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(54) Title: METHODS OF TREATING PERIPHERAL T CELL LYMPHOMA USING ANTI-CD30 ANTIBODY DRUG CONJUGATE THERAPY

(57) Abstract: The present disclosure, relates, in general to methods treating peripheral T cell lymphoma and who are receiving treatment with an anti-CD30 antibody drug conjugate in combination with accompanying chemotherapy.

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METHODS OF TREATING PERIPHERAL T CELL LYMPHOMA USING ANTI-CD30 ANTIBODY DRUG CONJUGATE THERAPY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the priority benefit of U.S. Provisional Patent Application 62/739,631, filed October 1, 2018, hereby incorporated by reference in its entirety.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates, in general, to methods of treating a peripheral T cell lymphoma by administering an anti-CD30 antibody drug conjugate therapy, in combination with a chemotherapeutic regimen of cyclophosphamide, doxorubicin and prednisone.

BACKGROUND

[0003] Peripheral T-cell lymphoma (PTCL) is a heterogeneous group of aggressive non-Hodgkin lymphoma (NHL). PTCL accounts for approximately 10% of all NHL cases in the US and Europe, and may be as high as 24% in Asia. The most common PTCL subtypes, including PTCL-not otherwise specified (PTCL-NOS), Angioimmunoblastic T-cell lymphoma (AITL), and anaplastic lymphoma kinase (ALK)-positive/negative anaplastic large cell lymphoma (ALCL), represent more than half of the cases of PTCL and are treated similarly[1]. CD30-positive peripheral T-cell lymphoma (PTCL) is an aggressive lymphoid neoplasm that often presents as advanced-stage, symptomatic disease. These types of lymphoma are difficult to treat and are often grouped together for enrollment in clinical trials based on their universally dismal outcomes. In the International Peripheral T-Cell and Natural Killer/T-Cell Lymphoma Study of over 1300 patients, the 5-year overall survival (OS) rates ranged from 12% to 49%, depending on histologic subtype[1]. Five-year failure-free survival, defined as time from initial diagnosis to progression, relapse after response, or death due to any cause, ranged from 6% to 36%. Other studies have reported complete remission (CR) rates of 40% to 50% with cyclophosphamide, doxorubicin, vincristine, and prednisone (CHOP) chemotherapy[3]. See also Mercadal et al. (2008) Ann Oncol 19(5): 958-63)).

[0004] The most common frontline treatment of PTCL is anthracycline-based chemotherapy with cyclophosphamide, doxorubicin, vincristine, and prednisone (CHOP) or CHOP-like regimens which do not result in durable remissions for the majority of patients. In several studies in newly diagnosed patients with PTCL, anthracycline-containing regimens resulted in suboptimal overall response rates ranging from 39% to 84% with low numbers of complete remissions.[2-4] In a retrospective analysis, the addition of etoposide to standard CHOP therapy

(CHOEP) resulted in improved 3-year event-free survival in younger ALK-positive sALCL patients (<60 years old) with a normal lactate dehydrogenase; no difference in overall survival was observed[5]. An optimal therapy for PTCL has not been identified, partly because previous studies have been limited by retrospective study design, inclusion of subgroups with varying prognoses, and small subject numbers[2,6-11]. The largest retrospective study to date is from the International Peripheral T-cell Lymphoma Project[1]. The study found that for the nodal subtypes PTCL-NOS, AITL, ALK-negative ALCL, and ALK-positive ALCL, the 5-year overall survival was 32%, 32%, 49%, and 70%, respectively. The high rate of subsequent disease progression among patients responding to frontline therapy has led some researchers to employ stem cell transplant (SCT) as a means of improving long-term outcomes; however, no randomized studies have been conducted. Even with intensified approaches to frontline therapy, such as including etoposide or transplant, most patients fail to respond[8,12].

SUMMARY

[0005] The present disclosure provides methods for treating peripheral T cell lymphoma comprising administering an anti-CD30 antibody-drug conjugate administered in combination with a chemotherapy regimen. It is contemplated that the therapeutic regimen may include chemotherapeutics known in the field of cancer treatment. Exemplary chemotherapeutics are disclosed in greater detail in the Detailed Description. In various embodiments, the methods herein include treatment comprising a chemotherapy consisting essentially of cyclophosphamide, doxorubicin and prednisone (CHP).

[0006] In one aspect, the disclosure provides a method of administering an anti-CD30 drug conjugate, e.g., brentuximab vedotin, to a subject having a peripheral T cell lymphoma every three weeks. The peripheral T cell lymphoma may be more particularly diagnosed as, for example, systemic anaplastic large cell lymphoma (sALCL), angioimmunoblastic T-cell lymphoma (AITL), peripheral T-cell lymphoma-not otherwise specified (PTCL-NOS), Adult T-Cell Leukemia/Lymphoma (ATLL), Enteropathy-associated T-cell lymphoma (EATL) and Hepatosplenic T-cell lymphoma. In various embodiments, the anti-CD30 antibody drug conjugate is administered at a dose of 1.8 mg/kg.

