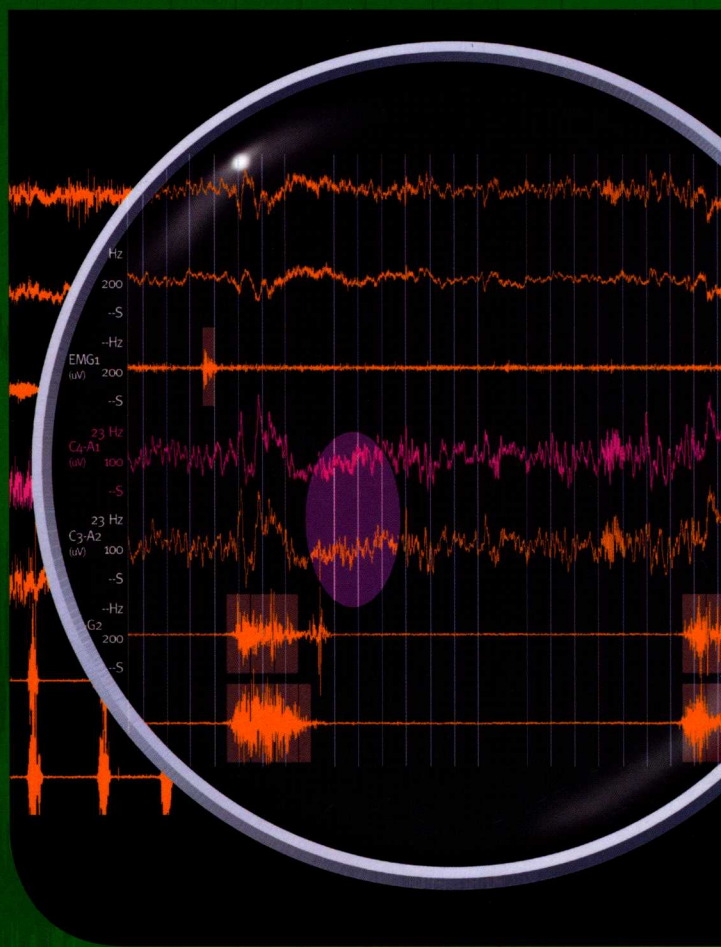
Oxford Textbook of

Sleep Disorders

Edited by

Sudhansu Chokroverty

Luigi Ferini-Strambi



Series Editor

Christopher Kennard

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Oxford Textbook of

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Preface

There have been rapid advances recently in basic science, technical, clinical, and therapeutic aspects of sleep medicine that have captivated sleep scientists and clinicians. Concomitantly, there has been a rapid increase in the number of individuals involved in clinical sleep medicine and sleep research, in addition to an explosive growth in the number of sleep centers, laboratories, and programs and an increasing number of sleep societies (national and international) and sleep medicine journals worldwide. There is an eagerness and increasing desire to absorb this evolving knowledge about sleep and its disorders. Therefore, there is a need for new books encompassing all this new knowledge. Despite the publication of a number of sleep-related books in the last few years, gaps remain in many areas. It is obvious that there is a distinct lack of adequate knowledge and awareness of sleep disorders within the neurological community, and thus sleep disorders are not dealt with adequately by most practicing neurologists. There are a few neurologically oriented short books available, but these do not give in-depth coverage of the topic. It is therefore an opportune moment to produce a volume in a succinct and lucid manner, covering the topic in a logical and orderly way and emphasizing the practical aspects with an underlying basic science component. Peter Stevenson, Senior Commissioning Editor of Medicine, Neurology, Neurosurgery, Psychiatry, and Oxford Medical Libraries at Oxford University Press (OUP), Oxford, United Kingdom contacted the Senior Editor (SC) to consider compiling such a book to fill these gaps, in collaboration with a co-editor from the European continent. Professor Luigi Ferini-Strambi from Milan, Italy agreed to be co-editor. We then proceeded to produce a comprehensive, balanced, and easily readable book emphasizing sleep neurology as part of the Oxford Textbooks in Clinical Neurology (OTCN) series in conformity with the wishes of Professor Chris Kennard, editor of the new OTCN series.

