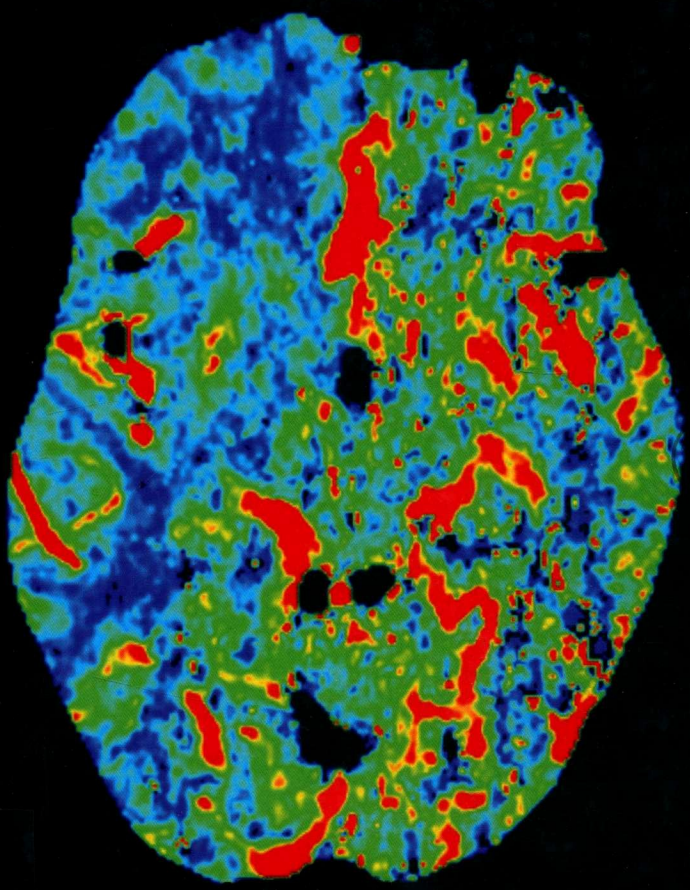
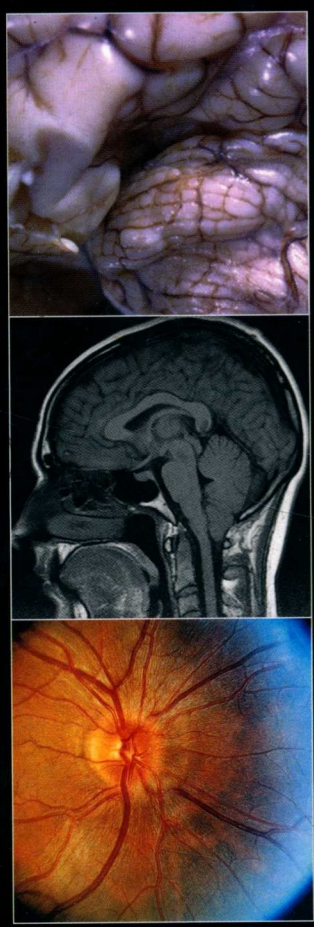
Hankey's CLINICAL NEUROLOGY

Second Edition





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PREFACE

A DECADE HAS PASSED since the first edition of *Clinical Neurology*. Those who have embraced it have encouraged us to update it. The explosion of rigorous scientific evidence for interventions in clinical neurology, coupled with astonishing advances in the clinical neurosciences, have further inspired us to undertake a second edition. As the initial authors (GJH and JMW) are now a decade older and have gravitated toward greater subspecialization, another couple of fellow enthusiasts (PBG and FT) from Grand Rapids and Chicago, USA have joined to facilitate a re-energized, comprehensive, and more global, rather than Anglo–Australian, effort. Together we have enlisted the generosity and specialist expertise of our friends and colleagues throughout the world who are recognized leaders in their field and who have kindly agreed to enlighten us with a chapter on the subject to which they are dedicated.

The subjects and format of the first edition have been maintained and are complemented by the addition of a new chapter on sleep disorders. The chapter covering degenerative diseases of the nervous system has now been subdivided into three main sections, dementias, Parkinson's disease and parkinsonian syndromes, and hereditary ataxias. The cranial neuropathies chapter now includes an entirely new section on neuro-ophthalmology. In addition there are over 440 new illustrations.

