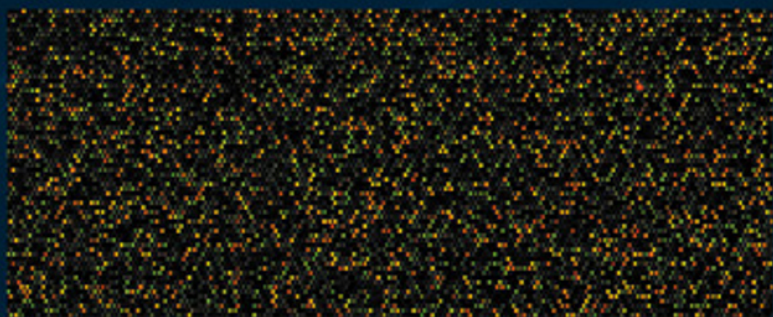
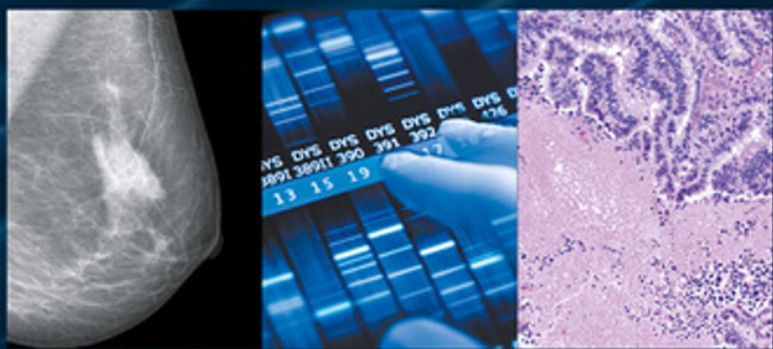
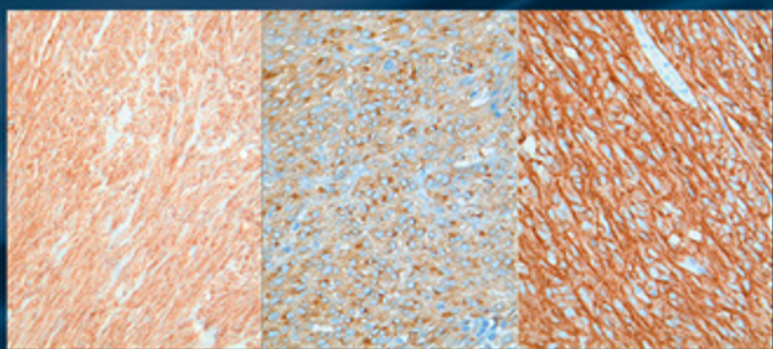


FIFTH EDITION

TEXTBOOK OF **UNCOMMON CANCER**



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Textbook of Uncommon Cancer

In Memoriam: MARK R. GREEN, MD (1945–2015)



We note, with great sadness, the passing of Mark Green MD, one of the founding editors of *Textbook of Uncommon Cancer*. In the mid-1980s, Christopher Williams, John Krikorian, Derek Raghavan, and Mark Green met at ASCO for a drink after the sessions had finished for the day. During a long and friendly discussion about patterns of practice in the USA, UK, and Australia, and other items of interest, it became clear that a common challenge was the occasional, and repeated, expenditure of much time in literature searches when members of the quartet, and their colleagues, were managing rare or uncommon cancers. Under the leadership of Christopher Williams, the first *Textbook of Uncommon Cancer* was born, and Mark contributed extensively to the design and execution of this landmark book, editing many chapters within his domains of interest. Over time, the textbook has been reprised, and while having had too many competing responsibilities to continue his editorial role, Mark retained a strong interest in the book, and followed the progress of each edition closely. We have lost a friend, colleague, and mentor with his passing. A trait that we remember so well was the conviviality, enthusiasm, and amazing and detailed knowledge of oncology that characterized Mark.