Most of the recent advances in sleep medicine have been captured in this monograph, with special emphasis on sleep neurology. The volume is essentially a clinical compendium, but also provides a background to the underlying basic science and techniques. The book is divided into 12 sections and several subsections: (1) Basic science; (2) Laboratory evaluation; (3) Clinical science: general introduction; (4) Hypersomnias; (5) Insomnias; (6) Circadian rhythm disorders; (7) Sleep neurology; (8) Parasomnias; (9) Sleep and medical disorders; (10) Sleep and psychiatric disorders; (11) Sleep in children, older adults, and women; (12) Miscellaneous sleep-related topics.

This book is directed primarily at neurologists and senior trainees, as well as internists (especially those specializing in pulmonary, cardiovascular, gastrointestinal, renal, and endocrine medicine), general practitioners/family physicians, psychiatrists, psychologists, pediatricians, otolaryngologists, dentists, neurosurgeons, and neuroscientists, and others interested in understanding sleep (eg, technologists, nurses, and other healthcare professionals). The book should be useful to both beginners and those advanced in the field.

Sudhansu Chokroverty
Luigi Ferini-Strambi

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We must first thank all the contributors for their scholarly writings and their patience in waiting to see the volume finally in production after a long and protracted period (beyond our control). We also wish to thank all the authors, editors, and publishers for granting us permission to reproduce illustrations, boxes, and tables that have previously been published in other books and journals. We must thank Peter Stevenson, the Senior Commissioning Editor of the Oxford Textbooks in Clinical Neurology series for his dedication, patience, and professionalism, and the editorial and production staff at the Oxford University Press. The Senior Editor (SC) wishes to thank Toni Bacala, the editorial assistant to the *Sleep Medicine* journal, for her tremendous support in organizing the table of contents, making corrections, typing, and editing, in addition to her main function as editorial assistant to the journal. Since Ms. Bacala left, Ms. Jamie Winder, the current editorial assistant took care of these functions. Last but not least, the senior editor must express his love and gratitude to his wife, Manisha Chokroverty, MD for her unfailing and continued support, love, patience and tolerance throughout the long period of editing, writing, and proof-reading during the book's production.