The perspective for each chapter is also fresh, as each chapter (with the exception of the chapter on stroke) has been written by one or more of our new contributors, in contrast to the first edition which represented the perspective of GJH and JMW. The purpose of the book, nevertheless, continues to focus on the essentials for students of clinical neurology, particularly neurologists-in-training and practicing neurologists, who wish to have ready access to a comprehensive, up-to-date, and evidence-based guide to the understanding, diagnosis, and management of common and important neurologic disorders.

Many of the illustrations are images taken from our own patients, whom we would like to thank for allowing us to photograph them or the outcome of their investigations. Furthermore, we would also like to thank all the current and past contributors of figures (too many to list individually here) for providing illustrations, as indicated throughout the book. Finally, we would like to thank our families and colleagues for supporting us in this endeavor. We hope you enjoy it and we welcome any comments and criticisms.

Graeme J. Hankey
Joanna M. Wardlaw
Philip B. Gorelick
Fernando D. Testai

DEDICATIONS

I dedicate this book in honor of Mr. Ralph Hauenstein for service to his country and his many generous commitments to the neuroscience programs at Saint Mary's Health Care and the Western Michigan area, and to Sister Myra Bergman for her dedication, devotion and spirited work as a missionary and religious leader in our region and beyond.

Philip B. Gorelick

To my wife, Flavia, for her love, patience, and endless support; to our beautiful children, Sofia and Martin, for being continuous examples of enthusiasm and dedication; to my parents, Ruben and Stella, and sisters, Alejandra and Naiara, for their motivation and support throughout the years; to our neurology residents for having chosen one of the most amazing paths in the medical sciences; and foremost, to our most brilliant mentors – our patients.

Fernando D. Testai

To the memory of my father, the late Dr. John Hankey

Graeme J. Hankey

I am grateful to my family for ongoing support and so dedicate this work to them.

