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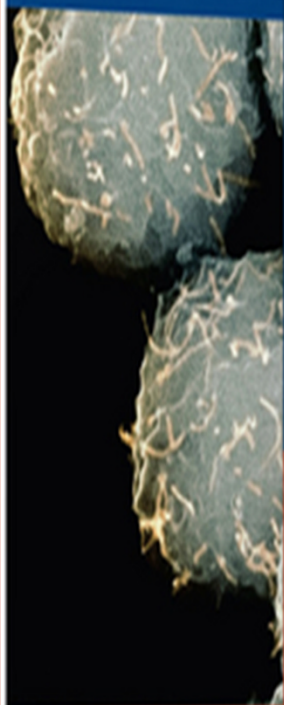
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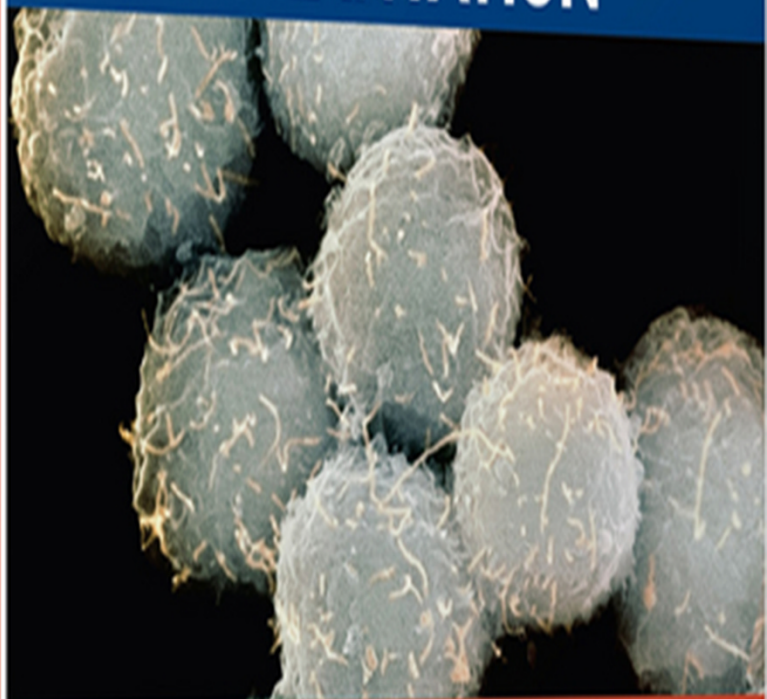
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Thomas' Hematopoietic Cell Transplantation

This book is dedicated to our patients and their families whose courage and trust enabled them to choose a difficult, dangerous, and sometimes unproven therapy which offered the only chance in their fight against a fatal disease. Today, many thousands of patients are alive after a successful hematopoietic cell transplantation, which would have been impossible without the fortitude of our patients, who took risks and thereby paved the way for the increasing application of this therapy. The progress in the area of clinical transplantation of hematopoietic cells would not have been possible without the dedicated, tireless work of the nurses and the supporting staff in the many transplant units around the world.

Thomas' Hematopoietic Cell Transplantation

Stem Cell Transplantation

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Preface to the First Edition

The widespread application of bone marrow transplantation (BMT) to the treatment of a steadily increasing number of life-threatening hematological, oncological, hereditary, and immunological disorders is the culmination of more than four decades of research by many investigators. Early attempts in the 1950s to transplant living cells from one individual to another were carried out in the face of considerable skepticism. It was generally accepted as axiomatic that the immunological barrier to "foreign tissue" could never be overcome.

The horrors of Nagasaki and Hiroshima spurred interest in studies of the lethal effects of irradiation. It was discovered that mice given total body irradiation in doses lethal to the marrow could be protected from death by shielding the spleen or by an infusion of marrow, and that the marrow of such animals contained living cells of donor origin. These observations suggested that patients with leukemia might be given a lethal exposure of total body irradiation, which would destroy the malignant cells along with remaining normal marrow. The exposure would also destroy the immune system, making it possible to protect against lethality by a transplant of normal marrow cells.

The theory was correct, but results were disappointing. Because the procedure was both unproved and dangerous, only those patients who had no other options were considered. Except for a few patients with an identical twin donor, there were no survivors beyond a few months. Understanding of the human leukocyte antigen (HLA) system was not yet available, and little was known about the complication we now call graft-versus-host disease (GVHD). Thus, after a brief period of enthusiasm, most investigators abandoned this seemingly hopeless pursuit. Fortunately, work in animal models continued. Studies in inbred rodents defined the genetics of the major histocompatibility system and the fundamental rules of transplantation biology. Immunosuppressive drugs were developed to limit the severity of the immune reactions between donor and host. Demonstration of successful marrow transplants in the canine model using littermates matched for the major histocompatibility complex set the stage for successful transplantation of marrow between human siblings. Thus, it is clear that a long series of experimental studies in animals ultimately made human marrow transplantation possible.

By the late 1960s, much was known about the HLA system, more effective antibiotics were available, and platelet transfusions were becoming routine. Thus began the modern era of human BMT. The past 25 years have witnessed an almost exponential growth in the number of transplants being performed and the number of diseases being considered for BMT. Initially, most grafts employed marrow from an HLA-identical sibling. Autologous marrow, long known to be effective in animal systems, is now being used with increasing frequency following intensive cancer chemotherapy. Hematopoietic progenitor cells from the peripheral blood are now being used for BMT, either alone or to supplement marrow. As a result of increasing national and international cooperation, large panels of volunteer marrow donors of known HLA type are becoming available to patients whose own marrow cannot be used or who do not have a family donor.

Currently, thousands of transplants are being performed each year world-wide. With the demonstration that marrow could be transplanted and that the cure rate would be substantial, the logical step was taken to treat patients early during the course of their respective disease (i.e. in leukemia when the burden of malignant cells was relatively low and when the patient was in excellent clinical condition). With improved patient selection, development of improved tissue typing methods, availability of potent antimicrobial agents, advances in supportive care, and improved prevention of GVHD, the results of BMT have continued to improve.

Marrow transplantation is now being applied to a long list of diseases with a wide range of results depending on the disease, the type of transplant, and the stage of the disease. For some of the diseases, BMT has already proven to be the most effective therapy (e.g., some leukemias and severe aplastic anemia), whereas for others it is the only available curative treatment (e.g., thalassemia). In very rare genetic disorders, one successful BMT may establish the success of the treatment. For other more common disorders, controlled trials are necessary to define the proper role of allogeneic or autologous BMT, or therapy not involving BMT.

Only through rigorous study and long-term follow-up can novel approaches be confirmed as effective (or ineffective). For those working in the field of marrow transplantation, a source of intellectual satisfaction has been the interdisciplinary nature of the studies. A view of the wide-ranging disciplines involved can be gleaned by reading the chapter titles for this book. A successful BMT program is always a team effort. There must be cooperation between blood banks, referring physicians, radiation oncologists, immunologists, and physicians from many subspecialties. A dedicated support staff of technicians, data managers, and, above all, nurses, is crucial. The nursing team in particular is responsible for the day-to-day care of patients. Nurses not only provide the bedside management of complex protocol studies, but also bear the burden of emotional support through the difficult hospital period. They are the most readily available source of information for the patients and families day and night. Without a strong nursing team, the entire BMT program is jeopardized.

Most important are the patients who come to the transplant center with the courage to accept days, weeks, and sometimes months of discomfort in the hope of surviving a fatal disease. We must ensure that we acknowledge and respect the dignity and individuality of each patient, that we provide adequate information for informed decision making and then include patients and families in the decision process. The greatest reward for clinical investigators is to see patients reintegrated into their personal, social, and professional lives, free of their disease and its complications.