[0007] In various embodiments, the PTCL is a sALCL. In various embodiments, the sALCL is selected from the group consisting of anaplastic lymphoma kinase positive (ALK+) sALCL and anaplastic lymphoma kinase negative (ALK-) sALCL. In various embodiments, the sALCL is an ALK+ sALCL. In various embodiments, the sALCL is an ALK- sALCL.

[0008] In various embodiments, the PTCL is not a sALCL. In various embodiments, the PTCL is selected from the group consisting of angioimmunoblastic T-cell lymphoma (AITL), peripheral T-cell lymphoma-not otherwise specified (PTCL-NOS), Adult T-Cell Leukemia/Lymphoma (ATLL), Enteropathy-associated T-cell lymphoma (EATL) and Hepatosplenic T-cell lymphoma.

[0009] In various embodiments, the PTCL is not an AITL. In various embodiments, the PTCL is selected from the group consisting of systemic anaplastic large cell lymphoma (sALCL), peripheral T-cell lymphoma-not otherwise specified (PTCL-NOS), Adult T-Cell Leukemia/Lymphoma (ATLL), Enteropathy-associated T-cell lymphoma (EATL) and Hepatosplenic T-cell lymphoma.

[0010] In various embodiments, the subject has an International Prognostic Index (IPI) score of 0 or 1. In various embodiments, the subject has an International Prognostic Index (IPI) score ≥ 2. In various embodiments, the subject has an International Prognostic Index (IPI) score of 2 or 3. In various embodiments, the subject has an International Prognostic Index (IPI) score ≥ 4. In various embodiments, the subject has an International Prognostic Index (IPI) score of 4 or 5.

[0011] In various embodiments, the subject has a Baseline ECOG Status of 0 or 1. In various embodiments, the subject has a Baseline ECOG Status of 2.

[0012] In various embodiments, the subject is newly disgnosed with PTCL and/or has not previously been treated for a hematologic cancer. In various embodiments, the subject has previously been treated for a hematologic cancer. In various embodiments, the cancer has relapsed or is refractory.

[0013] In various embodiments, the PTCL is a stage III or stage IV PTCL.

[0014] In various embodiments, the PTCL is a CD30-expressing PTCL tumor. In various embodiments, the PTCL is a CD30-expressing PTCL and the CD30 expression is ≥10% of lymphoma cells.

[0015] In various embodiments, the CD30 expression is measured by a FDA approved test. Exemplary tests include local pathology assessment in a CD30-qualified laboratory; CD30 positivity confirmed in diagnostic biopsy using immunohistochemistry. The 3 following criteria were used to declare CD30 positivity:

1) CD30 detected in 10% or greater of neoplastic cells (in cases where enumeration of neoplastic cells was not possible, total lymphocytes may have been used).

2) CD30 staining at any intensity above background.

3) Membranous, cytoplasmic, and/or golgi pattern of expression of the CD30 antigen.

[0016] In various embodiments, the combination therapy is administered every three weeks. In various embodiments, the combination therapy is administered on day 1 of a 21 day cycle. In various embodiments, the ADC + CHP combination therapy is administered for no more than eight cycles. In various embodiments, the ADC +CHP combination therapy is administered for six to eight cycles. In various embodiments, the A+CHP therapy is administered for 4, 5, 6, 7 or 8 cycles. Optionally, the subject receives single-agent anti-CD30 antibody drug conjugate, e.g., brentuximab vedotin, for eight to 10 additional cycles for a total of 16 cycles. In various embodiments, the anti-CD30 antibody drug conjugate is administered at 1.8 mg/kg with CHP combination therapy.

[0017] In various embodiments, the ADC or combination therapy is administered until a PET scan determines there is no tumor or progression of tumor.

[0018] In various embodiments, the anti-CD30 antibody of the anti-CD30 antibody drug conjugate comprises i) a heavy chain CDR1 set out in SEQ ID NO: 4, a heavy chain CDR2 set out in SEQ ID NO: 6, a heavy chain CDR3 set out in SEQ ID NO: 8; and ii) a light chain CDR1 set out in SEQ ID NO: 12, a light chain CDR2 set out in SEQ ID NO: 14, and a light chain CDR13 set out in SEQ ID NO: 16.

[0019] In various embodiments, the anti-CD30 antibody of the anti-CD30 antibody drug conjugate also comprises i) an amino acid sequence at least 85% identical to a heavy chain variable region set out in SEQ ID NO: 2 and ii) an amino acid sequence at least 85% identical to a light chain variable region set out in SEQ ID NO: 10. It is contemplated that the amino acid variable region sequence can be 90%, 95%, 96% 97%, 98% or 99% identical to either SEQ ID NO: 2 or SEQ ID NO: 10.

[0020] In various embodiments, the anti-CD30 antibody of the anti-CD30 antibody drug conjugate is a monoclonal anti-CD30 antibody. In various embodiments, the anti-CD30 antibody of the anti-CD30 antibody drug conjugate is a chimeric AC10 antibody.