Mark was a consummate and skilled clinician researcher. Born on January 13, 1945 in Norwalk, Connecticut, the son of a physician, he decided early in life that he wished to take on a career in medicine. He received his BA and MD from Harvard University and trained at Beth Israel Hospital (Boston) and then at the National Cancer Institute and Stanford University. In 1976, he joined the faculty of the cancer center at UC San Diego, and served as Director. In 1986, he led a team that gained NCI designation for the first time. A decade later, after steering an extraordinary team of clinical and translational researchers, he took on the role of Director of the Hollings Cancer Center and Mary M. Gilbreth Professor of Oncology at the Medical University of South Carolina, Charleston. He also served for decades as the leader of the Respiratory Committee of CALGB, leading major national trials and publishing paradigm shifting data extensively. Mark also served as a member of the American Board of Internal Medicine subspecialty Board of Medical Oncology from 1989 to 1999, serving as its Chair from 1995 to 1999. After retiring from his role as Director of the Hollings Cancer Center in 2004, he served as Medical Director of the Network for Medical Communication and Research, and then was appointed as chief medical officer of Xcenda and Vice President of the Xcenda Oncology Insights Consulting Practice in 2007. To honor his memory and contributions, the Mark R. Green MD Distinguished Endowed Visiting Professorship in Thoracic Oncology is maintained at MUSC. Mark has left behind his loving wife, Judith, two daughters, and a close family, and many, many friends. This fifth edition of TUC is dedicated to his work, career, and memory.

Textbook of Uncommon Cancer

FIFTH EDITION

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The right of D. Raghavan, M.S. Ahluwalia, C.D. Blanke, J. Brown, E.S. Kim, G.H. Reaman, and M.A. Sekeres to be identified as the editors of this work has been asserted in accordance with law.

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Dedications

The editors collectively dedicate this book to our colleague, and member of the founding editorial panel, Mark R. Green, MD.

To my children, Aisha and Angad, and my wife Harneet, for their affection and support; to my mother and mentors for their guidance; and to my patients for their inspiration. *Manmeet Ahluwalia*

To my friends, family, and SWOG. *Charles D. Blanke*

To my courageous patients and to the loves of my life: Wendel Naumann; Elizabeth Joan Robinson; and William David Robinson. Thank you for your patience and love. *Jubilee Brown*

To my father, Professor David Jaiman Kim, my mother Deborah Yong Ae Kim, my brother Donald Sunghyun Kim, my lovely wife Dr Haesue Florence Kim, and my wonderful children Elyssa and Alexander. You all define my happiness. *Edward S. Kim*

To Judy, Nicky, Stephanie, Megan, and Eric, for their constant support, friendship, inspiration, and tolerance of the life of an academic oncologist, and to four decades of patients for their courage and determination. *Derek Raghavan*

To Susan, Emily, and Sarah, for their support and to the children afflicted by rare cancers and their families who will always be a source of inspiration and motivation. *Gregory H. Reaman*

To my children, Gabriel, Samantha, and Silas, and to my wife Jennifer, for their love, support, and forbearance in this life I've chosen; to my parents and teachers, I'll always need your guidance; and to my patients, you still inspire me. *Mikael A. Sekeres*

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Preface

Nearly 30 years after the publication of the first edition of *Textbook of Uncommon Cancer*, a reconstituted editorial panel has taken on the task of updating the extant information on this increasingly important topic. Although there remains a paucity of level 1 trial data, partly because of small patient numbers and partly because of a lack of structured interest in collaborative research in these domains, the amount of available information has begun to increase. National and international health organizations are beginning to focus on the plight of patients with uncommon and unusual cancers, and have developed websites and other tools to provide information, access to treatment, and other assistance. Even government health agencies are beginning to grapple with this complex set of issues.

The biomedical community has begun to adapt the tools of molecular diagnosis to improve the characterization of uncommon cancers, and thus to attempt to develop targeted therapeutic agents, in some cases with substantial success. In parallel, structured management algorithms are being developed that assist in focusing our efforts on behalf of patients with these problems, including mechanisms to allow isolated patients and clinicians to collaborate with

real experts and centers of excellence, including the use of electronic tumor boards, distributed bio-repositories, and the creation of treatment pathways for some uncommon malignancies. Gradually the bar is being raised on the nature of publication, with increasing focus on case series from centers of excellence or cooperative groups, and perhaps a reduction in publication of isolated and unvalidated case reports in the high-tier peer-reviewed medical press.

In this edition of our book, we have added sections on social support, updated extensively the information on molecular characterization and diagnosis, and have focused heavily on innovations in surgery, radiotherapy, and systemic treatment, with a focus on novel and targeted agents and immunotherapeutics.

As in the past, our families and our support teams have made the sacrifices necessary to facilitate the writing and editing of a large textbook, and we appreciate them greatly, but also recognize that it is really not enough just to thank them all for their support, affection, and forbearance. Hopefully the knowledge that this book will help thousands of patients and families dealing with the plight of the fight against an uncommon cancer will help to thank them.