*Stephen J. Forman
Karl G. Blume
E. Donnall Thomas
Summer, 1993*

Preface to the Fifth Edition

Twenty-one years ago after the first edition and six years following the fourth edition of this textbook, the editors and publisher, Wiley-Blackwell, are proud to present the fifth edition of *Thomas' Hematopoietic Cell Transplantation*. The inspiration for the development of this fifth edition came from the rapid expansion of knowledge underlying transplantation biology, increased understanding of the complications of treatment, and new information related to the pathogenesis and treatment of diseases for which transplantation is utilized. The book also covers the expansion of stem-cell donor options and the genetic manipulation of cells of the hematopoietic and immune system.

In comparing this edition with the previous one, readers will find that there are new chapters focused on contributions to the field provided from basic science experiments in stem-cell biology, immunology, and tolerance. Along with these new chapters, previous contributions have been revised to reflect the deepening of our understanding of the benefits and challenges of transplantation and the impact of new therapies in the treatment of diseases for which transplant is a potentially curative therapy. In order to expand the information in each chapter, we have limited references to include only those that are most relevant.

New to the fifth edition is a companion digital edition replacing the CD ROM. The digital edition contains the entire text of the book in a searchable form and includes all the figures in a convenient downloadable format. The availability of the digital edition reflects changes in the way readers, including basic science and clinical investigators, clinicians, and nurses, access new information for both their research work and clinical care of patients.

We, the editors, also greatly appreciate the assistance of the staff at Wiley-Blackwell, who have been extremely helpful in the process of creating this new edition, now in two volumes, with a very different and modern cover presentation. The editors feel very proud to have assembled such a talented group of authors representing our colleagues who are experts in the clinical and basic science of transplantation. In addition, this edition would not have been possible without the dedicated work of our assistants, Sara E. Clark-Fuentes, Tanya Chiatovich, and, most importantly, Kimberlie Laramie. Finally, this edition honors the memory of Dr. Karl G. Blume and Dr. E. Donnell Thomas, who passed away in 2012. Their laboratory and clinical contributions helped begin and expand the field of transplantation as a curative therapy for patients suffering from leukemia and, over time, many other disorders. Both Dr. Thomas and Dr. Blume were the first two editors of the book and this edition is dedicated to them, and also to our patients and their families whose trusting partnership makes it possible to make progress and extend hope. We also honor the memory of Dr. Thomas' wife, Dottie, who we warmly consider to be the "mother" of hematopoietic cell transplantation, for her own contributions in helping Dr. Thomas and the field and for her support and editing of the first four editions of the book. They were our colleagues, mentors, and friends, and their impact will be felt in the field for many years to come.

Stephen J. Forman, MD
Robert S. Negrin, MD
Joseph H. Antin, MD
Frederick R. Appelbaum, MD

Tribute



Our textbook honors Dr. E. Donnall Thomas, the single individual most responsible for creating the subject of this book, and Karl G. Blume, the Founder of the Transplant Programs both at City of Hope and Stanford University. Don and Karl were the first editors of this textbook and both passed away in the years following the publication of the fourth edition. We include this tribute as a remembrance of each of them, given the work that they did in their rich, professional lives to develop stem cell transplantation as a curative therapy for so many patients around the world.

E. DONNALL THOMAS, M.D.

March 15, 1920–October 20, 2012

Don was born on March 15, 1920, and was the son of a solo general practitioner in a small Texas village. As a child he often recalled accompanying his father to his small office and to patients' homes and between he and his father, they spanned the period from horse and buggy house calls to our modern high-tech medicine. Don received his B.A. and M.D. from the University of Texas where he met his wife, Dottie (September 18, 1922–January 9, 2015). Besides raising three children and eight grandchildren together, Dottie was



Don's partner in every aspect of his professional life, from working in the laboratory to editing manuscripts and administering grants. Anyone who has been fortunate enough to work with Don knows that if he was the father of marrow transplantation, then Dottie was, without question, the mother, and we honor her memory as our friend and colleague in this tribute, too.

Don graduated from Harvard Medical School in 1947 and completed his internship and residency at Peter Bent Brigham Hospital in Boston. It was while in medical school that Don first became interested in normal and malignant hematopoiesis. During those years, Sidney Farber was initiating his first studies of the use of antifolates to treat children with acute leukemia, and Don witnessed the very first patient to achieve a remission with this approach. He was exposed to the pioneering work of Allan Erslev and his search for erythropoietin, and most importantly, he learned from Leon Jacobson and his studies showing that shielding the spleen protected mice from the otherwise lethal effects of total body irradiation. As data emerged that a similar irradiation protection effect could be achieved by transferring bone marrow from a nonirradiated to an irradiated mouse, Don became convinced of the clinical potential of marrow transplantation.

In 1955, Don moved to Cooperstown, New York, and the Mary Imogene Bassett Hospital, a Columbia University affiliate, where he began working on marrow transplantation both in the canine model and in humans with Dr. Joseph Ferrebee. In 1957, he published the first report on human patients, showing that complete remissions of leukemia could be achieved using total body irradiation followed by infusion of marrow from an identical twin. At that

time, there was little understanding of the principles of human histocompatibility and so attempts to expand these studies to patients without identical twins were uniformly unsuccessful. These failures were the stimulus for a long series of experiments conducted by Don in the canine model, showing that it was possible to expose dogs to supralethal doses of irradiation and rescue them by reinfusing their own marrow, that the marrow could be cryopreserved, and that large doses of peripheral blood could substitute for marrow. However attempts at allogeneic transplantation in this outbred species continued to fail because of graft-versus-host disease or graft rejection.

In 1963, Don moved to Seattle and the University of Washington to become the first head of the Division of Oncology. There he developed techniques for rudimentary histocompatibility typing in the dog and, by the mid-1960s, showed that by selecting matched donors and using methotrexate posttransplant, it was possible to successfully transplant marrow between matched littermates in almost every case. At the same time, based on the work of Dausset, Payne, Amos, and others, understanding of human histocompatibility dramatically increased and so, in the late 1960s, Don made the decision to return to the subject of allogeneic transplantation in humans. He began to assemble a team of physicians, nurses, and support personnel (many of whom are still part of the current Seattle Transplant Program) and obtained a program project grant from the National Cancer Institute. In November 1968, Dr. Robert Good and his colleagues carried out the first marrow transplant from a matched sibling for an infant with immunodeficiency, and in March 1969, Don performed the first matched sibling donor transplant for a patient with leukemia.

The Seattle Transplant Program was originally housed at the Seattle Public Health Hospital, but in 1972, when the hospital was faced with closure by the federal government, the Program moved to Providence Hospital. In 1975, Don and his team moved to the newly created Fred Hutchinson Cancer Research Center, a move that provided Don with increased space, resources, and scientific collaborations. That same year, he and his colleagues published their classic *New England Journal of Medicine* paper summarizing the field of allogeneic transplantation and particularly the early Seattle experience. These results demonstrated not only the feasibility of the procedure but also that there was a plateau on the survival curves following transplantation, suggesting that some of these patients were cured with this novel technique. Don continued to lead the Clinical Research Division of the Center and its transplant program until his partial retirement in 1989. He continued writing manuscripts, delivering lectures, and participating in research discussions at the Center.