Joanna M. Wardlaw

ABBREVIATIONS

5HT	5-hydroxytryptamine
AA	anaplastic astrocytoma
AAD	atlantoaxial dislocation
AASM	American Association of Sleep Medicine
Aβ	amyloid-β
Aca	aceruloplasminemia
ACE	angiotensin-converting enzyme
ACE-R	Addenbrooke's Cognitive Examination Revised
AChR	acetylcholine receptors
ACTH	adrenocorticotropic hormone
AD	Alzheimer's disease
ADAMTS	a disintegrin and metalloprotease with thrombospondin motif
ADC	apparent diffusion coefficient
ADCA	autosomal dominant cerebellar ataxia
ADEM	acute disseminated encephalomyelitis
ADHD	attention deficit hyperactivity disorder
ADL	activities of daily living/adrenoleukodystrophy
ADLP	adrenoleukodystrophy protein
ADP	adenosine diphosphate
AED	antiepileptic drug
AF	atrial fibrillation
AFB	acid-fast bacilli
AFP	alpha-fetoprotein
AHI	apnea/hypopnea index
AICA	anterior inferior cerebellar artery
AIDP	acute inflammatory demyelinating polyradiculoneuropathy
AIDS	aquired immunodeficiency syndrome
AION	anterior ischemic optic neuropathy
AIP	acute intermittent porphyria
ALD	adrenoleukodystrophy
ALDP	adrenoleukodystrophy protein
ALS	amyotrophic lateral sclerosis
ALT	alanine aminotransferase
AMAN	acute motor axonal neuropathy
AML	angiomyolipoma
AMN	adrenomyeloneuropathy
(c)AMP	(cyclic) adenosine monophosphate
AMSAN	acute motor and sensory axonal neuropathy
ANCL	adult neuronal ceroid lipofuscinoses
AO	anaplastic oligodendroglioma
AOA	oligoastrocytoma
ApoE	apolipoprotein E
APP	amyloid precursor protein
APS	antiphospholipid syndrome
aPTT	activated partial thromboplastin time
ARAS	ascending reticular activating system
ARDS	adult respiratory distress syndrome
ARI	absolute risk increase
ARR	absolute risk reduction
ARSA	arylsulfatase A
ARSACS	autosomal recessive spastic ataxia of Charlevoix–Saguenay
ARX	Aristaless-related homeobox
ASA	atrial septal aneurysm
ASD	atrial septal defect
AST	aspartate aminotransferase
AT	ataxia telangiectasia
ATM	acute transverse myelitis
AVM	arteriovenous malformation
AVS	acute vestibular syndrome
AZA	azathioprine
BAEP	brainstem auditory evoked potential
BAL	British anti-Lewisite
BBS	Bardet–Biedl syndrome
BDNGF	brain-derived nerve growth factor
BF	blood flow
bFGF	basic fibroblast growth factor
BHC	benign hereditary chorea
BMD	Becker's muscular dystrophy
BMI	body mass index
BNCT	boron neutron capture therapy
BP	blood pressure
BPAP	bilevel positive airways pressure
BPPV	benign paroxysmal positional vertigo
BSE	bovine spongiform encephalopathy
BSK	Barbour–Stoenner–Kelly
BWSTT	body weight supported treadmill training
CADASIL	cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopthy
CAM	computer assisted myelography
CAS	carotid artery stenting
CBD	corticobasal degeneration
CBF	cerebral blood flow
CBS	corticobasal syndrome/cystathionine β-synthase deficiency
CBT	cognitive behavioral therapy
CDC	Centers for Disease Control and Prevention
CEA	carotid endarterectomy/carcinoembryonic antigen
cEEG	continuous electroencephalography
CE-MRA	contrast-enhanced magnetic resonance angiography
CGRP	calcitonin gene-related peptide
CI	confidence interval/cholinesterase inhibitor
CIDP	chronic inflammatory demyelinating polyneuropathy
CIM	critical illness myopathy
CIMT	constraint-induced movement therapy
CIP	critical illness polyneuropathy
CIS	clinically isolated syndrome
CISC	clean intermittent self-catheterization