Sudhansu Chokroverty
Luigi Ferini-Strambi

Abbreviations

5-HT	5-hydroxytryptamine (serotonin)
5-HT_1, ...	serotonin receptors
5-HTT	serotonin transporter
A	adrenaline (epinephrine)
AAP	American Academy of Pediatrics
AASM	American Academy of Sleep Medicine
ABG	arterial blood gas
ACE	angiotensin-converting enzyme
ACh	acetylcholine
AChR	acetylcholine receptor
ACTH	corticotropin (adrenocorticotropic hormone)
AD	Alzheimer disease
ADA	adenosine deaminase
ADCADN	autosomal dominant cerebellar ataxia, deafness, and narcolepsy
ADH	antidiuretic hormone
ADHD	attention-deficit hyperactivity disorder
ADL	Activities of Daily Living
ADNFLE	autosomal dominant nocturnal frontal lobe epilepsy
AED	antiepileptic drug
AHI	apnea–hypopnea index
AI	apnea index
AI	atonia index
AIDS	acquired immunodeficiency syndrome
ALMA	alternating leg muscle activation
ALS	amyotrophic lateral sclerosis
ALTE	apparent life-threatening event
AMD	acid maltase deficiency
AMS	acute mountain sickness
ANS	autonomic nervous system
APAP	autotitrating continuous positive airway pressure
ARAS	ascending reticular activating system
ArD	arousal disorder
ASD	autism spectrum disorder
ASPD	advanced sleep phase disorder
ASV	adaptive servo-ventilation
ASV	assisted support ventilation
ASWPD	advanced sleep–wake phase disorder
BALM	Basic Language Morningness Scale
BDNF	brain-derived neurotrophic factor
BF	basal forebrain
Bic	bicuculline
BIPN	bilateral isolated phrenic neuropathy
BMI	body mass index
BP	blood pressure
BPAP	bilevel positive airway pressure
BPSD	behavioral and psychological signs of dementia
BRS	baroreflex sensitivity
BSMI	benign sleep myoclonus of infancy
BZD	benzodiazepine
BZDRA	benzodiazepine receptor agonist
CA	central apnea
CA	confusional arousal
CAF	central activation failure
CAP	cyclical alternating pattern
CBF	cerebral blood flow
CBT	cognitive–behavioral therapy
CBTI	cognitive–behavioral therapy for insomnia
CBZ	carbamazepine
CCHS	congenital central alveolar hypoventilation syndrome
CDR	Clinical Dementia Rating
CFS	chronic fatigue syndrome
CGI	clinical global impression
CGRP	calcitonin gene-related peptide
CHF	chronic heart failure
CHF	congestive heart failure
CI	confidence interval
CJD	Creutzfeldt–Jakob disease
CKD	chronic kidney disease
CMD	congenital muscular dystrophy
CMS	Centers Medicare and Medicaid Services
CMS	chronic mountain sickness
CMS	congenital myasthenic syndrome
CMT	Charcot–Marie–Tooth disease
CNS	central nervous system
CNZ	clonazepam
COMT	catechol-*O*-methyltransferase
COPD	chronic obstructive pulmonary disease
CPAP	continuous positive airway pressure
CPG	central pattern generator
CRC	central respiratory chemoreceptor
CRH	corticotropin-releasing hormone
CRP	C-reactive protein
CRSD	circadian rhythm sleep disorder

CRSWD	circadian rhythm sleep–wake disorder
CSB	Cheyne–Stokes breathing
CSF	cerebrospinal fluid
CSWS	electrical status epilepticus during slow-wave sleep (continuous spike and wave during slow-wave sleep)
CTb	cholera toxin b subunit
CV	cardiovascular
CVD	cardiovascular disease
CWP	chronic widespread pain
D_1, ...	dopamine receptors
DA	disorder of arousal
DA	dopamine
DAT	dopamine transporter
dDpMe	dorsal deep mesencephalic reticular nucleus