Appropriately, Don received almost every possible award for his work, including the American Society of Hematology's Henry M. Stratton Award, the General Motor's Kettering Prize, the American Society of Oncology's Karnofsky Award, the Presidential Medal of Science, and, of course, the 1990 Nobel Prize in Medicine which he shared with Joseph Murray. With each award, Don always emphasized how much of his work was a team effort. He invariably mentioned the contributions of Rainer Storb, Dean Buckner, Reg Clift, Paul Neiman, Alex Fefer, and Bob Epstein, who helped form the original Seattle Transplant Team, and of Ted Graham, who moved with Don from Cooperstown to help in the animal research. Don never failed to credit the nursing and support staff who played such a critical role in these efforts and, like Karl, always acknowledged the patients and their families who were true partners in his work.



KARL G. BLUME, M.D.

April 10, 1937–January 9, 2013

Karl G. Blume was born in Germany on April 10, 1937; he received his medical education under the mentorship of Professor Georg W. Löhr at the University of Freiburg and graduated in 1963. After graduation he undertook his residency at Marburg and then held two fellowships: one at Freiburg and the other at City of Hope in 1970 and 1971, respectively. His early work was in red cell biochemistry, and he pursued his postdoctoral fellowship under Dr. Ernest Beutler.

In 1975, after discussions with Dr. E. Donnall Thomas in Seattle and with his encouragement, Dr. Beutler decided to develop an allogeneic bone marrow transplantation (BMT) program at City of Hope and recruited Karl to return to City of Hope to establish the program. The program at City of Hope was, in many ways, derived from work and discussions that Karl had with colleagues at the Fred Hutchinson Cancer Research Center and resulted in lifelong friends from those early days of the development of transplantation to treat diseases of bone marrow and immune system origin. The first transplantation at City of Hope was performed on May 18, 1976.

Karl's clinical and research work focused on the problems that confront patients undergoing transplantation, namely, prevention of relapse, understanding the process of immune reconstitution, the treatment and prevention of graft-versus-host disease and cytomegalovirus infection management, and, among his early insights, issues related to patients' quality of life after transplantation and their long-term health. In 1981, Karl was the principal investigator for City of Hope's National Cancer Institute's first approved program project grant in transplantation, which contained projects that focused on those problems, and he organized a talented group of young laboratory and clinical scientists to work together in understanding and solving these challenges. He published the first results from City of Hope on the transplants for acute leukemia in the *New England Journal of Medicine* in 1981, showing the impact of remission status on outcome.

Based on his success at City of Hope, in 1987 Karl was recruited by Stanley Schrier and Ron Levy to begin a new transplant program

at Stanford University. Thus, he again developed from scratch his second successful transplantation program, mentoring numerous young physicians and inspiring colleagues and staff to work with him in a common quest to cure patients with hematologic malignancy and return them to their normal lives. Just as he had done at City of Hope, he developed and led another successful program project grant application. He also established the Division of Blood and Marrow Transplantation at Stanford University, taking a personal interest in the lives of each of his patients, incorporating all aspects of the care team into their treatment, including nursing, social work, dietary, and physical therapy, and confirming again a model for patient care and research in use at transplant programs around the country. During that time, he trained both Rob Negrin and Nelson Chao, who went on to direct transplantation programs at Stanford University and at Duke University, respectively. Therefore, Karl was responsible for at least three of the major BMT programs in the United States, not to mention the numerous fellows he trained and mentored at City of Hope and Stanford University.

In 2000, Karl attained emeritus status at Stanford University and stepped down from the role of chief of the BMT division to develop the Stanford Cancer Institute. He continued to serve Stanford University as associate director of research in the Department of Medicine. In 2003, he directed his energies toward developing and achieving the coveted National Cancer Institute-designated cancer center status for the Stanford Cancer Institute, a first for the university.

Karl was also a driving force in 1994 in the founding of the American Society of Blood and Marrow Transplantation, now an international organization for physicians and researchers committed to serving patients with a variety of blood diseases. He was also a leader in the American Society of Hematology and, for many years, was in charge of the organization's Career Development Program. Early on, he recognized that our responsibilities were not only to our patients now but also to those who come to us in the future. He became the first honorary member of ASBMT and, with Richard O'Reilly, was the first coeditor of *The Biology of Blood and Marrow Transplantation*, the major journal in the field. Karl worked tirelessly to make it the central journal in the field, and when there

were questions about the cost of the first issues, he made a personal financial donation to ensure the journal's successful launch.

Karl won many honors, both in the United States and Germany, but his major legacy is the impact he had on the thousands of patients he treated and the others he inspired to follow in his footsteps. All of us who knew and loved him knew that his highest priorities remained the quality of life of his patients and their families and the well-being of his transplantation team and those of his colleagues around the country and world. He held us all to high standards of excellence, but he maintained it with wonderful warmth, humor, and sensitivity over the decades and across continents. All of us who worked with him benefited from his respect and could always count on him to extend a helping hand and open ears, as he wanted nothing more than to help, to give of himself, and to be a force for good in this world.

In addition to his interest in music, sports – especially Stanford athletics – and the politics of the world and its impact on all of us, he was an exemplary family man. His children, Philipp and Caroline, could always rely on him for advice, affection, and guidance. In his last years, the lives and activities of his grandchildren, Adrian, Katie, Laura, Kevin, and David, were his focus and, of course, they adored him. Vera, his wife of 45 years, was his partner in his life and his work, as Dottie was to Don, and, at difficult times, always his source of strength and calm.

Although Don and Karl are most noted for their leadership and pioneering scientific achievements, for those of us who have been fortunate enough to work with them, they are equally admired for the way in which they achieved their success. They were always focused, hardworking, and uncompromising in their laboratories and especially in clinical research. They could both be demanding critics and held others accountable for their actions, yet at the same time, they were always generous with their ideas, loyal to their colleagues, and quick to deflect praise to their coworkers and help younger colleagues who chose this career.

For many of us in the field who had the privilege of knowing and working with both Don and Karl and for the many patients who are alive because of their work and dedication, the sentiment of a Hebrew proverb seems appropriate for each of them: "Say not in grief he is no more, but live in thankfulness that he was."