[0021] In various embodiments, the antibody drug conjugate comprises monomethyl auristatin E and a protease-cleavable linker. In various embodiments, the protease cleavable linker is comprises a thiolreactive spacer and a dipeptide. In various embodiments, the protease cleavable linker consists of a thiolreactive maleimidocaproyl spacer, a valine–citrulline dipeptide, and a p-amino-benzyloxycarbonyl spacer.

[0022] In various embodiments, the antibody is an IgG antibody, preferably an IgG1 antibody.

[0023] In various embodiments, the anti-CD30 antibody drug conjugate is brentuximab vedotin.

[0024] In various embodiments, the subject is also receiving a chemotherapy consisting essentially of cyclophosphamide, doxorubicin and prednisone (CHP) as a combination therapy. In various embodiments, the cyclophosphamide is administered at 750 mg/m^2, doxorubicin is administered at 50 mg/m^2, and prednisone is administered at 100 mg on days 1 to 5 of a 21 day cycle.

[0025] In various embodiments, the anti-CD30 antibody drug conjugate is brentuximab vedotin and is administered at 1.8 mg/kg, cyclophosphamide is administered at 750 mg/m^2, doxorubicin is administered at 50 mg/m^2, and prednisone is administered at 100 mg on days 1 to 5 of a 21 day cycle.

[0026] In a third aspect, the disclosure provides a method of treating a subject having peripheral T cell lymphoma comprising administering as frontline treatment an effective amount of a composition comprising bretuximab vedotin (A) in combination with chemotherapy consisting of cyclophosphamide, doxorubicin and prednisone (CHP), wherein the brentuximab vedotin is administered at 1.8 mg/kg every two weeks, cyclophosphamide is administered at 750 mg/m^2 on day 1 of a 21 day cycle, doxorubicin is administered at 50 mg/m^2 on day 1 of a 21 day cycle, and prednisone is administered at 100 mg on days 1 to 5 of a 21 day cycle, until a maximum of eight cycles, and wherein the brentuximab vedotin is administered within about 1 hour after administration of the CHP therapy; optionally the subject is characterized by one or more of the following: (1) ALK-positive sALCL with an IPI score greater than or equal to 2, ALK-negative sALCL, PTCL-NOS, AITL, Adult T-cell leukemia/lymphoma (ATLL; acute and lymphoma types only, must be positive for human T-cell leukemia virus 1), Enteropathy-associated T-cell lymphoma (EATL), Hepatosplenic T-cell lymphoma; (2) Fluorodeoxyglucose (FDG)-avid disease by PET and measurable disease of at least 1.5 cm by CT, or (3) an Eastern Cooperative Oncology Group (ECOG) performance status prior to therapy of 2 or less. The methods herein further provide that progression free survival (PFS) of the subject after therapy is maintained for greater than 1 year. In various embodiments, the progression free survival (PFS) of the subject after therapy is maintained for approximately 2 years. In certain embodiments, after six to eight cycles of A+CHP therapy the subject has a Deauville score of 3 or less, or 2 or less.

[0027] It is specifically provided herein that all aspects of the disclosure described above with the methods of treatment are applicable to the anti-CD30 antibody drug conjugate for use in any of the indications described above.

[0028] It is understood that each feature or embodiment, or combination, described herein is a non-limiting, illustrative example of any of the aspects of the invention and, as such, is meant to be combinable with any other feature or embodiment, or combination, described herein. For example, where features are described with language such as “one embodiment”, “some embodiments”, “certain embodiments”, “further embodiment”, “specific exemplary embodiments”, and/or “another embodiment”, each of these types of embodiments is a non-limiting example of a feature that is intended to be combined with any other feature, or combination of features, described herein without having to list every possible combination. Such features or combinations of features apply to any of the aspects of the invention. Where examples of values falling within ranges are disclosed, any of these examples are contemplated as possible endpoints of a range, any and all numeric values between such endpoints are contemplated, and any and all combinations of upper and lower endpoints are envisioned.

DETAILED DESCRIPTION

[0029] The present disclosure provides methods for treating peripheral T cell lymphomas comprising administering an anti-CD30 antibody drug conjugate, optionally in combination with a chemotherapeutic regimen.

[0030] **Definitions**

[0031] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The following references provide one of skill with a general definition of many of the terms used in this invention: Singleton et al., DICTIONARY OF MICROBIOLOGY AND MOLECULAR BIOLOGY (2d ed. 1994); THE CAMBRIDGE DICTIONARY OF SCIENCE AND TECHNOLOGY (Walker ed., 1988); THE GLOSSARY OF GENETICS, 5TH ED., R. Rieger et al. (eds.), Springer Verlag (1991); and Hale & Marham, THE HARPER COLLINS DICTIONARY OF BIOLOGY (1991).