Abbreviations

2D-RT	two-dimensional radiotherapy	allo-SCT	allogeneic stem cell transplantation
3D-CRT	three-dimensional conformal radiotherapy	ALPL	alkaline phosphatase
AA	aplastic anemia	A2M	α 2-macroglobulin
ABC	adenoid basal carcinoma	AMACR	α -methyl-CoA racemase
ABMTR	American Bone Marrow Transplant Registry	AMH	antimüllerian hormone
ABVD	adriamycin, bleomycin, vinblastine, and dacarbazine	AMKL	acute megakaryoblastic leukemia
AC	adenocarcinoma/atypical carcinoid	AML	acute myeloid leukemia/angiomyolipoma
ACA	adrenocortical adenoma	anti-PD-1	antiprogrammed cell death 1
ACC	acinar cell carcinoma/adenoid cystic carcinoma/adrenocortical carcinoma	AP	accelerated phase
aCML	atypical chronic myeloid leukemia	APC	adenomatous polyposis coli
ACOSOG	American College of Surgeons Oncology Group	APR	abdominoperineal resection
aCPP	atypical choroid plexus papilloma	APUD	amine precursor uptake and decarboxylation
ACS	American Cancer Society	APW	absolute percentage washout
ACT	adrenocortical tumor	AR	androgen receptor
ACTH	adrenocorticotrophic hormone	ara-C	cytarabine
ACVBP	doxorubicin, cyclophosphamide, vindesine, bleomycin, and prednisone	ara-G	9- β -arabinofuranosyl guanine
ADAM	Arginine Deiminase and Mesothelioma (trial)	ART	adenocarcinoma of the rete testis
ADC	apparent diffusion coefficient	AS	angiosarcoma
ADCC	antibody-dependent cellular cytotoxicity	ASC	adenosquamous carcinoma/atypical squamous cells
ADH	antidiuretic hormone	ASCR	autologous stem cell rescue
ADI-PEG20	pegylated arginine deiminase	ASCT	autologous stem cell transplant
ADOC	adriamycin, cisplatin, cyclophosphamide, and vincristine	ASM	aggressive systemic mastocytosis
AEs	adverse events	ASPS	alveolar soft part sarcoma
AFH	angiomatoid fibrous histiocytoma	ASR	age-standardized rate
AFIP	Armed Forces Institute of Pathology	ASS1	argininosuccinate synthetase 1
AFP	α -fetoprotein	AT/RT	atypical teratoid/rhabdoid tumor
AFPGC	α -fetoprotein-producing gastric carcinoma	ATC	anaplastic thyroid carcinomas
AFX	atypical fibroxanthoma	ATG	antithymocyte globulin
AGA	American Gastroenterological Association	ATP	adenosine triphosphate
AI	aromatase inhibitor/doxorubicin and ifosfamide	ATS	American Thoracic Society
AIDS	acquired immunodeficiency syndrome	AUC	area under the curve
AIS	adenocarcinoma <i>in situ</i>	AVL	atypical vascular lesions
AJCC	American Joint Committee on Cancer	BAC	bronchioalveolar carcinoma
AKT	protein kinase B/serine/threonine-protein kinase	BAP1	<i>BRCA1</i> -associated protein 1
ALA	American Lung Association	BAT	best available therapy
5-ALA	5-aminolevulinic acid	BBB	blood–brain barrier
ALCL	anaplastic large cell lymphoma	BC	blast crisis
ALK	anaplastic lymphoma kinase	BCC	basal cell carcinoma
ALL	acute lymphoblastic leukemia	BCG	bacillus Calmette–Guérin
		BCM	breast cancer in men
		BCOP	Breast Outcomes Database
		BCS	breast conserving surgery
		BD-IPMN	branch duct intraductal papillary mucinous neoplasm
		BED	biologically effective dose
		BEP	bleomycin, etoposide, and cisplatin
		bFGF	basic fibroblast growth factor