List of Abbreviations

AA	Amyloid A	ALDH	Aldehyde dehydrogenase
AA	Aplastic anemia	ALG	Antilymphocyte globulin
AABB	American Association of Blood Banks	ALK	Anaplastic lymphoma kinase
aaIPI	Age-adjusted International Prognostic Index	ALL	Acute lymphoblastic leukemia
AAV	Adeno-associated virus	AlloHCT	Allogeneic hematopoietic cell transplantation
ABC	Activated B-cell-like	AlloSCT	Allogeneic stem-cell transplantation
ABL	Abelson leukemia virus	ALP	Alkaline phosphatase
aBMT	Autologous bone marrow transplantation	ALPS	Autoimmune lymphoproliferative syndrome
ABMTR	Autologous Blood and Marrow Transplant Registry – North America	ALT	Alanine aminotransferase
ABVD	Doxorubicin, bleomycin, vinblastine, dacarbazine	AMA	Antimitochondrial antibody
ABW	Actual body weight	AMKL	Acute megakaryoblastic leukemia
AC	Adriamycin (doxorubicin), cyclophosphamide	AML	Acute myeloid leukemia
ACE	Adriamycin (doxorubicin), cyclophosphamide, etoposide	ANC	Absolute neutrophil count
ACEI	Angiotensin-converting enzyme inhibitor	ANKL	Aggressive natural killer cell leukemia
ACIF	Anticomplement immunofluorescence	AOTONJ	Antiosteoclastic therapy-associated osteonecrosis of the jaws
ACIP	Advisory Committee on Immunization Practices	AP	Accelerated phase
ACOR	Association of Online Cancer Resources	AP-1	Activator protein-1
ACP	Advanced care planning	APACHE	Acute Physiology, Age, Chronic Health Evaluation
ACR	Albumin-to-urine creatinine ratio	APBMT	Asia Pacific Blood and Marrow Transplantation
ACS	Acute chest syndrome	APC	Antigen-presenting cell
ACTH	Adrenocorticotrophic hormone	APECED	Autoimmune polyendocrinopathy–candidiasis–ectodermal dystrophy
ACVBP	Adriamycin (doxorubicin), cyclophosphamide, vindesine, bleomycin, prednisone	API	4',6-Diamidino-2-phenylindole
AD	Autoimmune disease	APL	Acute promyelocytic leukemia
ADA	Adenosine deaminase	APMF	Acute panmyelosis with myelofibrosis
ADCC	Antibody-dependent cell-mediated cytotoxicity	Ara-C	Cytosine arabinoside
ADH	Antidiuretic hormone	ARB	Angiotensin receptor blocker
ADL	Activities of daily living	ARDS	Acute or adult respiratory distress syndrome
AdV	Adenovirus	ARF	Acute renal failure
AEL	Acute erythroleukemia	ARL	AIDS-related lymphoma
AFP	α -Fetoprotein	ARS	Acute radiation syndrome
AGM	Aorta–gonad–mesonephros (region)	ARSA	Arylsulfatase A
aGVHD	Acute graft-versus-host disease	ART	Assisted reproductive technology
AH	Ancestral haplotype	ASBMT	American Society for Blood and Marrow Transplantation
aHCT	Autologous hematopoietic cell transplantation	ASCT	Autologous stem-cell transplantation
AHNMD	Associated clonal hematologic non-mast-cell lineage disease	ASO	Allele-specific oligonucleotide
AHPCS	Autologous hematopoietic progenitor-cell support	ASO-PCR	Allele-specific oligonucleotide polymerase chain reaction
aHR	Adjusted hazard ratio	AST	Aspartate aminotransferase
AHRQ	Agency for Health Care Research and Quality	AT	Alkyltransferase
aHUS	Atypical hemolytic uremic syndrome	ATG	Antithymocyte globulin
AIDS	Acquired immune deficiency syndrome	ATL	Adult T-cell leukemia
AIF	Apoptosis-inducing factor	ATLL	Adult T-cell leukemia/lymphoma
AIHA	Autoimmune hemolytic anemia	ATM	Ataxia Telangiectasia Mutated
AIRE	Autoimmune regulator	ATRA	All- <i>trans</i> -retinoic acid
AITD	Autoimmune thyroid disease	AUC	Area under the curve
AITL	Angioimmunoblastic T-cell lymphoma	AutoHCT	Autologous hematopoietic cell transplantation
AKI	Acute kidney injury	AVP	Arginine vasopressin
AKIN	Acute Kidney Injury Network	AYA	Adolescent and young adult
aKIR	Activating killer immunoglobulin-like receptor	AZT	Zidovudine
AL	Amyloid light-chain	BAEP	Brainstem auditory evoked potentials
ALA	α -Lipoic acid	BAFF	B-cell-activating factor
ALC	Absolute lymphocyte count	BAIAP3	Brain-specific angiogenesis inhibitor 1-associated protein 3
ALCL	Anaplastic large-cell lymphoma	BAL	Bronchoalveolar lavage
		BC	Blast crisis

BCC	Basal cell carcinoma	CBSC	Cord blood stem cell
BCMA	B-cell maturation antigen	CBT	Cognitive-behavioral therapy
BCNA	Bicyclic nucleoside analog	CBT	Cord blood transplantation
BCNU	1,3-Bis(2-chloroethyl)-1-nitrosourea (carmustine)	CBV	Cyclophosphamide, BCNU, etoposide
BCR	B-cell receptor	CC	Complete chimerism
BCR	Breakpoint cluster region	CCG	Children's Cancer Group
BD	Bortezomib, dexamethasone	CCI	Charlson Comorbidity Index
BDP	Beclomethasone 17,21-dipropionate	CCI	Corrected count increment
BEAC	BCNU, etoposide, Ara-C (cytosine arabinoside), cyclophosphamide	CCNU	1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea
BEAM	BCNU, etoposide, Ara-C (cytosine arabinoside), melphalan	CCR	Cytologic complete remission
BED	Biologically effective dose	CCSG	Children's Cancer Study Group
BEP	Bleomycin, etoposide, cisplatin	CCyR	Complete cytogenetic remission
BER	Base excision repair	CDA	Cytidine deaminase
BFI	Brief Fatigue Inventory	CDAD	<i>Clostridium difficile</i> -associated diarrhea
BFM	Berlin-Frankfurt-Münster	CDAI	Crohn Disease Activity Index
BFU-E	Burst-forming units – erythroid	CDC	Centers for Disease Control and Prevention
BIW	Twice weekly	CDC	Complement-dependent cytotoxicity
BL	Burkitt lymphoma	CDF	Cumulative distribution function
BLA	Biologics license application	CDK	Cyclin/cyclin-dependent kinase
BL-CFC	Blast colony-forming cell	CE	Carboplatin, etoposide
BLS	Bare lymphocyte syndrome	CEA	Carcinoembryonic antigen
BLyS	B-lymphocyte stimulator	CEACAM	Carcinoembryonic-antigen-related cell-adhesion molecule
BM	Bone marrow	CEC	Carboplatin, etoposide, cyclophosphamide
BMC	Bone marrow cell	CEL-NOS	Chronic eosinophilic leukemia-not otherwise specified
BMD	Bone mineral density	CEM	Carboplatin, etoposide, melphalan
BMDW	Bone Marrow Donors Worldwide	CESD	Center for Epidemiologic Studies – Depression
BMFS	Bone marrow failure syndromes	CFAR	Cyclophosphamide, fludarabine, alemtuzumab, rituximab
BMI	Body mass index	CFH	Complement factor H
BMSC	Bone marrow stem cell	CFU	Colony-forming unit
BMSCT	Blood and Marrow Stem Cell Transplant	CFU-B	Colony-forming unit – B-lymphocyte
BMT CTN	Blood and Marrow Transplant Clinical Trials Network	CFU-BLAST	Colony-forming unit – blast
BMT	Bone marrow transplantation	CFU-E	Colony-forming unit – erythroid
BMTCN	Blood and Marrow Transplantation Certified Nurse	CFU-F	Colony-forming unit – fibroblast
BMTinfonet	Blood and Marrow Transplant Information Network	CFU-GEMM	Colony-forming unit – granulocyte/erythroid/macrophage/megakaryocyte
BMTSS	Bone Marrow Transplant Survivor Study	CFU-GM	Colony-forming unit – granulocyte-macrophage
BNLI	British National Lymphoma Investigation	CFU-MEG	Colony-forming unit – megakaryocytic
BNP	Brain natriuretic peptide	CFU-Mix	Colony-forming unit – mixed
BO	Bronchiolitis obliterans	CFU-S	Colony-forming unit – spleen
BOOP	Bronchiolitis obliterans organizing pneumonia	CFU-T	Colony-forming unit – T-lymphocyte
BPDCN	Blastic plasmacytoid dendritic cell neoplasm	CGD	Chronic granulomatous disease
BPI	Bactericidal/permeability-increasing	CGH	Comparative genomic hybridization
BPI	Brief Pain Inventory	cGVHD	Chronic graft-versus-host disease
BR	Bendamustine, rituximab	CHD	Coronary heart disease
Breg	Regulatory B (cell)	CHF	Congestive heart failure
BSE	Bovine spongiform encephalopathy	CHOEP-14	Doxorubicin, vincristine, etoposide, prednisone
BSI	Brief symptom inventory	CHOP	Cyclophosphamide, hydroxydaunomycin, vincristine (Oncovin), prednisone
BTk	Bruton's tyrosine kinase		Complete hematologic response
BTLA	B- and T-lymphocyte attenuator	CHR	Child Health Ratings Inventory
BU	Busulfan	CHRI	Chediak-Higashi syndrome
BuMel	Busulfan, melphalan	CHS	Comorbidity index
BUN	Blood urea nitrogen	CI	Confidence interval
C1P	Ceramide-1 phosphate	CI	Cumulative incidence
CABSI	Catheter-associated bloodstream infection	CIA	Collagen-induced arthritis
CAEBV	Chronic active Epstein-Barr virus	CIBMTR	Center for International Blood and Marrow Transplant Research
CALGB	Cancer and Acute Leukemia Group B		Combined immunodeficiency syndrome
CALLA	Common acute lymphoblastic leukemia antigen	CID	Chronic inflammatory demyelinating polyneuropathy
CAR	Chimeric antigen receptor	CIDP	Cumulative incidence function
CAR	Cocksackie and adenovirus receptor	CIF	Chromosomal integration of human herpesvirus 6
CAR	CXCL12 adventitial reticular cell	CIHV-6	Critical illness polyneuropathy
CARES	Cancer Rehabilitation Evaluation System	CIPN	Creutzfeldt-Jakob disease
cART	Combination antiretroviral therapy	CJD	Chronic kidney disease
CB	Cord blood	CKD	Clinical Laboratory Approved Amendments
CBC	Cord blood cell	CLIA	Chronic lymphoid/lymphocytic leukemia
CBF	Core binding factor	CLL	Clofarabine
CBG	Corticosteroid-binding globulin	CLO	
CBHC	Cord blood hemopoietic cell		