[0032] Each publication, patent application, patent, and other reference cited herein is incorporated by reference in its entirety to the extent that it is not inconsistent with the present disclosure.

[0033] As used herein and in the appended claims, the singular forms "a," "and," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a derivative" includes a plurality of such derivatives and reference to "a subject" includes reference to one or more subjects and so forth.

[0034] It is to be further understood that where descriptions of various embodiments use the term "comprising," those skilled in the art would understand that in some specific instances, an embodiment can be alternatively described using language "consisting essentially of" or "consisting of."

[0035] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice of the disclosed methods and compositions, the exemplary methods, devices and materials are described herein.

[0036] “Therapeutically effective amount” as used herein refers to that amount of an agent effective to produce the intended beneficial effect on health.

[0037] A “therapy” as used herein refers to either single agent therapy with anti-CD30 antibody drug conjugate or a combination therapy comprising anti-CD30 drug conjugate in combination with a chemotherapeutic regimen. A preferred embodiment includes combination therapy comprising administering an anti-CD30 antibody drug conjugate with a chemotherapy consisting essentially of cyclophosphamide, doxorubicin and prednisone (CHP therapy).

[0038] “Antibody +CHP therapy”, or “A+CHP therapy” as used herein refers to treatment of a subject with an anti-CD30 antibody drug conjugate as described herein in combination with chemotherapy consisting essentially of cyclophosphamide, doxorubicin and prednisone therapy (CHP therapy).

[0039] "Lymphoma" as used herein is hematological malignancy that usually develops from hyper-proliferating cells of lymphoid origin. Lymphomas are sometimes classified into two major types: Hodgkin lymphoma (HL) and non-Hodgkin lymphoma (NHL). Lymphomas may also be classified according to the normal cell type that most resemble the cancer cells in accordance with phenotypic, molecular or cytogenic markers. Lymphoma subtypes under that classification include without limitation mature B-cell neoplasms, mature T cell and natural killer (NK) cell neoplasms, Hodgkin lymphoma and immunodeficiency-associated lympho-proliferative disorders. Lymphoma subtypes include precursor T-cell lymphoblastic lymphoma (sometimes

referred to as a lymphoblastic leukemia since the T-cell lymphoblasts are produced in the bone marrow), follicular lymphoma, diffuse large B cell lymphoma, mantle cell lymphoma, B-cell chronic lymphocytic lymphoma (sometimes referred to as a leukemia due to peripheral blood involvement), MALT lymphoma, Burkitt's lymphoma, mycosis fungoides and its more aggressive variant Sezary's disease, peripheral T-cell lymphomas not otherwise specified, nodular sclerosis of Hodgkin lymphoma, and mixed-cellularity subtype of Hodgkin lymphoma.

[0040] "Peripheral T Cell lymphoma" refers to a subset of heterogeneous, aggressive non-Hodgkin lymphoma (NHL). As used herein "peripheral" does not refer to the extremities, but identifies PTCL as a cancer that arises in the lymphoid tissues outside of the bone marrow, such as lymph nodes, spleen, gastrointestinal tract, and skin (e.g., cutaneous peripheral T cell lymphoma). (Lymphoma Research Foundation https://www.lymphoma.org/aboutlymphoma/nhl/ptcl/ PTCL can include involvement of T cells and natural killer (NK) cells. PTCL are different than cutaneous T cell lymphoma (CTCL), which originate in the skin. Peripheral T cell lymphoma includes systemic anaplastic large cell lymphoma (sALCL), angioimmunoblastic T-cell lymphoma (AITL), peripheral T-cell lymphoma-not otherwise specified (PTCL-NOS), Adult T-Cell Leukemia/Lymphoma (ATLL), Enteropathy-associated T-cell lymphoma (EATL) and Hepatosplenic T-cell lymphoma. See below

PTCL sub-type	**Total Patients[1,2,3]**	**CD30-Expression at 10% Threshold[4]**	**CD30-Expression at 5% Threshold[4*]**	**CD30-Expression at 1% Threshold[5]**
ALCL	~1950	100%	100%	100%
PTCL-NOS	~2300	52%	58%	Insufficient Data
AITL	~1700	50%	63%	
ATLL	~450	53%	56%	
EATL	~200	50%	50%	
Total	**~6,600**	**~4,200**	**~4,700 (+12%)**	

1. SEER: https://seer.cancer.gov/statfacts/html/nhl.html Projected number of new NHL cases in 2018: 74,680

2. Blood: http://www.bloodjournal.org/content/89/11/3909.long?sso-checked=true: PTCL accounts for 12% of NHL malignancies
3. Annals of Oncology: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4481543/: Subtypes by percentage
4. Blood: http://www.bloodjournal.org/cgi/pmidlookup?view=long&pmid=25224410: CD30 expression rates for subtypes
5. Haematologica: http://www.haematologica.org/content/98/8/e81: **CD30 expression by subtype**

[0041] "Leukemia" as the term is used herein is a hematological malignancy that usually develops from hyper-proliferating cells of myeloid origin, and include without limitation, acute lymphoblastic leukemia (ALL), acute myelogenous leukemia (AML), chronic lymphocytic leukemia (CLL), chronic myelogenous leukemia (CML) and acute monocyctic leukemia (AMoL). Other leukemias include hairy cell leukemia (HCL), T-cell lymphatic leukemia (T-PLL), large granular lymphocytic leukemia and adult T-cell leukemia.