bid	twice daily	CHOP	cyclophosphamide, doxorubicin, vincristine, and prednisone
BiIN	biliary intraepithelial neoplasm	CHOPR	cyclophosphamide, doxorubicin, vincristine, prednisone, and rituximab
BMF	bone marrow failure	CI	confidence interval
BML	benign metastasizing leiomyoma	CIBMTR	Center for International Blood and Marrow Transplant Research
BMM	bone marrow mastocytosis	CIN	cervical intraepithelial neoplasia
BOT	borderline ovarian tumor	CIS	carcinoma <i>in situ</i>
BPH	benign prostatic hyperplasia	CK	cytokeratin
BS	breast sarcomas	CLARINET	Controlled Study of Lanreotide Antiproliferative Response in Neuroendocrine Tumors
BSO	bilateral salpingo-oophorectomy	CLL	chronic lymphoblastic leukemia/chronic lymphocytic leukemia
BTK	Bruton tyrosine kinase	CMF	cyclophosphamide, methotrexate, and 5-fluorouracil
BTTP	British Testicular Tumour Panel	CML	chronic myelocytic leukemia
BWH/DFCI	Brigham and Women's Hospital/Dana-Farber Cancer Institute	CMML	chronic myelomonocytic leukemia
BWS	Beckwith–Weidemann syndrome	CMN	congenital mesoblastic nephroma
CA4P	combretastatin A4 phosphate	CMV	cytomegalovirus
CA19-9	carbohydrate antigen 19-9	CNL	chronic neutrophilic leukemia
C-ALCL	cutaneous anaplastic large cell lymphoma	CNS	central nervous system
CALGB	Cancer and Leukemia Group B	COG	Children's Oncology Group
CAN	copy number alteration	COMFORT-I	Controlled Myelofibrosis Study with Oral JAK Inhibitor Therapy
CAP	cyclophosphamide, doxorubicin, and cisplatin	COMS	Collaborative Ocular Melanoma Study
CAPOX	capecitabine and oxaliplatin	COX-2	cyclooxygenase-2
CAR	chimeric antigen receptor	CP	chronic phase/craniopharyngioma
CASR	calcium-sensing receptor	CPAM	congenital pulmonary airway malformation
CASTLE	carcinoma showing thymus-like differentiation	CPC	choroid plexus carcinoma
CBF	core-binding factor	CPP	choroid plexus papilloma
CBTRUS	Central Brain Tumor Registry of the United States	CPT	choroid plexus tumor
CCA	clear cell adenocarcinoma	CR	complete remission/complete response
CCAM	congenital cystic adenomatoid malformation	CR1	first complete remission
CCC	clear cell carcinoma	CRC	colorectal carcinoma
CCG	Children's Cancer Group	CrCl	creatinine clearance
CCNU	lomustine (1-(2-chloroethyl)-3-cyclohexyl-1-nitrosurea)	CRH	corticotropin-releasing hormone
CCOC	clear cell ovarian carcinoma	CROSS	Chemoradiotherapy for Oesophageal Cancer Followed by Surgery Study
CCP-RCC	clear cell papillary renal cell carcinoma	CRT	conformal radiotherapy
CCSK	clear cell sarcoma of the kidney	CsA	cyclosporine
CCST	clear cell "sugar" tumor	CSF	cerebrospinal fluid
CCyR	complete cytogenetic response	CSF3R	colony-stimulating factor receptor
CD	celiac disease/cluster of differentiation	CSI	craniospinal irradiation
CDC	collecting duct carcinoma	CSS	cancer-specific survival
CDK	cyclin-dependent kinase	CT	computed tomography
CEA	carcinoembryonic antigen	CTLA	cytotoxic T lymphocyte antigen
CECT	contrast-enhanced computed tomography	CTLA-4	cytotoxic T lymphocyte-associated molecule-4
CEL-NOS	chronic eosinophilic leukemia – not otherwise specified	CTV	clinical target volume
CERN	Collaborative Ependymoma Research Network	CVP	cyclophosphamide, vincristine, and prednisone
CgA	chromogranin A	CyBorD	cyclophosphamide, bortezomib, and dexamethasone
CGCL	central giant cell lesion	CYFRA	cytokeratin 19
CGD-TCL	cutaneous $\gamma\delta$ T cell lymphoma	DBA	Diamond–Blackfan anemia
CGE	cobalt-Gray equivalent	DCE	dynamic contrast enhanced
CGH	comparative genomic hybridization		
CGI	cisplatin, gemcitabine, and ifosfamide		
CGNP	cerebellar granule neuron precursors		
CHOEP	cyclophosphamide, doxorubicin, etoposide, vincristine, and prednisone		