(f/i/s/v)CJD	(familial/iatrogenic/sporadic/variant) Creutzfeldt–Jakob disease
CK	creatine kinase
CLAM	cholesterol-lowering agent
CM	congenital myopathy
CMAP	compound muscle action potential
CMD	congenital muscular dystrophy
CMT	Charcot–Marie–Tooth disease
CMV	cytomegalovirus
CNS	central nervous system
COACH	cerebellar vermis hypo/aplasia, oligophrenia, ataxia congenital, coloboma, and hepatic fibrosis
COMT	catechol-O-methyltransferase
CORS	cerebello-oculo-renal syndrome
COX	cyclo-oxygenase
CPA	cerebello-pontine angle
CPAP	continuous positive airway pressure
CPK	creatine phosphokinase
CPM	central pontine myelinolysis
CPP	cerebral perfusion pressure
Cr	creatinine
CRAO	central retinal artery occlusion
CRP	C-reactive protein
CRVO	central retinal vein occlusion
CS	Cowden's syndrome
CSA	central sleep apnea
CSF	cerebrospinal fluid
CT	computed tomography
CTA	computed tomography angiography
CTV	computed tomography venography
CV	color vision
CVA	cerebrovascular accident
CVT	cerebral venous thrombosis
DAI	diffuse axonal injury
DALY	disability-adjusted life year
DBS	deep-brain stimulation
DFA	direct immunofluorescent antibody
DGC	dystrophin glycoprotein complex
DIC	disseminated intravascular coagulation
DLB	dementia with Lewy bodies
DMD	Duchenne's muscular dystrophy
DNA	deoxyribonucleic acid
DNET	dysembryoplastic neuroepithelial tumor
DRPLA	dentato-rubro-pallido-luysian atrophy
DSA	digital subtraction cerebral angiography
DSPN	distal symmetric polyneuropathy
DUB	deubiquitinating enzyme
DVT	deep vein thrombosis
DWI	diffusion-weighted imaging
EACA	epsilon-aminocaproic acid
EBRT	external beam radiation therapy
EBV	Epstein–Barr virus
ECG	electrocardiogram/electrocardiography
ECT	electroconvulsive therapy
EDH	extradural hematoma
EEG	electroencephalography
EGF(R)	epidermal growth factor (receptor)
EIAC	enzyme-inducing anticonvulsant
EITB	enzyme-linked immunoelectrotransfer blot assay
ELISA	enzyme-linked immunosorbent assay
EM	erythema migrans
EMD	Emery–Dreifuss muscular dystrophy
EMG	electromyography
EOG	electro-oculogram
EPP	endplate potential
EPT	enhanced physiologic tremor
ER	extended-release
ERG	electroretinography
ESR	erythrocyte sedimentation rate
ESRD	end-stage renal disease
ET	essential tremor
EV	Eustachian valve
EVD	extraventricular drain
FA	Friedreich's ataxia
FAST	Functional Assessment Staging Test
FDA	Food and Drug Administration
FES	functional electrical stimulation
FFI	fatal familial insomnia
FHM	familial hemiplegic migraine
FIESTA	fast imaging employing steady state acquisition sequence
FLAIR	fluid attenuated inversion recovery
FMD	fibromuscular dysplasia
FSHD	facioscapulohumeral muscular dystrophy
FTA	fluorescent treponemal antibody
FTD	frontotemporal dementia
FTLD	frontotemporal lobar degeneration
FVC	forced vital capacity
FXTAS	fragile X-associated tremor/ataxia syndrome
GABA	gamma-aminobutyric acid
GAD	glutamic acid decarboxylase
GALC	galactocerebrosidase
GBM	glioblastoma multiforme
GBS	group B streptococci/Guillain–Barré syndrome
GCI	glial cytoplasmic inclusion
GCS	Glasgow Coma Scale
GCSE	generalized convulsive status epilepticus
GCT	undifferentiated germinoma
GFR	glomeruler filtration rate
Glut 1	glucose transporter type 1 (deficiency)
GMP	guanosine monophosphate
GPi	globus pallidus internus
GSS	Gerstmann–Straüssler–Scheinker syndrome
GTN	glyceryl trinitrate
GTP	guanosine triphosphate
H&E	hematoxylin and eosin
HAART	highly-active antiretroviral therapy
HAM/TSP	HTLV-associated myelopathy/tropical spastic paraparesis
HANAC	hereditary angiopathy, nephropathy, aneurysm, and muscle cramps
HARP	hypoprebetalipoproteinemia, acanthocytes, retinitis pigmentosa, pallidal degeneration
HCD	hepatocerebral degeneration
HCG	human chorionic gonadotropin
HCP	hereditary coproporphyria