[0042] The term "pharmaceutically acceptable" as used herein refers to those compounds, materials, compositions, and/or dosage forms that are, within the scope of sound medical judgment, suitable for contact with the tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problems or complications commensurate with a reasonable benefit/risk ratio. The term "pharmaceutically compatible ingredient" refers to a pharmaceutically acceptable diluent, adjuvant, excipient, or vehicle with which an antibody-drug conjugate is administered.

[0043] The terms "specific binding" and "specifically binds" mean that the anti-CD30 antibody will react, in a highly selective manner, with its corresponding target, CD30, and not with the multitude of other antigens.

[0044] The term "monoclonal antibody" refers to an antibody that is derived from a single cell clone, including any eukaryotic or prokaryotic cell clone, or a phage clone, and not the method by which it is produced. Thus, the term "monoclonal antibody" as used herein is not limited to antibodies produced through hybridoma technology.

[0045] The terms "identical" or "percent identity," in the context of two or more nucleic acids or polypeptide sequences, refer to two or more sequences or subsequences that are the same or have a specified percentage of nucleotides or amino acid residues that are the same, when compared and aligned for maximum correspondence. To determine the percent identity, the sequences are aligned for optimal comparison purposes (e.g., gaps can be introduced in the sequence of a first amino acid or nucleic acid sequence for optimal alignment with a second amino or nucleic acid sequence). The amino acid residues or nucleotides at corresponding amino acid positions or nucleotide positions are then compared. When a position in the first sequence is occupied by the same amino acid residue or nucleotide as the corresponding

position in the second sequence, then the molecules are identical at that position. The percent identity between the two sequences is a function of the number of identical positions shared by the sequences (i.e., % identity=# of identical positions/total # of positions (e.g., overlapping positions)x100). In certain embodiments, the two sequences are the same length.

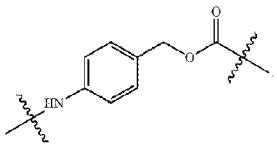
[0046] The term "substantially identical," in the context of two nucleic acids or polypeptides, refers to two or more sequences or subsequences that have at least 70% or at least 75% identity; more typically at least 80% or at least 85% identity; and even more typically at least 90%, at least 95%, or at least 98% identity (for example, as determined using one of the methods set forth below).

[0047] The determination of percent identity between two sequences can be accomplished using a mathematical algorithm. A preferred, non-limiting example of a mathematical algorithm utilized for the comparison of two sequences is the algorithm of Karlin and Altschul, 1990, Proc. Natl. Acad. Sci. USA 87:2264-2268, modified as in Karlin and Altschul, 1993, Proc. Natl. Acad. Sci. USA 90:5873-5877. Such an algorithm is incorporated into the NBLAST and XBLAST programs of Altschul, et al., 1990, J. Mol. Biol. 215:403-410. BLAST nucleotide searches can be performed with the NBLAST program, score=100, wordlength=12 to obtain nucleotide sequences homologous to a nucleic acid encoding a protein of interest. BLAST protein searches can be performed with the XBLAST program, score=50, wordlength=3 to obtain amino acid sequences homologous to protein of interest. To obtain gapped alignments for comparison purposes, Gapped BLAST can be utilized as described in Altschul et al., 1997, Nucleic Acids Res. 25:3389-3402. Alternatively, PSI-Blast can be used to perform an iterated search which detects distant relationships between molecules (Id.). Another preferred, non-limiting example of a mathematical algorithm utilized for the comparison of sequences is the algorithm of Myers and Miller, CABIOS (1989). Such an algorithm is incorporated into the ALIGN program (version 2.0) which is part of the GCG sequence alignment software package. Additional algorithms for sequence analysis are known in the art and include ADVANCE and ADAM as described in Torellis and Robotti, 1994, Comput. Appl. Biosci. 10:3-5; and FASTA described in Pearson and Lipman, 1988, Proc. Natl. Acad. Sci. 85:2444-8. Alternatively, protein sequence alignment may be carried out using the CLUSTAL W algorithm, as described by Higgins et al., 1996, Methods Enzymol. 266:383-402.

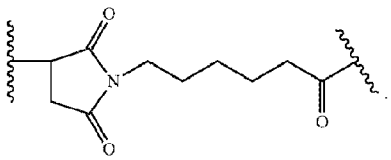
[0048] The abbreviation "MMAE" refers to monomethyl auristatin E.

[0049] The abbreviations "vc" and "val-cit" refer to the dipeptide valine-citrulline.