DCIS	ductal carcinoma <i>in situ</i>	ENSAT	European Network for the Study of Adrenal Tumors
DCR	disease control rate	EORTC	European Organization for Research and Treatment of Cancer
DEB-TACE	drug-eluting bead transarterial chemoembolization	EP	etoposide and cisplatin
DES	diethylstilbestrol	eP/D	extended pleurectomy/decortication
DFR	distant failure rate	EPOH	etoposide, prednisone, vincristine, cyclophosphamide, and doxorubicin
DFS	disease-free survival	EPP	extrapleural pneumonectomy
DFSP	dermatofibrosarcoma protuberans	ER	estrogen receptor
DHEA	dehydroepiandrosterone	ERCP	endoscopic retrograde cholangiopancreatography
DHEA-S	dehydroepiandrosterone sulfate	ERK	extracellular signal-regulated kinase
DIC	disseminated intravascular coagulation	ERMS	embryonal rhabdomyosarcoma
DIG/DIA	desmoplastic infantile ganglioglioma/astrocytoma	ERS	European Respiratory Society
DIPSS	Dynamic International Prognostic Scoring System	ES	Ewing sarcoma
DKC	dyskeratoses congenita	ESS	endometrial stromal sarcoma
DLBCL	diffuse large B cell lymphoma	ET	essential thrombocythemia/essential thrombocytosis
DLCO	diffusing capacity of the lung for carbon monoxide	ETANTR	embryonal tumor with abundant neuropil and true rosettes
DNET	dysembryoplastic neuroepithelial tumor	ETFL	European Task Force on Lymphoma
DoR	duration of response	ETMR	embryonal tumor with multilayered rosettes
DS	Down syndrome	ETS	E-twenty-six
DSC	dynamic susceptibility contrast	ETT	epithelioid trophoblastic tumor
DSNLB	dynamic sentinel lymph node biopsy	ETV	endoscopic third ventriculostomy
DSRCT	desmoplastic small round cell tumor	EURORDIS	European Organisation for Rare Diseases
DSS	disease-specific survival/Durie–Salmon staging	EUS	endoscopic ultrasound
DTC	differentiated thyroid cancer	EWS	Ewing sarcoma
DTPA	diethylene triamine pentaacetic acid	EXPeRT	European Cooperative Study Group for Pediatric Rare Tumors
DVT	deep venous thrombosis	FA	Fanconi anemia
EATL	enteropathy-associated T cell lymphoma	FAC	5-fluorouracil, doxorubicin, and cyclophosphamide
EAU	European Association of Urology	FACT	Fosbretabulin in Anaplastic Cancer of the Thyroid (study)
EBER	Epstein–Barr virus encoded small nuclear RNA	FAK	focal adhesion kinase
EBMT	European Group for Blood and Marrow Transplantation	FAM	5-fluorouracil, doxorubicin, and mitomycin-C
EBNA	Epstein–Barr nuclear antigen	FANC	Fanconi anemia complementation
EBRT	external beam radiotherapy	FAP	familial adenomatous polyposis
EBV	Epstein–Barr virus	FDA	Food and Drug Administration
EC	endometrioid carcinoma	FDG	fluorodeoxyglucose
ECOG	Eastern Cooperative Oncology Group	FDG-PET	fluorodeoxyglucose-positron emission tomography
EES	extrauterine endometrioid stromal sarcoma	FEV ₁	forced expiratory volume in 1 s
EET	endoscopic endonasal transsphenoidal	FFPE	formalin-fixed paraffin-embedded
EFS	event-free survival	FGF	fibroblast growth factor
EGF	epidermal growth factor	FGFR	fibroblast growth factor receptor
EGFR	epidermal growth factor receptor	FHIT	fragile histidine triad
EGILS	European Gastro-Intestinal Lymphoma Study	FIGO	International Federation of Gynecology and Obstetrics
EIC	endometrial intraepithelial carcinoma	FIHP	familial isolated hyperparathyroidism
EMA	epithelial membrane antigen/European Medicines Agency	FISH	fluorescent <i>in situ</i> hybridization
EMA-CO	etoposide, methotrexate (with folinic acid), actinomycin D, cyclophosphamide, and vincristine	FLAER	fluorochrome conjugated variant of aerolysin
EMC	extraskelatal myxoid chondrosarcoma	FLAIR	fluid-attenuated inversion recovery
EMT	epithelial-to-mesenchymal transition	FLIT	fetal lung interstitial tumor
ENB	esthesioneuroblastoma		
ENETS	European Neuroendocrine Tumor Society		