HD	Huntington's disease
HDL	Huntington disease-like
HE	hepatic encephalopathy
HELLP	hemolysis, elevated liver enzymes, low-platelet count syndrome
HHT	hereditary hemorrhagic telangiectasia (Osler–Rendu–Weber syndrome)
HHV	human herpesvirus
hIBM	hereditary inclusion body myopathy
HIF	hypoxia-inducible factor
HIS	head impulse sign
HIT	horizontal head impulse test
HIV	human immunodeficiency virus
HLA	human leukocyte antigen
HNPP	hereditary neuropathy with liability to pressure palsies
HPE	holoprosencephaly
HR	hazard ratio/heart rate
HRIG	human rabies immune globulin
HSP	hereditary spastic paraparesis
HSV	herpes simplex virus
HTIG	human tetanus immune globulin
HTLV	human T-lymphotropic virus
hyperPP	hyperkalemic periodic paralysis
hypoPP	hypokalemic periodic paralysis
HZV	herpes zoster virus
IBM	inclusion body myositis
IBPN	immune-mediated brachial plexus neuropathy
ICA	internal carotid artery
ICCA	infantile convulsions and choreoathetosis
ICH	intracerebral hemorrhage
ICP	intracranial pressure
ICU	Intensive Care Unit
ICVT	intracranial cerebral venous thrombosis
IF	intrinsic factor
Ig	immunoglobulin
IGF	insulin-like growth factor
IGRA	interferon-γ release assay
IIH	idiopathic intracranial hypertension
IL	interleukin
ILAE	International League against Epilepsy
ILOCA	idiopathic late onset cerebellar ataxia
INO	internuclear ophthalmoplegia
INR	international normalized ratio
ION	ischemic optic neuropathy
IOP	intraocular pressure
IPC	intermittent pneumatic compression
IPV	inactivated poliovirus vaccine
IRIS	immune reconstitution inflammatory syndrome
IVIG	intravenous immune globulin
JCV	John Cunningham virus
JME	juvenile myoclonic epilepsy
KBS	Klüver–Bucy syndrome
KD	Krabbe disease
KSS	Kearns–Sayre syndrome
LAA	left atrial appendage
LCMV	lymphocytic choriomeningitis virus
LD	Lhermitte–Duclos disease
LDL	low-density lipoprotein
LEMS	Lambert–Eaton myasthenic syndrome
LFT	liver function testing
LGG	low-grade glioma
LGMD	limb-girdle muscular dystrophy
LGV	lymphogranuloma venereum
LHON	Leber's hereditary optic neuropathy
LITAF	lipopolysaccharide-induced tumor necrosis factor-alpha factor
LLN	lower limit of normal
LMN	lower motor neuron
LNS	Lesch Nyhan syndrome
LNSS	linear nevus sebaceous syndrome
LMWH	low-molecular weight heparin
LOC	loss of consciousness
LP	lumbar puncture
LS	Leigh syndrome
LTBI	latent tuberculous infection
MAO	monoamine oxidase
MAP	mean arterial pressure
MAPT	microtubule-associated tau gene
MBP	myelin basic protein
MCA	middle cerebral artery
MCI	mild cognitive impairment
MCP	middle cerebellar peduncle
MCPH	microcephaly
MCTD	mixed connective tissue disease
MEG	magnetoencephalography
MELAS	mitochondrial encephalomyopathy, lactic acidosis, and stroke-like episodes
MEP	motor evoked potential
MERRF	myoclonic epilepsy with ragged red fibers
MFAP	muscle fiber action potential
MFS	Miller–Fisher syndrome
MHA-TP	microhemagglutination for antibodies to *Treponema pallidum*
MG	myasthenia gravis
MGMT	methylguanine-DNA methyltransferase
MIP	maximum intensity projection/maximal inspiratory pressure
MJD	Machado–Joseph disease
MLD	metachromatic leukodystrophy
MLF	medial longitudinal fasciculus
MMF	mycophenolate mofetil
MMR	mumps, measles, rubella
MMSE	Mini Mental State Examination
MND	motor neuron disease
MoCA	Montreal Cognitive Assessment
MOTSA	multiple overlapping thin-slab acquisition
MPR	multi-planar reformat
MRA	magnetic resonance angiography
MRI	magnetic resonance imaging
mRS	Modified Rankin Score
MRSA	methicillin-resistant *Staphylococcus aureus*
MRV	magnetic resonance venography
MS	multiple sclerosis
MSA	multiple system atrophy
MSLT	Multiple Sleep Latency Test