[0050] The abbreviation "PAB" refers to the self-immolative spacer:



[0051] The abbreviation "MC" refers to the stretcher maleimidocaproyl:



[0052] cAC10-MC-vc-PAB-MMAE refers to a chimeric AC10 antibody conjugated to the drug MMAE through a MC-vc-PAB linker.

[0053] An anti-CD30 vc-PAB-MMAE antibody-drug conjugate refers to an anti-CD30 antibody conjugated to the drug MMAE via a linker comprising the dipeptide valine citrulline and the self-immolative spacer PAB as shown in Formula (I) of US Patent No. 9,211,319.

Antibodies

[0054] Murine anti-CD30 mAbs known in the art have been generated by immunization of mice with Hodgkin's disease (HD) cell lines or purified CD30 antigen. AC10, originally termed C10 (Bowen et al., 1993, J. Immunol. 151:5896 5906), is distinct in that this anti-CD30 mAb that

was prepared against a hum an NK-like cell line, YT (Bowen et al., 1993, J. Immunol. 151:5896 5906). Initially, the signaling activity of this mAb was evidenced by the down regulation of the cell surface expression of CD28 and CD45 molecules, the up regulation of cell surface CD25 expression and the induction of homotypic adhesion following binding of C10 to YT cells. Sequences of the AC10 antibody are set out in SEQ ID NO: 1-16 and Table A below. See also US Patent No. 7,090,843, incorporated herein by reference, which discloses a chimeric AC10 antibody.

[0055] Generally, antibodies of the disclosure immunospecifically bind CD30 and exert cytostatic and cytotoxic effects on malignant cells in Hodgkin's disease and mature T cell lymphoma. Antibodies of the disclosure are preferably monoclonal, and may be multispecific, human, humanized or chimeric antibodies, single chain antibodies, Fab fragments, F(ab') fragments, fragments produced by a Fab expression library, and CD30 binding fragments of any of the above. The term "antibody," as used herein, refers to immunoglobulin molecules and immunologically active portions of immunoglobulin molecules, i.e., molecules that contain an antigen binding site that immunospecifically binds CD30. The immunoglobulin molecules of the disclosure can be of any type (e.g., IgG, IgE, IgM, IgD, IgA and IgY), class (e.g., IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2) or subclass of immunoglobulin molecule.

[0056] In certain embodiments of the disclosure, the antibodies are human antigen-binding antibody fragments of the present disclosure and include, but are not limited to, Fab, Fab' and $F(ab')_2$, Fd, single-chain Fvs (scFv), single-chain antibodies, disulfide-linked Fvs (sdFv) and fragments comprising either a V_L or V_H domain. Antigen-binding antibody fragments, including single-chain antibodies, may comprise the variable region(s) alone or in combination with the entirety or a portion of the following: hinge region, CH1, CH2, CH3 and CL domains. Also included in the disclosure are antigen-binding fragments also comprising any combination of variable region(s) with a hinge region, CH1, CH2, CH3 and CL domains. Preferably, the antibodies are human, murine (e.g., mouse and rat), donkey, sheep, rabbit, goat, guinea pig, camelid, horse, or chicken. As used herein, "human" antibodies include antibodies having the amino acid sequence of a human immunoglobulin and include antibodies isolated from human immunoglobulin libraries, from human B cells, or from animals transgenic for one or more human immunoglobulin, as described infra and, for example in U.S. Pat. No. 5,939,598 by Kucherlapati et al.

[0057] The antibodies of the present disclosure may be monospecific, bispecific, trispecific or of greater multi specificity. Multispecific antibodies may be specific for different epitopes of

CD30 or may be specific for both CD30 as well as for a heterologous protein. See, e.g., PCT publications WO 93/17715; WO 92/08802; WO 91/00360; WO 92/05793; Tutt, et al., 1991, J. Immunol. 147:60 69; U.S. Pat. Nos. 4,474,893; 4,714,681; 4,925,648; 5,573,920; 5,601,819; Kostelny et al., 1992, J. Immunol. 148:1547 1553.

[0058] Antibodies of the present disclosure may be described or specified in terms of the particular CDRs they comprise. In certain embodiments antibodies of the disclosure comprise one or more CDRs of AC10. The disclosure encompasses an antibody or derivative thereof comprising a heavy or light chain variable domain, said variable domain comprising (a) a set of three CDRs, in which said set of CDRs are from monoclonal antibody AC10, and (b) a set of four framework regions, in which said set of framework regions differs from the set of framework regions in monoclonal antibody AC 10,and in which said antibody or derivative thereof immunospecifically binds CD30.

[0059] In a specific embodiment, the disclosure encompasses an antibody or derivative thereof comprising a heavy chain variable domain, said variable domain comprising (a) a set of three CDRs, in which said set of CDRs comprises SEQ ID NO:4, 6, or 8 and (b) a set of four framework regions, in which said set of framework regions differs from the set of framework regions in monoclonal antibody AC10, and in which said antibody or derivative thereof immunospecifically binds CD30.