DHE	dihydroergotamine
DLB	dementia with Lewy bodies
DLCO	diffusion capacity of carbon monoxide
DLMO	dim light melatonin onset
DM	dermatomyositis
DM	myotonic dystrophy (dystrophia myotonica)
DMD	Duchenne muscular dystrophy
DORA	dual orexin receptor antagonist
DPGi	dorsal paragigantocellular nucleus
DPS	diaphragm pacing stimulation
DR	dorsal raphe
DRG	dorsal respiratory group
DSM	Diagnostic and Statistical Manual of Mental Disorders
DSPD	delayed sleep phase disorder
DSPS	delayed sleep phase syndrome
DSWPD	delayed sleep–wake phase disorder
DU	duodenal ulcer
DZ	dizygotic
EA	epileptic activity
EAE	experimental autoimmune encephalomyelitis
EDS	excessive daytime sleepiness
EDSS	Expanded Disability Status Scale
EEG	electroencephalography
EFM	excessive fragmentary myoclonus
EHS	exploding head syndrome
EMG	electromyography
EOG	electrooculography
EPAP	expiratory positive airway pressure
EPSP	excitatory postsynaptic potential
EQS	excessive quantity of sleep
ERP	event-related potential
ESES	electrical status epilepticus during sleep
ESRD	end-stage renal disease
ESS	Epworth Sleepiness Scale
FAP	fixed action pattern
FASPD	familial advanced sleep disorder
FASPS	familial advanced sleep phase syndrome
FCD	focal cortical dysplasia
FDG	[^{18}F]fluorodeoxyglucose
FFI	fatal familial insomnia
FiO_2	fraction of inspired oxygen
FLEPS	Frontal Lobe Epilepsy and Parasomnias Scale
fMRI	functional magnetic resonance imaging
FOSQ	Functional Outcomes of Sleep Questionnaire
FOT	forced oscillation technique
FRC	functional residual capacity
FRSD	free-running (non-24-hour) sleep disorder
FSH	follicle-stimulating hormone
FSHD	facioscapulohumeral muscular dystrophy
FTD	frontotemporal dementia
FVC	forced vital capacity
GABA	γ-aminobutyric acid
GAD	glutamate decarboxylase
GBP	gabapentin
GBS	Guillain–Barré syndrome
GER	gastroesophageal reflux
GERD	gastro-esophageal reflux disease
GH	growth hormone
GHRH	growth hormone-releasing hormone
GI	gastrointestinal
Gia	alpha gigantocellular nucleus
GiV	ventral gigantocellular nucleus
Glu	glutamate
Gly	glycine
GnRH	gonadotropin-releasing hormone
GTCS	generalized tonic–clonic seizure
HA	histamine
HACE	high-altitude cerebral edema
HAPE	high-altitude pulmonary edema
HAPH	high-altitude pulmonary hypertension
Hcrt, hcrt	hypocretin (orexin)
HCSB	Hunter–Cheyne–Stokes breathing
HD	hemodialysis
HD	Huntington disease
HF	high-frequency
HFLM	high-frequency leg movements
HFpEF	heart failure with preserved ejection fraction
HFT	hypnagogic foot tremor
HH	hypnagogic hallucination
HHV	human herpesvirus
HIV	human immunodeficiency virus
HLA	human leukocyte antigen
HMSN	hereditary motor and sensory neuropathy
HPA	hypothalamic–pituitary–adrenal
HPS	hypothalamic–pituitary–somatotropic
HR	hazard ratio
HR	heart rate
HRQoL	health-related quality of life
HRV	heart rate variability
HUTT	head-up tilt test
HV	hippocampal volume
IBS	irritable bowel syndrome
ICD	International Classification of Diseases
ICHD	International Classification of Headache Disorders
ICSD	International Classification of Sleep Disorders
ICU	intensive care unit
IED	interictal epileptiform discharge
IFN	interferon
Ig	immunoglobulin
IH	idiopathic hypersomnia
IL	interleukin
ILD	interstitial lung disease