CLP	Common lymphoid progenitor	DFCI	Dana–Farber Cancer Institute
CLR	C-type lectin receptor	DFS	Disease-free survival
CMF	Cyclophosphamide, methotrexate, fluorouracil	DGK	Deoxyguanosine kinase
CMI	Cellular mediated immunity	DH	Double hit
CML	Chronic myeloid/myelogenous leukemia	DHAP	Dexamethasone, high-dose cytarabine, cisplatin
CMMML	Chronic myelomonocytic leukemia	DHEA	Dehydroepiandrosterone
CMN	Chronic myeloid neoplasm	DHEAS	Dehydroepiandrosterone sulfate
CMP	Common myeloid progenitor	DHFR	Dihydrofolate reductase
CMR	Complete molecular response	DHPG	9-(1,3-Dihydroxy-2-propoxymethyl)guanine (ganciclovir)
CMV	Cytomegalovirus	DIC	Disseminated intravascular coagulation
CMV-Ig	Cytomegalovirus antibody-enriched intravenous immunoglobulin	DILI	Drug-induced liver injury
CMV-IP	Cytomegalovirus-associated interstitial pneumonia	DIPSS	Dynamic International Prognostic Scoring System
CNI	Calcineurin inhibitor	DKA	Diabetic ketoacidosis
CNL	Chronic neutrophilic leukemia	DLA	Dog leukocyte antigen
CNS	Central nervous system	DLBCL	Diffuse large B-cell lymphoma
COG	Children's Oncology Group	DLCL	Diffuse large cell lymphoma
ConA	Concanavalin A	DLCO	Diffusion capacity of the lung for carbon monoxide
COP	Cryptogenic organizing pneumonia	DLI	Donor lymphocyte infusion
COPE	Coping Orientations to Problems Experienced Scale	DLT	Dose-limiting toxicity
COX-2	Cyclooxygenase-2 (inhibitor)	DM	Diabetes mellitus
CP	Chronic phase	DMSO	Dimethyl sulfoxide
CR	Complete remission	DN	Double negative
CRBSI	Catheter-related bloodstream infection	DNA	Deoxyribonucleic acid
CREG	Cross-reactive group	DNAX	DNA accessory molecule
CRM	Continual reassessment method	DNR	Do not resuscitate
CRS	Cytokine release syndrome	DOTA	1,4,7,10-Tetraazacyclododecane- <i>N,N',N'',N'''</i> -tetraacetic acid
CRVT	Catheter-related venous thrombosis	DOTMP	1,4,7,10-Tetraazacyclododecane-1,4,7,10-tetramethylenephosphonic acid
CSA	Cyclosporine A	DPC	Days post-coitum
CSF	Cerebrospinal fluid	DPTS	Delayed pulmonary toxicity syndrome
CSF	Colony-stimulating factor	DR	Death receptor
CSP	Cyclosporine	DRG	Dorsal root ganglion
CT	Computed tomography	DSA	Donor-specific antibody
CT	Cyclophosphamide, thioTEPA	DSB	Double-strand break
CTC	Cyclophosphamide, thioTEPA, carboplatin	DSII	Disease-Specific Impairment Inventory
CTC	Cytotoxic T cell	DSRCT	Desmoplastic small round cell tumor
CTCL	Cutaneous T-cell lymphoma	dsRNA	Double-stranded RNA
CTD	Cyclophosphamide, thalidomide, dexamethasone	DST	Donor-specific transfusion
CTL	Cytotoxic T-lymphocyte	DTH	Delayed type hypersensitivity
CTLA	Cytotoxic T-lymphocyte antigen	DTI	Diffusion-tensor MRI
CTLP	Cytotoxic T-lymphocyte precursor	DTPA	Diethylenetriaminepentaacetic acid
CTN	Clinical Trials Network	DVT	Deep venous thrombosis
CTX	Cyclophosphamide	DXA	Dual-energy X-ray absorptiometry
CTXD	Cancer and Treatment Distress	EAE	Experimental allergic encephalomyelitis
CTZ	Chemotactic trigger zone	EAE	Experimental autoimmune encephalomyelitis
CVAD	Fractionated cyclophosphamide, vincristine, adriamycin, dexamethasone	EATL	Enteropathy-associated T-cell lymphoma
CVC	Central venous catheter	EB	Embryoid body
CVD	Cardiovascular disease	EBMT	European Group for Blood and Marrow Transplantation
CVID	Common variable immune deficiency	EBMTR	European Bone Marrow Transplant Registry
CVRF	Cardiovascular risk factor	EBNA	Epstein–Barr (virus) nuclear antigen
CVVH	Continuous veno-venous hemofiltration	EBV	Epstein–Barr virus
CVVHDF	Continuous veno-venous hemodiafiltration	EBV-LDP	Epstein–Barr virus-associated lymphoproliferative disorder
CY	Cyclophosphamide	EC	Endothelial cell
CyBorD	Cyclophosphamide, bortezomib, dexamethasone	EC	Epirubicin, cyclophosphamide
CYP	Cytochrome P	ECAT	Extracorporeal adsorption therapy
DAD	Direct antigen detection	ECFC	Endothelial colony-forming cells
DAF	Decay-accelerating factor	ECG	Electrocardiogram
DAG	Diacylglycerol	ECIL	European Conference on Infections in Leukaemia
DAH	Diffuse alveolar hemorrhage	ECM	Extracellular matrix
DAMP	Damage-associated molecular pattern	ECF	Extracorporeal photopheresis
DAS	Dasatinib	ED	Erectile dysfunction
DC	Dendritic cell	EDSS	Expanded Disability Status Scale
DCEP	Dexamethasone, cyclophosphamide, etoposide, cisplatin	EDTMP	Ethylenediaminetetramethylenephosphonic acid
DCK	Deoxycytidine kinase	EEG	Electroencephalogram
DDR	Discoidin domain receptor	EFS	Event-free survival
DFA	Direct fluorescent antibody (test)	EGBMT	European Group for Blood and Marrow Transplantation
		ELISA	Enzyme-linked immunosorbent assay