[0060] In various embodiments, the invention encompasses an antibody or derivative thereof comprising a light chain variable domain, said variable domain comprising (a) a set of three CDRs, in which said set of CDRs comprises SEQ ID NO:12, 14 or 16, and (b) a set of four framework regions, in which said set of framework regions differs from the set of framework regions in monoclonal antibody AC10, and in which said antibody or derivative thereof immunospecifically binds CD30.

[0061] Additionally, antibodies of the present disclosure may also be described or specified in terms of their primary structures. Antibodies having at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95% and most preferably at least 98% identity (as calculated using methods known in the art and described herein) to the variable regions of AC10 are also included in the present invention, and preferably include the CDRs of AC10. Antibodies of the present invention may also be described or specified in terms of their binding affinity to CD30. Preferred binding affinities include those with a dissociation constant or Kd less than 5 x10 ^{2} M, 10^{-2} M, $5x10^{-3}$ M, 10^{-3} M, $5x10^{-4}$ M, 10^{-4} M, $5x10^{-5}$ M, 10^{-5} M, $5x10^{-6}$ M, 10^{-6} M, $5x10^{-7}$ M, 10^{-7} M, $5x10^{-8}$ M, 10^{-8}M, $5x10^{-9}$ M,

10^{-9} M, $5x10^{-10}$ M, 10^{-10} M, $5x10^{-11}$ M, 10^{-11} M, $5x10^{-12}$ M, 10^{-12} M, $5x10^{-13}$ M, 10^{-13} M, $5x10^{-14}$ M, 10^{-14} M, $5x10^{-15}$ M, or 10^{-15} M.

[0062] The antibodies also include derivatives that are modified, i.e., by the covalent attachment of any type of molecule to the antibody such that covalent attachment does not prevent the antibody from binding to CD30 or from exerting a cytostatic or cytotoxic effect on Hodgkin's Disease cells. For example, but not by way of limitation, the antibody derivatives include antibodies that have been modified, e.g., by glycosylation, acetylation, PEGylation, phosphylation, amidation, derivatization by known protecting/blocking groups, proteolytic cleavage, linkage to a cellular ligand or other protein, etc. Any of numerous chemical modifications may be carried out by known techniques, including, but not limited to specific chemical cleavage, acetylation, formylation, metabolic synthesis of tunicamycin, etc. Additionally, the derivative may contain one or more non-classical amino acids.

[0063] The antibodies of the present invention may be generated by any suitable method known in the art.

[0064] The invention further provides nucleic acids comprising a nucleotide sequence encoding a protein, including but not limited to, a protein of the invention and fragments thereof. Nucleic acids of the invention preferably encode one or more CDRs of antibodies that bind to CD30 and exert cytotoxic or cytostatic effects on HD cells. Exemplary nucleic acids of the invention comprise SEQ ID NO:3, SEQ ID NO:5, SEQ ID NO:7, SEQ ID NO:11, SEQ ID NO:13, or SEQ ID NO:15. Variable region nucleic acids of the invention comprise SEQ ID NO:1 or SEQ ID NO:9. (See Table A).

Table A

MOLECULE	NUCLEOTIDE OR AMINO ACID	SEQ ID NO
AC 10 Heavy Chain Variable Region	Nucleotide	1
AC 10 Heavy Chain Variable Region	Amino Acid	2
AC 10 Heavy Chain-CDR1 (H1)	Nucleotide	3
AC 10 Heavy Chain-CDR1 (H1)	Amino Acid	4
AC 10 Heavy Chain-CDR2 (H2)	Nucleotide	5
AC 10 Heavy Chain-CDR2 (H2)	Amino Acid	6
AC 10 Heavy Chain-CDR3 (H3)	Nucleotide	7
AC 10 Heavy Chain-CDR3 (H3)	Amino Acid	8
AC 10 Light Chain Variable Region	Nucleotide	9
AC 10 Light Chain Variable Region	Amino Acid	10
AC 10 Light Chain-CDR1 (L1)	Nucleotide	11
AC 10 Light Chain-CDR1 (L1)	Amino Acid	12
AC 10 Light Chain-CDR2 (L2)	Nucleotide	13

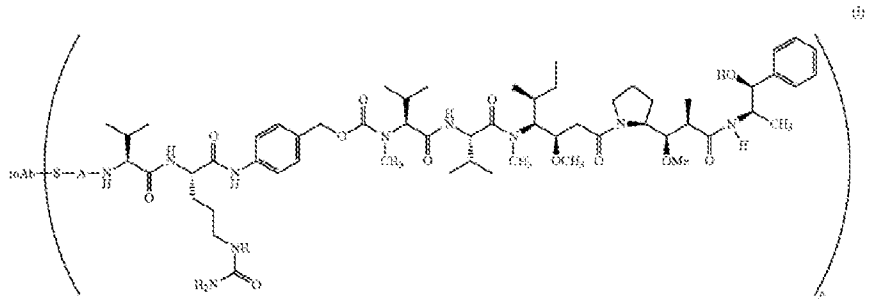
AC 10 Light Chain-CDR2 (L2)	Amino Acid	14
AC 10 Light Chain-CDR3 (L3)	Nucleotide	15
AC 10 Light Chain-CDR3 (L3)	Amino Acid	16

[0065] In various embodiments, the antibody is an IgG antibody, e.g. an IgG1, IgG2, IgG3 or IgG4 antibody, preferably an IgG1 antibody.