IPAP	inspiratory positive airway pressure
IPN	isolated phrenic neuropathy
ipRGC	intrinsically photoreceptive ganglion cell
IPSP	inhibitory postsynaptic potential
iRBD	idiopathic REM sleep behavior disorder
IRLSSG	International Restless Leg Syndrome Study Group
ISI	Insomnia Severity Index
ISWRD	irregular sleep–wake rhythm disorder
IVIg	intravenous immunoglobulin
JLD	jet lag disorder
JME	juvenile myoclonic epilepsy
KLS	Kleine–Levin syndrome
KSS	Karolinska Sleepiness Scale
LC	locus coeruleus
LDT	laterodorsal tegmental nucleus
LEMS	Lambert–Eaton myasthenic syndrome
LES	lower esophageal sphincter
LEV	levetiracetam
LF	low-frequency
LGMD	limb-girdle muscular dystrophy
LH	lateral hypothalamus
LH	luteinizing hormone
LKS	Landau–Kleffner syndrome
LTG	lamotrigine
LV	left-ventricular
LVEF	left-ventricular ejection fraction
LVIDd	left-ventricular internal diameter in diastole
MA	monoamine
MAD	mandibular advancement device
MAO	monoamine oxidase
MAOI	monoamine oxidase inhibitor
MCH	melanin-concentrating hormone
MCI	mild cognitive impairment
MDD	major depressive disorder
MDMA	3,4-methylenedioxymethamphetamine
MEMA	middle ear muscle activity
MEP	maximum expiratory pressure
MEP	motor evoked potential
MG	myasthenia gravis
MHA	morning headache
MIBG	*meta*-iodobenzylguanidine
MIP	maximal inspiratory pressure
MMC	migrating motor complex
MMSE	Mini Mental State Examination
MnPN	median preoptic nucleus
MRI	magnetic resonance imaging
MRS	magnetic resonance spectroscopy
MS	multiple sclerosis
MSA	multiple system atrophy
MSLT	multiple sleep latency test
MT_1, MT_2	melatonin receptors
mTBI	minor traumatic brain injury
MVC	maximum voluntary contraction
MWT	maintenance of wakefulness test
MZ	monozygotic
NA	noradrenaline (norepinephrine)
nAChR	neuronal nicotinic acetylcholine receptor
NAVA	neurally adjusted ventilatory assist
NC	narcolepsy with cataplexy
NDRI	norepinephrine (noradrenaline)–dopamine reuptake inhibitor
NFLE	nocturnal frontal lobe epilepsy
NIV	noninvasive positive pressure ventilation
NLP	no conscious light perception
NM	nucleus basalis of Meynert
NMDA	*N*-methyl-D-aspartate
NMO	neuromyelitis optica
NMS	non-motor symptoms
NMSQuest	Non-Motor Symptoms Questionnaire
NMSS	Non-Motor Symptoms Scale
NO	nitric oxide
NOA	number of awakenings
NOS	not otherwise specified
NPARM	non-polyalanine repeat mutation
NPs	nasal prongs
NREM	non-rapid-eye-movement
NRS	nonrestorative sleep
NSAID	nonsteroidal anti-inflammatory drug
NTS	nucleus tractus solitarius
NYHA	New York Heart Association
OA	obstructive apnea
OAHI	obstructive apnea–hypopnea index
OCD	obsessive–compulsive disorder
OCST	out-of-center sleep studies
OHS	obesity–hypoventilation syndrome
ONS	occipital nerve stimulation
OR	odds ratio
OSA	obstructive sleep apnea
OSAS	obstructive sleep apnea syndrome
OXC	oxcarbazepine
PA	paroxysmal arousal
P_ACO_2	alveolar partial pressure of carbon dioxide
$PaCO_2$	arterial partial pressure of carbon dioxide
PaO_2	arterial partial pressure of oxygen
PAP	positive airway pressure
PARM	polyalanine repeat mutation
PB	phenobarbital
PCO_2	partial pressure of carbon dioxide
P_{crit}	critical closing pressure
PD	Parkinson disease
PDSS	Parkinson's Disease Sleep Scale
PE	pulmonary embolism
PeF	perifornical area
peri-LCα	peri-locus coeruleus alpha nucleus
PET	positron emission tomography
PFC	prefrontal cortex
PFT	pulmonary function tests
PGO	pontine–geniculate–occipital
PH	posterior hypothalamus
PHT	phenytoin
PIA	pontine inhibitory area
PIM/AIE	psychobiological inhibition/ attention–intention–effort
PIP	periorbital integrated potential
PLM	periodic leg/limb movements
PLMD	periodic limb movement disorder
PLMS	periodic leg/limb movements during sleep
PLMSI	PLMS index