ELN	European LeukemiaNet	GA	Glatiramer acetate
EM	Erythema multiforme	GABG	German Autologous Bone Marrow Transplant Group
EMLA	Eutectic Mixture of Local Anesthetic	GALT	Gut-associated lymphoid tissue
EN	Enteral nutrition	GAP	GTPase-activating protein
ENKL	Extranodal NK/T-cell nasal type leukemia	GBM	Glioblastoma multiforme
ENSG	European Neuroblastoma Study Group	G-BM	G-PBHC and/or G-CSF primed bone marrow
ENU	Ethyl- <i>N</i> -nitrosourea	gc	Genome copies
EORTC	European Organization for Research and Treatment of Cancer	GCB	Germinal center B-cell-like
EPC	Endothelial progenitor cell	G-CSF	Granulocyte colony-stimulating factor
EPO	Erythropoietin	GCT	Germ-cell tumor
EPOCH	Etoposide, prednisone, vincristine (Oncovin), doxorubicin hydrochloride	GDP	Guanosine diphosphate
ER	Endoplasmic reticulum	GEBDIS	German Breast Cancer Dose Intensity Study
ER	Estrogen receptor	GEE	Generalized estimating equation
ERIC	European Research Initiative in chronic lymphocytic leukemia	GEL/TAMO	Grupo Español de Linfomas/Trasplante Autólogo de Médula Ósea
ERT	Enzyme replacement therapy	GEM	Gemcitabine
ESBL	Extended-spectrum β -lactamase	GEM	Grid Enabled Measures
ESC	Embryonic stem cell	GEP	Gene expression profiling
ESFT	Ewing sarcoma family of tumors	GF	Graft failure
ET	Essential thrombocythemia	GFP	Green fluorescent protein
ETP	Early thymic progenitor	GFR	Glomerular filtration rate
ETS	Euthyroid sick syndrome	GGT	γ -Glutamyl transferase
EWOG	European Working Group	GH	Growth hormone
EWOG-MDS	European Working Group of Myelodysplastic Syndromes in Childhood	GHRH	Growth hormone-releasing hormone
FA	Fanconi anemia	GHSB	German Hodgkin Study Group
FAB	French–American–British Classification	GI	Gastrointestinal (tract)
FACIT-SP	Functional Assessment of Chronic Illness Therapy – Spirituality and Wellbeing Scale	GICAT	Gruppo Italiano Collaborativo AIDS e Tumori (Italian Cooperative Group on AIDS and Tumors)
FACS	Fluorescence-activated cell sorter	GISL	Gruppo Italiano per lo Studio dei Linfomi (Italian Lymphoma Study Group)
FACT	Foundation for the Accreditation of Cellular Therapy	GITMO	Gruppo Italiano per il Trapianto di Midollo Osseo
FACT	Functional Assessment of Chronic Illness Therapies	GM	Galactomannan
FACT-BMT	Functional Assessment of Cancer Therapy – BMT Module	GM-CSF	Granulocyte–macrophage colony-stimulating factor
FAMA	Fluorescent-antibody staining of membrane antigen	GMP	Granulocyte macrophage progenitor (cell)
FasL	Fas ligand	GMP	Guanosine monophosphate
FC	Facilitator cell	GNB	Gram-negative bacilli
FCH	Fibrosing cholestatic hepatitis	GnRH	Gonadotropin-releasing hormone
FCR	Fludarabine, cyclophosphamide, rituximab (RTX)	gp	Glycoprotein
FDA	Food and Drug Administration	G-PBHC	Granulocyte colony-stimulating factor-mobilized peripheral blood hematopoietic cell
FDG	[¹⁸ F]Fluorodeoxyglucose	GPI	Glycosylphosphatidylinositol
FDR	False discovery rate	GPI-AP	Glycosylphosphatidylinositol-anchored protein
FEC	Fluorouracil, epirubicin, cyclophosphamide	GRE	Glucocorticoid response element
FEV₁	Forced expiratory ventilation in 1 second	GSH	Glutathione (reduced)
FFP	Fresh frozen plasma	GST	Glutathione- <i>S</i> -transferase
FFS	Failure-free survival	GTP	Good tissue practice
FHCRC	Fred Hutchinson Cancer Research Center	GTP	Guanosine triphosphate
FISH	Fluorescence in situ hybridization	GVD	Gemcitabine, vinorelbine, liposomal doxorubicin
FKBP	Tacrolimus (FK)-binding protein	GVH	Graft-versus-host
FL	Follicular lymphoma	GVHD	Graft-versus-host disease
FLACC	Face, Legs, Activity, Cry, Consolability (pain assessment tool)	GVHL	Graft-versus-Hodgkin disease (lymphoma)
FLAIR	Fluid attenuated inversion recovery	GVL	Graft-versus-leukemia
FLC	Free light chain	GVLE	Graft-versus-leukemia effect
FLIPI	Follicular Lymphoma International Prognostic Index	GVT	Graft-versus-tumor
FLU	Fludarabine	GWAS	Genome-wide association study
FN	Febrile neutropenia	H&E	Hematoxylin and eosin (stain)
FNA	Fine-needle aspiration	HA	Hemagglutinins
FNH	Focal nodular hyperplasia	HAART	Highly active antiretroviral therapy
FoxP3	Forkhead box P3	HADS	Hospital Anxiety and Depression Scale
FSH	Follicle-stimulating hormone	HAMA	Human antimouse antibody
FSI	Fatigue Symptom Inventory	HA-MRSA	Healthcare-associated MRSA
FTBI	Fractionated total body irradiation	HAV	Hepatitis A virus
FTBI	Full total body irradiation	HBoV	Human bocavirus
FTI	Farnesyltransferase inhibitor	HBV	Hepatitis B virus
FTOC	Fetal thymic organ culture	HC	Hematopoietic cell
5-FU	5-Fluorouracil	HC	Hemorrhagic cystitis
FVC	Forced vital capacity	HC	Histocompatibility complex