xxvi Abbreviations

FMTC	familial medullary thyroid cancer	HBOC	hereditary breast and ovarian cancer
FNA	fine needle aspiration	HBV	hepatitis B virus
FNCLCC	French Federation of Cancer Centers Sarcoma Group	HCC	hepatocellular carcinoma
FOLFIRI	leucovorin, 5-fluorouracil, and irinotecan	HCC-CC	hepatocellular cholangiocarcinoma
FOLFOX	leucovorin, 5-fluorouracil, and oxaliplatin	HCD	heavy chain disease
FOXP1	forkhead box P1 transcription factor	hCG	human chorionic gonadotropin
FSRT	fractionated stereotactic radiotherapy	β-HCG	β-human chorionic gonadotropin
5-FU	5-fluorouracil	HCL	hairy cell leukemia
GBM	glioblastoma	HCT	hematocrit/hematopoietic cell transplantation
GC	gemcitabine and cisplatin	HDC/HDCT	high-dose chemotherapy
GCALS	gastric carcinoma associated with lymphoid stroma	HDGC	hereditary diffuse gastric cancer
GCC	glassy cell carcinoma	HD-MTX	high-dose methotrexate
GCIG	Gynecologic Cancer InterGroup	HDR	high-dose rate
GCN	germ cell neoplasm	HER2	human epidermal growth factor receptor type 2
G-CSF	granulocyte colony-stimulating factor	HES	hypereosinophilic syndrome
GCT	germ cell tumor	HGNEC	high-grade neuroendocrine carcinoma
GEM-FLP	5-fluorouracil, leucovorin, gemcitabine, and cisplatin	HGSC	high-grade serous carcinoma
GEP	gastroenteropancreatic	HGSOC	high-grade serous ovarian carcinoma
GEP-NET	gastroenteropancreatic neuroendocrine tumor	HHV	human herpesvirus
GETT	Groupe d'Etudes des Tumeurs Thymiques	5-HIAA	5-hydroxyindoleacetic acid
GFAP	glial fibrillary acidic protein	HIPEC	hyperthermic intraperitoneal chemotherapy
GHSG	German Hodgkin Study Group	HIV	human immunodeficiency virus
GI	gastrointestinal	HLA	human leukocyte antigen
GIMEMA	Il Gruppo Italiano Malattie E Matologiche dell'Adulto	HLH	hemophagocytic lymphohistiocytosis
GIST	gastrointestinal stromal tumor	HLRCC	hereditary leiomyomatosis and renal cell carcinoma
GKRS	gamma knife radiosurgery	HNC	head and neck cancer
GMALL	German Multicenter Study Group for Adult Acute Lymphoblastic Leukemia	HNF-1β	hepatocyte nuclear factor-1β
G-MALTL	gastric mucosa-associated lymphoid tissue lymphoma	HNPCC	hereditary nonpolyposis colorectal cancer
GM-CSF	granulocyte-macrophage colony-stimulating factor	HPA	hypothalamus–pituitary–adrenal
G-NET	gastric neuroendocrine tumor	HPF	high-power field
GOG	Gynecologic Oncology Group	HPS	hemophagocytic syndrome
GPI	glycosylphosphatidylinositol	HPT-JT	hyperparathyroidism–jaw tumor
GPI-80	glycosylphosphatidyl inositol-anchored protein 80	HPV	human papillomavirus
GPOH	German Society of Pediatric Oncology and Hematology	HR	hazard ratio
GS	granulocytic sarcoma	HRD	homologous recombination deficiency
GSC	glioma stem cell	HSCT	hematopoietic stem cell transplantation
GST	glutathione <i>S</i> -transferase/gonadal (sex cord) stromal tumor	HSTCL	hepatosplenic T cell lymphoma
GTD	gestational trophoblastic disease	HT	helical tomotherapy
GTML	glutamate type I transporter	hTERT	human telomerase reverse transcriptase
GTN	gestational trophoblastic neoplasia	HU	Hounsfield unit/hydroxycarbamide/ hydroxyurea
GTP	gemcitabine, paclitaxel, and cisplatin	HUMARA	human androgen receptor analysis
GTR	gross total resection	hyper-CVAD	rituximab, cyclophosphamide, vincristine, doxorubicin, and dexamethasone
GTV	gross tumor volume	IARC	International Agency for Research on Cancer
GVHD	graft-versus-host disease	IASLC	International Association for the Study of Lung Cancer
GWAS	genome-wide association studies	IBD	inflammatory bowel disease
H&E	hematoxylin and eosin	IBMTR	International Bone Marrow Transplant Registry
HAART	highly active antiretroviral therapy	ICC	interstitial cells of Cajal
		ICE	ifosfamide, carboplatin, and etoposide
		ICP	intracranial pressure