PLMW	periodic leg/limb movements during wakefulness
PM	polymyositis
PMR	progressive muscle relaxation
PMS	propriospinal myoclonus
PnC	pontis caudalis
PNE	primary nocturnal enuresis
PnO	pontis oralis
PNS	peripheral nervous system
PO_2	partial pressure of oxygen
POA	preoptic area
POAH	proptic nucleus of the anterior hypothalamus
PPS	postpoliomyelitis syndrome
PPT	pedunculopontine
PRM	primidone
PROM	proximal myotonic myopathy
PrP	prion protein
PS	paradoxical sleep
PSG	polysomnography
PSM	propriospinal myoclonus
PSP	progressive supranuclear palsy
PSQI	Pittsburgh Sleep Quality Index
PST	problem-solving therapy
PTSD	post-traumatic stress disorder
PTT	pulse transit time
PVDF	polyvinylidene fluoride
PVR	peripheral vascular resistance
PWS	Prader–Willi syndrome
QoL	quality of life
R&K	Rechtschaffen & Kales
rACC	rostral anterior cingulate cortex
RAM	reward activation model
RBD	REM sleep behavior disorder
RBDSS	RBD Severity Scale
rCBF	regional cerebral blood flow
RCT	randomized controlled trial
RDI	respiratory disturbance index
REM	rapid eye movement
RERA	respiratory-effort-related arousal
RF	reticular formation
RFM	rhythmic foot movement
RIA	radioimmunoassay
RIP	respiratory inductive plethysmography
RISP	recurrent isolated sleep paralysis
RLP	reduced light perception
RLS	restless legs syndrome
RMD	rhythmic movement disorder
RMg	nucleus raphe magnus
RMMA	rhythmic masticatory muscle activity
RSWA	REM sleep without atonia
rtPCR	real-time polymerase chain reaction
RV	residual volume
RWA	REM sleep without atonia
SAHS	sleep apnea–hypopnea syndrome
SaO_2	arterial oxygen saturation
SB	sleep bruxism
SBD	sleep-related breathing disorder
SCA	spinocerebellar ataxia
SCD	sickle cell disease
SCN	suprachiasmatic nucleus
SD	sleep deprivation
SDB	sleep disordered breathing
SE	sleep efficiency
SEP	somatosensory cortical evoked potential
Ser	serotonin
SF-36	36-Item Short Form Health Survey
SFMM	sleep-related faciomandibular myoclonus
sIBM	sporadic inclusion-body myositis
SIDS	sudden infant death syndrome
SLD	sublaterodorsal nucleus
SLE	systemic lupus erythematosus
SMA	spinal muscular atrophy
SMR	sensorimotor rhythm
SN	substantia nigra
SNA	sympathetic neural activity
SNIP	supine vital capacity nasal inspiratory pressure
SNP	single nucleotide polymorphism
SNRI	serotonin and norepinephrine (noradrenaline) reuptake inhibitor
SOL	sleep onset latency
SooS	sudden onset of sleepiness
SOREMP	sleep onset REM period
SOREMS	sleep onset REM sleep
SPECT	single-photon emission computed tomography
SRBD	sleep-related breathing disorder
SRED	sleep-related eating disorder
SRMD	sleep-related movement disorder
SSI	Standard Shiftwork Index
SSRI	selective serotonin reuptake inhibitor
SubC	subcoeruleus nucleus
SUDEP	sudden unexpected death in epilepsy
SUNCT	short-lasting unilateral neuralgiform headache with conjunctival injection and tearing
SW	sleepwalking
SWA	slow-wave activity
SWD	shift work sleep disorder
SWD	sleep–wake disorder
SWS	slow-wave sleep
SXB	sodium oxybate
t-MHA	tele-methylhistamine
T&A	tonsillectomy/adenoidectomy
T2DM	type 2 diabetes mellitus
TAC	trigeminal autonomic cephalalgia
TBI	traumatic brain injury
Th	thalamocortical
TH	tyrosine hydroxylase
THC	Δ^9-tetrahydrocannabinol
TIA	transient ischemic attack
TLC	total lung capacity
TMD	temporomandibular disorder
TMN	tuberomammillary nucleus
TMS	transcranial magnetic stimulation
TNF	tumor necrosis factor
TPM	topiramate
TSH	thyroid-stimulating hormone
TST	total sleep time
TST	total sleep time