4-HC	4-Hydroperoxycyclophosphamide	ICOS	Inducible costimulator (protein)
HCG	Human chorion gonadotropin	ICOS-L	Inducible costimulator ligand
HCoV	Human coronavirus	ICSI	Intracytoplasmic sperm injection
HCT	Hematopoietic cell transplantation	ICU	Intensive care unit
HCT-CI	HCT-Comorbidity Index	ID	Intermediate dose
HCV	Hepatitis C virus	iDC	Immature dendritic cells
HD	Hodgkin disease	IDO	Indoleamine 2,3-dioxygenase
HDAC	High-dose Ara-C	IDOX	4-Iodo-4-deoxydoxorubicin
HDC	High-dose chemotherapy	IDSA	Infectious Diseases Society of America
HDIT	High-dose immunosuppressive therapy	IE	Immediate early (antigen expression)
HDT	High-dose therapy	IEM	Inborn errors of metabolism
HEPA	High-efficiency particulate air	IFI	Invasive fungal infection
HES	Hydroxyethyl starch	IFN	Interferon
HES	Hypereosinophilic syndrome	IFRT	Involved field radiotherapy
hESC	Human embryonic stem cell	Ig	Immunoglobulin
HEV	Hepatitis E virus	IGCCCCG	International Germ Cell Cancer Collaborative Group
HFTBI	Hyperfractionated total body irradiation	IGEV	Ifosfamide, gemcitabine, vinorelbine, prednisone
HGF	Hepatocyte growth factor	IGF	Insulin-like growth factor
HGNC	HUGO Genome Nomenclature Committee	IGFBP	Insulin-like growth factor binding protein
HHS	Human and Health Services	IgG	Immunoglobulin G
HHV	Human herpesvirus	IgH	Immunoglobulin heavy chain
HI	Hemagglutination inhibition	IGRT	Image-guided radiation therapy
HIB	<i>Haemophilus influenzae</i> type B	IHC	Immunohistochemistry
HIF	Hypoxia-inducible transcription factor	IHWG in HCT	International Histocompatibility Working Group in Hematopoietic Cell Transplantation
HIV	Human immunodeficiency virus	iKIR	Inhibitory killer immunoglobulin-like receptor
HL	Hodgkin lymphoma	IL	Interleukin
HLA	Human leukocyte antigen	IM	Imatinib
HLH	Hemophagocytic lymphohistiocytosis	IMGT	International ImMunoGenetics
hMPV	Human metapneumovirus	IMID	Immunomodulatory drug
HOVON	Hemato-Oncologie voor Volwassenen Nederland	IMPDH	Inosine monophosphate dehydrogenase
HPA	Hypothalamic-pituitary-adrenal	IMRT	Intensity-modulated radiation therapy
HPC	Hematopoietic progenitor cell	IMWG	International Myeloma Working Group
HPI	Helicase-primase inhibitor	IND	Improvised nuclear device
HPV	Human papillomavirus	IND	Investigational new drug
HR	Hazard ratio	iNK-T	Invariant natural killer T (cell)
HR	Homologous recombination	iNOS	Inducible NO synthase
HRCT	High-resolution chest tomography	INR	International normalized ratio
HRE	Hypoxia-inducible transcription factor response element	INRG	International Neuroblastoma Risk Group
HRhV	Human rhinovirus	INRGSS	International Neuroblastoma Risk Group Staging System
HRPBC	High-risk primary breast cancer	INSS	International Neuroblastoma Staging System
HRQOL	Health-related quality of life	INSTI	Integrase strand transfer inhibitor
HRSA	Health Resources and Services Administration	IORT	Intraoperative radiotherapy
HRT	Hormone replacement therapy	IP	Interstitial pneumonia
HSC	Hematopoietic stem cell	IP₃	Inositol-1,4,5-triphosphate
HSC	Hepatic stellate cell	IPD	Invasive pneumococcal disease
HSCT	Hematopoietic stem-cell transplantation	IPEX	Immunodysregulation polyendocrinopathy enteropathy X-linked (syndrome)
HSDD	Hypoactive sexual desire disorder	IPFSG	International Prognostic Factor Study Group
HSPC	Hematopoietic stem/progenitor cell	IPI	International Prognostic Index
HSTCL	Hepatosplenic T-cell lymphoma	iPS	Induced pluripotent stem
HSV	Herpes simplex virus	IPS	Idiopathic pneumonia syndrome
HSV-TK	Herpes simplex virus thymidine kinase	IPS	Interstitial pneumonia syndrome
HT	Histologic transformation	IPSS	International Prognostic Scoring System
5-HT	5-Hydroxytryptamine (serotonin)	IPV	Inactivated polio vaccine
hTERT	Human telomerase reverse transcriptase	IRB	Institutional Review Board
HTLV	Human T-cell lymphotropic virus	IRF	Interferon regulatory factor
HTS	High-throughput sequencing	IRSG	Intergroup Rhabdomyosarcoma Study Group
HU	Hydroxyurea	IS	Immune synapse
HUS	Hemolytic uremic syndrome	IS	Immunosuppressive
HVEM	Herpes virus entry mediator	IS	International Scale
HVG	Host-versus-graft (reaction)	ISC	Intestinal stem cell
IA	Invasive aspergillosis (infection)	ISO	Isohemagglutinin
IBCSG	International Breast Cancer Study Group	IST	Immunosuppressive therapy
IBDIS	International Breast Cancer Dose Intensity Study	ISW	Immune suppression withdrawal
IBMTR	International Bone Marrow Transplant Registry	ITAM	Immunoreceptor tyrosine-binding activation motif
IBW	Ideal body weight	ITCC	Innovative Therapies for Children with Cancer
ICAM	Intracellular adhesion molecule		
ICE	Ifosfamide, carboplatin, etoposide		

ITD	Internal tandem duplication	mAb	Monoclonal antibody
ITIM	Immunoreceptor tyrosine-binding inhibition motif	MAC	Membrane attack complex
iTreg	Induced regulatory T (cell)	MAC	Myeloablative conditioning
ITT	Intent-to-treat	MAFIA	Macrophage Fas-induced apoptosis
IUPM	Infectious units per million	MALDI-TOFMS	Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry
IV	Intravenous	MAP	High-dose methotrexate, cisplatin, and doxorubicin
IVF	In vitro fertilization	MAPK	Mitogen-activated protein kinase
IVF	Intravenous fluid	MBC	Metastatic breast cancer
IVIg	Intravenous immunoglobulin	MBL	Monoclonal B-cell lymphocytosis
IκB	Inhibitor I kappa B	MBP	Myelin basic protein
JACIE	Joint Accreditation Committee of ISCT-Europe and EBMT	MCD	Minimal change disease
JAK	Janus kinase	MCL	Mantle cell lymphoma
JALSG	Japan Adult Leukemia Study Group	MCL	Mast cell leukemia
JCBBN	Japan Cord Blood Bank Network	mCMV	Murine cytomegalovirus
JCV	JC virus	M-CSF	Macrophage colony-stimulating factor
JIA	Juvenile idiopathic arthritis	MCyR	Major cytogenetic response
JMDP	Japan Marrow Donor Program	MDASI	M.D. Anderson Symptom Inventory
JMML	Juvenile myelomonocytic leukemia	mDC	Mature dendritic cells
K15	Cytokeratin 15	MDex	Melphalan, dexamethasone
KD	Kinase domain	MDRD	Modification of Diet in Renal Disease (Study)
KGF	Keratinocyte growth factor	MDS	Myelodysplastic syndrome
KIR	Killer immunoglobulin-like receptor	MDSC	Myeloid-derived suppressor cell
KM	Kaplan–Meier	MEAC	Minimum effective analgesic concentration
KPC	<i>Klebsiella pneumoniae</i> carbapenemase	MEL	Melphalan
KPS	Karnofsky Performance Score	MEP	Megakaryocyte erythrocyte progenitor
KREC	Kappa-deleting recombination excision circle	mESC	Mouse embryonic stem cell
LAIV	Live attenuated influenza vaccine	mesna	Sodium 2-mercaptoethanesulfonate
LAMP	Loop-mediated isothermal amplification	MetaEICESS	Meta European Intergroup Cooperative Ewing Sarcoma Study
LAVV	Live attenuated varicella vaccine	MF	Mycosis fungoides
LBL	Lymphoblastic lymphoma	MF	Myelofibrosis
LC	Langerhans cell	MFC	“Multiparametric” flow cytometric
LCH	Langerhans cell histiocytosis	MFC	Multidimensional flow cytometry
LCL	Lymphoblastic cell lines	MFD	Matched family donor
LD	Linkage disequilibrium	MG	Myasthenia gravis
LDH	Lactate dehydrogenase	MGDF	Megakaryocyte growth and development factor
LEDGF	Lens epithelium-derived growth factor	MGH	Massachusetts General Hospital
LenDex	Lenalidomide, dexamethasone	MGMT	Methylguanine methyltransferase
LET	Linear energy transfer	MGUS	Monoclonal gammopathy of undetermined significance
LFA	Leukocyte function-associated antigen	mHA	Minor histocompatibility antigen
LFR	Limited field radiation	mHAQ	Modified Health Assessment Questionnaire
LFS	Leukemia-free survival	MHC	Major histocompatibility complex
LFS	Lung function score	MHV	Mouse hepatitis virus
LGL	Large granular lymphocyte	MIC	Minimum inhibitory concentration
LH	Luteinizing hormone	MICA	MHC class I chain-related gene A
LHRH	Luteinizing hormone-releasing hormone	MIP-1	Macrophage inflammatory protein 1
LIF	Leukemia inhibitory factor	MIPI	Mantle Cell Prognostic Index
LMD	Laser microdissection	MIRD	Medical internal radiation dose
LMP	Latency membrane protein	MIRL	Membrane inhibitor of reactive lysis
LMWH	Low molecular weight heparin	miRNA	micro-RNA
LN	Lymph node	miTT	Modified intent-to-treat
LOH	Loss of heterozygosity	MJM	Muscle and Joint Measure
LPHD	Lymphocyte-predominant Hodgkin disease	MKP	Megakaryocyte progenitor
LPS	Lipopolysaccharide	MLC	Mixed leukocyte culture
LQ	Linear quadratic	MLD	Metachromatic leukodystrophy
LRD	Lower respiratory tract disease	MLL	Mixed leukemia lymphoma gene
LRP	Lipoprotein receptor-related protein	MLL	Mixed lineage leukemia
LRP	Lung resistance protein	MLR	Mixed leukocyte reaction
LRR	Leucine-rich-repeat	MLS	Maroteaux–Lamy syndrome
LSD	Lysosomal storage disorders	MM	Multiple myeloma
LTC-IC	Long-term culture initiating cell	MMF	Mycophenolate mofetil
LTfU	Long-term follow-up	MMR	Major molecular response
LT-HSC	Long-term hematopoietic stem cell	MMR	Measles/mumps/rubella
LUTS	Lower urinary tract syndrome	MMRD	Mismatched related donor
LV	Lenti virus	MMUD	Mismatched unrelated donor
LVEF	Left ventricular ejection fraction		
M protein	Monoclonal protein		
MA	Myeloablative		