ICR	imprinting control region	LCH	Langerhans cell histiocytosis
IDH	isocitrate dehydrogenase	LCNEC	large cell neuroendocrine carcinoma
IELSG	International Extranodal Lymphoma Study Group	LCNED	large cell carcinoma with neuroendocrine differentiation
IFN	interferon	LCNEM	large cell carcinoma with neuroendocrine morphology
IFUM	Iressa Follow-Up Measure (trial)	LCT	Leydig cell tumor
Ig	immunoglobulin	LDH	lactate dehydrogenase
IGCLC	International Gastric Cancer Linkage Consortium	LELC	lymphoepithelioma-like carcinoma of the cervix
IGF	insulin-like growth factor	LFS	Li–Fraumeni syndrome
IGFR	insulin-like growth factor receptor	LG	lymphomatoid granulomatosis
IG-IMRT	image-guided intensity-modulated radiotherapy	LGSC	low-grade serous carcinoma
IHC	immunohistochemical/immunohistochemistry	LH	luteinizing hormone
IL	interleukin	LHRH	luteinizing hormone-releasing hormone
IM	infantile myofibromatosis	LMP	latent membrane protein/low malignant potential
IMC	inflammatory myofibroblastic tumor	LMS	leiomyosarcoma
IMIG	International Mesothelioma Interest Group	LN	lymph node
IMRT	intensity-modulated radiotherapy	LOF	loss of function
IMT	inflammatory myofibroblastic tumor	LOH	loss of heterozygosity
INRG	International Neuroblastoma Risk Group	LPL	lymphoplasmacytic lymphoma
INT	Instituto Nazionale Tumori	LRA	long-acting release
IOM	Institute of Medicine	LRC	locoregional control
IP	intraoperative	LRF	leukemia/lymphoma-related factor
IPACTR	International Pediatric Adrenocortical Tumor Registry	LyP	lymphomatoid papulosis
IPASS	Iressa Pan-Asia Study	MAC	membrane attack complex
IPI	International Prognostic Index	MAF	metanephric adenofibroma
IPIG	International PNH Interest Group	MALT	mucosa-associated lymphoid tissue
IPMN	intraductal papillary mucinous neoplasm	MAP2	microtubule-associated protein 2
IPNB	intraductal papillary neoplasm of the bile duct	MAPK	mitogen-activated protein kinase
IPPBR	International Pleuropulmonary Blastoma Registry	MARS	Mesothelioma and Radical Surgery (trial)
IPSET	International Prognostic Score for Thrombosis in Essential Thrombocythemia	MASC	mammary analog secretory carcinoma
IPSS	International Prognostic Scoring System	mBCR	minor breakpoint cluster region
IRSG	Intergroup Rhabdomyosarcoma Study Group	MBCR	major breakpoint cluster region
ISM	indolent systemic mastocytosis	MBOT	mucinous borderline ovarian tumor
ISUP	International Society of Urological Pathology	MCC	Merkel cell carcinoma/mitomycin C
IT	immature teratoma	MCD	multicentric Castleman disease
ITC	insular thyroid carcinoma	MCL	mantle cell lymphoma
ITMIG	International Thymic Malignancy Interest Group	MCN	mucinous cystic neoplasms
ITP	ifosfamide, taxol, and cisplatin	MCUL1	multiple cutaneous uterine leiomyomatosis
IV	intravenous	MCyR	major cytogenetic response
IVADo	ifosfamide, vincristine, actinomycin-D, and doxorubicin	MDACC	MD Anderson Cancer Center
IVC	inferior vena cava	MD-IPMN	main duct intraductal papillary mucinous neoplasm
IVLBL	intravascular large B cell lymphoma	MDM	mixed desmoplastic melanoma
JMML	juvenile myelomonocytic leukemia	MDNEC	moderately differentiated neuroendocrine carcinoma
JXG	juvenile xanthogranuloma	MDS	myelodysplastic syndromes
KPS	Karnofsky performance status	MEC	mucoepidermoid carcinoma
KS	Kaposi sarcoma	MEITL	monomorphic epitheliotropic intestinal T cell lymphoma
KSHV	Kaposi sarcoma -associated herpesvirus	MEK	mitogen-activated protein kinase kinase
LAR	long-acting release/long-acting repeatable	MELTUMPS	melanocytic tumors of unknown metastatic potential
LC	local control	MEN	multiple endocrine neoplasia
LCA	leukocyte common antigen	MET	mesenchymal–epithelial transition
		MF	mitotic figure