TTH	tension-type headache
UA	upper airway
UARS	upper airway resistance syndrome
UES	upper esophageal sphincter
UPPP	uvulopalatopharyngoplasty
VBM	voxel-based morphometry
VC	vital capacity
vGlut2	vesicular glutamate transporter 2
vlPAG	ventrolateral part of the periaqueductal gray matter
VLPO	ventrolateral preoptic nucleus
VNS	vagus nerve stimulation
VNTR	variable number tandem repeat
VPA	valproate
VPSG	video-polysomnography
VRG	ventral respiratory group
VTA	ventral tegmental area
W	wake
WASM	World Association of Sleep Medicine
WASO	wake after sleep onset
WED	Willis–Ekbom disease
ZI	zona incerta

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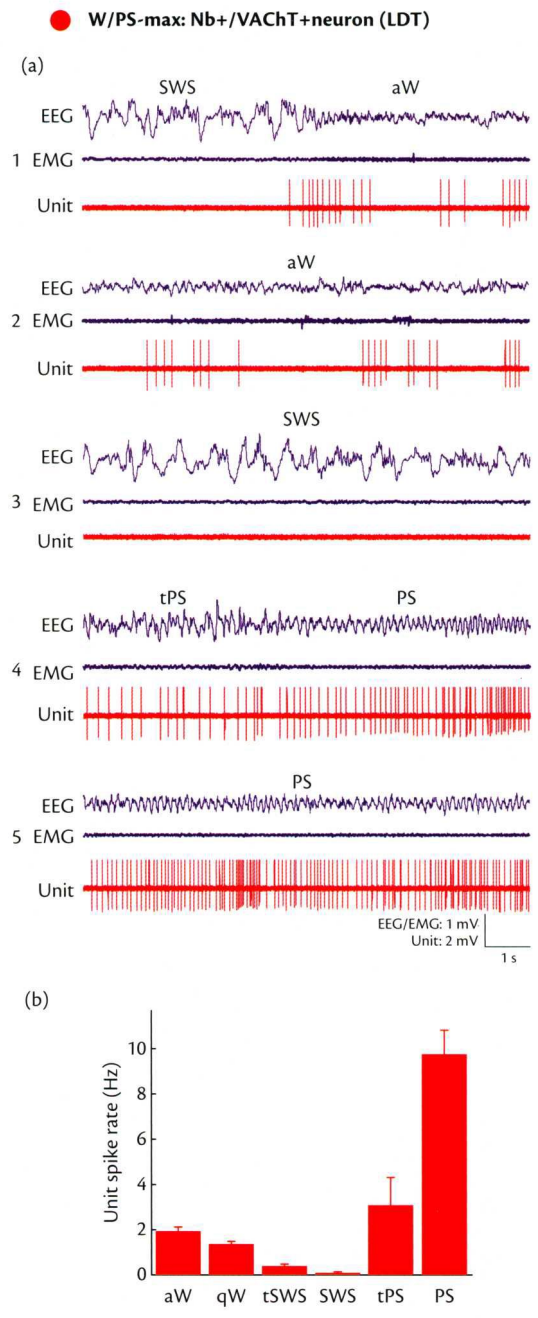

Fig. 4.2 Discharge of cholinergic W/ PS-max active unit across sleep–wake states in rat. Data from a recorded, Neurobiotin (Nb)-labeled cell (#CBS28U03) that was identified as immunopositive for vesicular ACh transporter (VAChT) and located in the LDT. (a) Polygraphic records from 10 s epochs or periods of the unit together with EEG (from retrosplenial cortex) and EMG activity during a transition from SWS to aW (1), aW (2), SWS (3), a transition from tPS to PS (4), and PS (5). (b) Bar graph showing mean spike rate of the unit across sleep–wake stages. Note that during W (2), the unit discharged tonically at a slow rate (1.91 Hz) with prominence of fast EEG activity, ceased firing during SWS (3) (0.06 Hz) in association with slow EEG activity (~1– 4 Hz), and discharged maximally and tonically to reach its highest rates during PS (5) (9.70 Hz) in association with prominent rhythmic theta (~6– 8 Hz) along with fast EEG activity. It changed its rate of discharge prior to cortical activation in the transition from SWS to aW (1) and prior to PS during tPS (4) as EEG activity progresses to theta. The unit discharge was significantly positively correlated with EEG gamma (r = 0.37) along with theta activity (***r*** = 0.93). aW: active wake; qW: quiet wake; tSWS: transition to slow-wave sleep; SWS: slow-wave sleep; tPS: transition to paradoxical sleep; PS: paradoxical sleep.