MNC	Mononuclear cell	NHEJ	Non-homologous end-joining
MODS	Multiple-organ dysfunction syndrome	NHL	Non-Hodgkin lymphoma
MOG	Myelin oligodendrocyte glycoprotein	NHLBI	National Heart, Lung, and Blood Institute
MOPP	Mechlorethamine, vincristine (Oncovin), procarbazine, prednisone	NIH	National Institutes of Health
MP	Melphalan, prednisone	NIL	Nilotinib
MP	Methylprednisolone	NIMA	Non-inherited maternal antigen
MPA	Mycophenolic acid	NIPA	Non-inherited paternal antigen
MPAG	7-O-Mycophenolic acid glucuronide	NK	Natural killer (cell)
MPAL	Mixed phenotype acute leukemia	NK	Normal karyotype
MPB	Mobilized peripheral blood (cells)	NK-T	Natural killer T (cell)
MPFC	Multiparameter flow cytometry	NLR	Nucleotide-binding oligomerization domain leucine-rich-repeat-containing receptor
MPN	Myeloproliferative neoplasm	NM	Non-myeloablative
MPP	Multipotent progenitor	NMA	Non-myeloablative
MPT	Melphalan, prednisone, thalidomide	NMDA	N-Methyl-D-aspartate
MPV	melphalan, prednisone, bortezomib (Velcade)	NMDP	National Marrow Donor Program
MRC	Medical Research Council	NMHC	Non-myeloablative hematopoietic cell transplantation
MRD	Minimal residual disease	NMRTI	Non-nucleoside reverse transcriptase inhibitor
MRI	Magnetic resonance imaging	NO	Nitric oxide
m-RNA	Messenger RNA	NOD	Non-obese diabetic (mouse)
MRP	Multidrug resistance-associated protein	NOD	Nucleotide-binding oligomerization domain
MRS	Magnetic resonance spectroscopy	NPC	Nasopharyngeal carcinoma
MRSA	Methicillin-resistant <i>Staphylococcus aureus</i>	NRM	Non-relapse mortality
mRSS	Modified Rodman skin score	NRS	Neurological Rating Scale
MS	Mass spectrometry	NRTI	Nucleoside reverse transcriptase inhibitor
MS	Multiple sclerosis	NS	Nephrotic syndrome
MSC	Mesenchymal stem cell	NS	Noonan syndrome
MSC	Mesenchymal stromal cell	NSAID	Non-steroidal anti-inflammatory drug
MSCH	Mouse spinal cord homogenate	N-SH2	N-Terminal src-homology 2
MSFC	Multiple sclerosis functional composite	NST	Non-myeloablative stem-cell transplantation
MSI	Microsatellite instability	NT-proBNP	N-Terminal fragment of pro-brain natriuretic peptide
MSKCC	Memorial Sloan Kettering Cancer Center	nTreg	Naturally occurring regulatory T (cell)
MS-LCH	Multi-system Langerhans cell histiocytosis	NWTS	National Wilms Tumor Study
MSSA	Methicillin-susceptible <i>Staphylococcus aureus</i>	NZB	New Zealand black
MTD	Maximum tolerated dose	NZW	New Zealand white
MTOR	Mammalian target of rapamycin	OATP	Organic anion-transporting polypeptide
Mtvs	Mouse mammary tumor virus	OCTP	Organic cation-transporting polypeptide
MTX	Methotrexate	OFAR	Oxaliplatin, fludarabine, cytarabine, rituximab
MUD	Matched unrelated donor	OLD	Obstructive lung disease
MV	Measles virus	ONJ	Osteonecrosis of the jaw
MVA	Multivariate analysis	ONS	Oncology Nursing Society
MZ	Marginal zone	OPA	Office of Patient Advocacy
NA	Nucleoside analog	OPG	Osteoprotegerin
NA-DP	Nucleoside analog diphosphate	OPM	Oropharyngeal mucositis
NANT	New Approaches to Neuroblastoma Therapy	O-PRISM	Oncologic Pediatric Risk of Mortality
NAP1	North American Pulsed Field Type 1	OR	Odds ratio
NASH	Non-alcoholic steatohepatitis	OS	Overall survival
NAT	Nucleic acid amplification test	PACT	Psychological Assessment of Candidates for Transplantation Scale
NA-TP	Nucleoside analog triphosphate	PAD	Bortezomib, adriamycin, dexamethasone
nbmtLINK	National Bone Marrow Transplant link	PALE	Post-transplant acute limbic encephalitis
NC	Nucleated cell	PAM	Pretransplant assessment of mortality
NCAM	Neural cell adhesion molecule	PAMP	Pathogen-associated molecular pattern
NCCN	National Comprehensive Cancer Network	PAS	Periodic acid-Schiff
NCHS	National Center for Health Statistics	PB	Peripheral blood
NCI	National Cancer Institute	PBHC	Peripheral blood hematopoietic cell
NCIC	National Cancer Institute of Canada	PBHCT	Peripheral blood hematopoietic cell transplantation
NCI-WG	National Cancer Institute – Working Group	PBL	Peripheral blood lymphocyte
nCR	Near complete response	PBMC	Peripheral blood mononuclear cell
NCR	Natural cytotoxicity receptor	PBMTC	Pediatric Blood and Marrow Transplant Consortium
NDK	Nucleotide diphosphate kinase	PBPC	Peripheral blood progenitor cell
NE	Norepinephrine	PBSC	Peripheral blood stem cell
NEMO	Nuclear factor-kappa B essential modulator	PCA	Patient-controlled analgesia
NER	Nucleotide excision repair	PCNSL	Primary central nervous system lymphoma
NF-AT	Nuclear factor of activated T cells	PCORI	Patient-Centered Outcomes Research Institute
NF-κB	Nuclear factor-kappa B	PCR	Polymerase chain reaction
NGS	Next-generation sequencing	PCR	Programmed cell renewal
NHANES	National Health and Nutrition Examination Surveys		