xxviii Abbreviations

MFH	malignant fibrous histiocytoma	NNLM	National Network of Libraries of Medicine
MG	myasthenia gravis	NORD	National Organization of Rare Disorders
MGMT	<i>O</i> -6-methylguanine DNA methyltransferase	NOS	not otherwise specified
MGUS	monoclonal gammopathy of undetermined significance	NPC	nasopharyngeal cancer
MHC	major histocompatibility complex	NR	not reached
MHE	malignant hemangioendothelioma	NS	Noonan syndrome
MIA	minimally invasive adenocarcinoma	NSCLC	non-small cell lung carcinoma
MIBG	meta-iodobenzylguanidine	NSE	neuron-specific enolase
MITF	melanogenesis-associated transcription factor	NWTSG	National Wilms Tumor Study Group
MKI	multikinase inhibitor	NYHA	New York Heart Association
MM	malignant mesothelioma	OAR	organs at risk
MMC	mitomycin-C	OGCT	ovarian germ cell tumor
MMP	matrix metalloproteinase	17-OHP	17-hydroxyprogesterone
MMR	major molecular response	OR	odds ratio
MMS	Mohs micrographic surgery	ORR	objective response rate/overall response rate
MMTV	malignant mesothelioma of the tunica vaginalis	OS	overall survival
MOPP	mechlorethamine, vincristine, procarbazine, and prednisone	OSSN	ocular surface squamous neoplasia
MPAL	mixed phenotype acute leukemia	P/D	pleurectomy/decortication
MPN	myeloproliferative neoplasm	PAC	cisplatin, doxorubicin, and cyclophosphamide/ plasma aldosterone concentration
MPNST	malignant peripheral nerve sheath tumor	PAP	prostatic acid phosphatase
MRPC	magnetic resonance cholangiopancreatography	PARA	paraganglioma
MRI	magnetic resonance imaging	PARP(i)	poly-(ADP-ribose)-polymerase (inhibitor)
MRS	magnetic resonance spectroscopy	PAS	periodic acid-Schiff
MS	mastocytosis	PBPC	peripheral blood progenitor cell
MSD	matched sibling donor	PC	prostate cancer
MSI-H	microsatellite instability – high	PCL	plasma cell leukemia
MSKCC	Memorial Sloan Kettering Cancer Center	PCNA	proliferating cell nuclear antigen
MTC	medullary thyroid carcinoma	PCNSL	primary central nervous system lymphoma
MTO	C-metomidate	PCR	polymerase chain reaction
mTOR	mammalian target of rapamycin	PCV	procarbazine, lomustine, and vincristine
MTSCC	mucinous tubular and spindle cell carcinoma	PD-1	programmed cell death (protein) 1
MTX	methotrexate	PDAC	pancreatic ductal adenocarcinoma
MUC	mucin	PDGF	platelet-derived growth factor
MYB	myeloblastosis	PDGFR	platelet-derived growth factor receptor
MZL	marginal zone lymphoma	PD-L1	programmed death ligand 1
N:C	nuclear-to-cytoplasmic (ratio)	PDM	pure desmoplastic melanoma
NAACCR	North American Association of Central Cancer Registries	PEComa	perivascular epithelioid cell tumor
NCCN	National Comprehensive Cancer Network	PEL	primary effusion lymphoma
NCDB	National Cancer Data Base	PET	positron emission tomography
NCI	National Cancer Institute	PFS	progression-free survival
Nd:YAG	neodymium-doped yttrium-aluminium garnet	PGL1–5	paraganglioma syndromes
NE	neuroendocrine	Ph ⁺ ALL	Philadelphia chromosome-positive acute lymphoblastic leukemia
NEC	neuroendocrine carcinoma	PHEO	pheochromocytoma
NEN	neuroendocrine neoplasm	PHH3	phosphohistone H3
NEPC	neuroendocrine prostate cancer	PHP	percutaneous hepatic perfusion
NET	neuroendocrine tumor	PHPT	primary hyperparathyroidism
NF	neurofibromatosis	PI3K	phosphatidylinositol 3-kinase
NHEJ	non-homologous end joining	PIP2	phosphatidylinositol-4,5-bisphosphate
NHL	non-Hodgkin lymphoma	PIP3	phosphatidylinositol-3,4,5-triphosphate
NIH	National Institutes of Health	PJS	Peutz—Jeghers syndrome
NK	natural killer	PLAP	placenta-like alkaline phosphate
NLPHL	nodular lymphocyte-predominant Hodgkin lymphoma	PLGA	polymorphous low-grade adenocarcinoma
		PLGF	placental growth factor
		PLGGs	pediatric low-grade gliomas
		PLL	prolymphocytic leukemia
		PMA	pilocytoplast astrocytoma