MSM	men who have sex with men
MSPNST	malignant peripheral nerve sheath tumor
MTHFR	methylenetetrahydrofolate reductase
MTR	methionine synthase
MUP	motor unit action potential
MuSK	muscle-specific receptor tyrosine kinase
MUT	methylmalonyl-CoA mutase
MWT	Maintenance of Wakefulness Test
MZ	monozygotic/marginal zone
NAAT	nucleic acid amplication testing
NAc	neuroacanthocytosis
NAD	nicotinamide adenine dinucleotide
NADP	nicotinamide adenine dinucleotide phosphate
NAION	nonarteritic anterior ischemic optic neuropathy
NARP	neurogenic weakness with ataxia and retinitis pigmentosa
NBIA	neurodegeneration with brain iron accumulation
NCL	neuronal ceroid lipofuscinosis
NCS	nerve conduction studies
NCSE	nonconvulsive status epilepticus
NDT	neurodevelopmental therapy
NF	neuroferritinopathy
NF-1	neurofibromatosis 1
NFT	neurofibrillary tangle
NFG	nerve growth factor
NFLE	nocturnal frontal lobe epilepsy
NGGCT	nongerminoma
NHL	non-Hodgkin's lymphoma
NIF	negative inspiratory pressure
NIH-SS	National Institutes of Health Stroke Scale
NIID	neuronal intranuclear inclusion disease
NMDA	*N*-methyl-D-aspartate
NMJ	neuromuscular junction
NMO	neuromyelitis optica
NMS	neuroleptic malignant syndrome
NO	nitrous oxide
NPC	Niemann–Pick type C
NPH	normal pressure hydrocephalus
NPHP	nephronophthisis
NSE	neuron-specific enolase
NTD	neural tube defect
O-AA	organic amino aciduria
OAA	oculomotor apraxia
OCD	obsessive compulsive disorder
ONH	optic nerve head
OP	opening pressure
OPCA	olivopontocerebellar atrophy
OPV	oral poliovirus vaccine
OR	odds ratio
OSA	obstructive sleep apnea
OTR	ocular tilt reaction
PA	pernicious anemia
PACI	partial anterior circulation infarct
PACS	partial anterior circulation syndrome
PAF	pure autonomic failure
PAM	potassium aggravated myotonia
PAS	para-aminosalicylic acid/periodic acid–Schiff
PC	phase contrast
PCD	paraneoplastic cerebellar degeneration
PCNSL	primary CNS lymphoma
PCom	posterior communicating artery
PCR	polymerase chain reaction
PCV	vincristine
PD	Parkinson's disease
PDD	Parkinson's disease dementia
PDGF	platelet-derived growth factor
PDW	proton density-weighted
PE	plasma exchange
PEG	percutaneous endoscopic gastrostomy
PEM	paraneoplastic encephalomyelitis
PEO	progressive external ophthalmoplegia
PET	positron emission tomography
PFK	phosphofructokinase
PFO	patent foramen ovale
PION	posterior ischemic optic neuropathy
Pi-TON	posterior indirect traumatic optic neuropathy
PKAN	pantothenate kinase-associated neurodegeneration
PLED	periodic lateralized epileptiform discharge
PLEX	plasmapheresis
PLM	periodic leg movement
PLMD	periodic leg movement disorder
PMA	progressive myoclonic ataxia
PME	progressive myoclonic epilepsy
PML	progressive multi-focal leukoencephalopathy
PMN	polymorphonuclear
PMzD	Pelizeaus–Merzbacher disease
PNET	primitive neuroectodermal tumor
PNFA	progressive nonfluent aphasia
POCI	posterior circulation infarct
POCS	posterior circulation syndrome
POEMS	polyneuropathy, organomegaly, endocrinopathies, M-protein, skin changes including thickening and hyperpigmentation, clubbing of the fingers
POST	positive occipital sharp transients of sleep
POVL	postoperative visual loss
PP	preplate zone/perfusion pressure
PPA	primary progressive aphasia
PPRF	paremedian pontine reticular formation
PRES	posterior reversible encephalopathy syndrome
PRG	pontine respiratory group
PrP	prion protein
PSN	paraneoplastic sensory neuropathy
PSP	progressive supranuclear palsy
PSV	peak systolic velocity
PSWC	periodic sharp wave complex
PTH	parathyroid hormone
PTSD	post-traumatic stress disorder
PWI	perfusion-weighted imaging
PXA	pleomorphic xanthoastrocytoma
PXE	pseudoxanthoma elasticum
RBC	red blood cell
RCT	randomized controlled trial
RCVS	reversible cerebral vasoconstriction syndrome
RDI	respiratory disturbance index
REM	rapid eye movement
RERA	respiratory event-related arousal

RF	resistance to flow
rFVIIa	recombinant activated factor VII
RLS	right-to-left shunt/restless legs syndrome
RMSF	Rocky Mountain spotted fever
RNA	ribonucleic acid
RNS	repetitive nerve stimulation
ROM	range-of-motion
RPR	rapid plasma reagin
RR	risk ratio/relative risk
RRR	relative risk reduction
(r)-tPA	(recombinant) tissue plasminogen activator
SAM	S-adenosyl-methionine
SC	Sydenham's chorea
SCA	spinocerebellar ataxia
SCC	semicircular canal
SCD	subacute combined degeneration
SCI	spinal cord injury
SCLC	small-cell lung carcinoma
SCN	suprachiasmatic nucleus
$ScvO_2$	central venous oxygen saturation
SD	semantic dementia
SDB	sleep-related breathing disorder
SDS	Shy–Drager syndrome
SE	status epilepticus
SEGA	subependymal giant cell astrocytoma
SFEMG	single fiber electromyography
SGCT	subependymal giant cell tumor
SIADH	syndrome of inappropriate antidiuretic hormone
SIBM	sporadic inclusion body myositis
SIS	second impact syndrome
SISCOM	subtraction ictal SPECT coregistered to MRI
SLE	systemic lupus erythematosus
SMA	spinal muscular atrophy
SMN	survival of motor neuron
SNAP	sensory nerve action potential
SND	striatonigral degeneration
SOD	septo-optic dysplasia
SOREMP	sleep onset REM period
SPECT	single photon emission tomography
SSCP	single-stranded conformational polymorphism
SSEP	somatosensory evoked potential
SSPE	subacute sclerosing panencephalitis
SSRI	selective serotonin-reuptake inhibitor
SSS	superior sagittal sinus/Scandinavian Stroke Scale
SUDEP	sudden unexplained death in epilepsy
SVV	subjective visual vertical
SVZ	subventricular zone
SW	Sturge–Weber syndrome
SWI	susceptibility-weighted imaging
TA	temporal arteritis
TAB	temporal artery biopsy
TACI	total anterior circulation infarct
TACS	total anterior circulation syndrome
TAO	thyroid-associated ophthalmopathy
TB	tuberculosis
TBI	traumatic brain injury
TCD	transcranial Doppler ultrasonography
TCS	tuberous sclerosis complex
TGF	transforming growth factor
THB	tetrahydrobiopterin
TIA	transient ischemic attack
TMJ	temporomandibular joint
TMP–SMX	trimethoprim–sulfamethoxazole
TN	trigeminal neuralgia
TNF	tumor necrosis factor
TOAST	Trial of Org 10172 in Acute Stroke Treatment
TOE	trans-esophageal echocardiography
TOF	time-of-flight
TPHA	*Treponema pallidum* particle agglutination assay
TS	Tourette's syndrome
TSE	turbo spin echo/transmissible spongiform encephalopathy
TSH	thyroid stimulating hormone
TST	thermoregulatory sweat test
TTE	transthoracic echocardiography
TTR	time in therapeutic range/transthyretin
UBO	unidentified bright object
UFH	unfractionated heparin
ULN	upper limit of normal
UMN	upper motor neuron
VA	visual acuity
VaD	vascular dementia
VAPP	vaccine-associated paralytic poliomyelitis
VLDL	very low-density lipoprotein
VDRL	Venereal Disease Research Laboratory
V-EEG	video electroencephalography
VEGF	vascular endothelial growth factor
VEMP	vestibular evoked potential
VEP	visual evoked potential
VF	visual field
VGCC	voltage-gated calcium channel
VHL	von Hippel–Lindau disease
VKA	vitamin K antagonist
VLCFA	very long-chain fatty acid
VLM	ventrolateral medulla
VNG	video-nystagmography
VNS	vagal nerve stimulation
VOR	vestibulo-ocular reflex
VP	vascular parkinsonism/variegate porphyria
VPM	ventral posteromedial
VR	volume rendered
VSGP	vertical supranuclear gaze palsy
VSR	vestibulospinal reflex
VTE	venous thromboembolism
vWF	von Willebrand factor
VWFCP	von Willebrand factor-cleaving protease
VZ	ventricular zone
VZV	varicella-zoster virus
WBC	white blood cell
WBRT	whole brain radiation therapy
WD	Wilson's disease
WHO	World Health Organization
WNV	West Nile virus
XP	xeroderma pigmentosum

CONTENTS

HANKEY'S SECOND EDITION

CLINICAL NEUROLOGY

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