Antibody-Drug Conjugates

[0066] Contemplated herein is the use of antibody drug conjugates comprising an anti-CD30 antibody, covalently linked to MMAE through a vc-PAB linker. The antibody drug conjugates are delivered to the subject as a pharmaceutical composition. CD30 antibody drug conjugates are described in US Patent No. 9,211,319, herein incorporated by reference.

[0067] In various embodiments, the antibody-drug conjugates of the present invention have the following formula:



[0068] or a pharmaceutically acceptable salt thereof; wherein: mAb is an anti-CD30 antibody, S is a sulfur atom of the antibody A- is a Stretcher unit, p is from about 3 to about 5.

[0069] The drug loading is represented by p, the average number of drug molecules per antibody in a pharmaceutical composition. For example, if p is about 4, the average drug loading taking into account all of the antibody present in the pharmaceutical composition is about 4. P ranges from about 3 to about 5, more preferably from about 3.6 to about 4.4, even more preferably from about 3.8 to about 4.2. P can be about 3, about 4, or about 5. The average number of drugs per antibody in preparation of conjugation reactions may be characterized by conventional means such as mass spectroscopy, ELISA assay, and HPLC. The quantitative distribution of antibody-drug conjugates in terms of p may also be determined. In some

instances, separation, purification, and characterization of homogeneous antibody-drug-conjugates where p is a certain value from antibody-drug-conjugates with other drug loadings may be achieved by means such as reverse phase HPLC or electrophoresis.

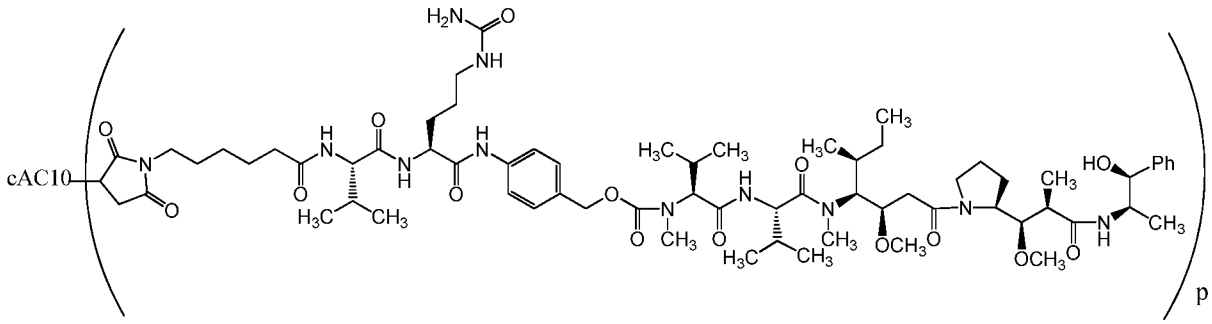
[0070] The Stretcher unit (A), is capable of linking an antibody unit to the valine-citrulline amino acid unit via a sulfhydryl group of the antibody. Sulfhydryl groups can be generated, for example, by reduction of the interchain disulfide bonds of an anti-CD30 antibody. For example, the Stretcher unit can be linked to the antibody via the sulfur atoms generated from reduction of the interchain disulfide bonds of the antibody. In some embodiments, the Stretcher units are linked to the antibody solely via the sulfur atoms generated from reduction of the interchain disulfide bonds of the antibody. In some embodiments, sulfhydryl groups can be generated by reaction of an amino group of a lysine moiety of an anti-CD30 antibody with 2-iminothiolane (Traut's reagent) or other sulfhydryl generating reagents. In certain embodiments, the anti-CD30 antibody is a recombinant antibody and is engineered to carry one or more lysines. In certain other embodiments, the recombinant anti-CD30 antibody is engineered to carry additional sulfhydryl groups, e.g., additional cysteines.

[0071] The synthesis and structure of MMAE is described in U.S. Pat. No. 6,884,869 incorporated by reference herein in its entirety and for all purposes. The synthesis and structure of exemplary Stretcher units and methods for making antibody drug conjugates are described in, for example, U.S. Publication Nos. 2006/0074008 and 2009/0010945 each of which is incorporated herein by reference in its entirety.

[0072] Representative Stretcher units are described within the square brackets of Formulas IIIa and IIIb of US Patent 9,211,319, and incorporated herein by reference.

[0073] In various embodiments, the antibody drug conjugate comprises monomethyl auristatin E and a protease-cleavable linker. It is contemplated that the protease cleavable linker is comprises a thiolreactive spacer and a dipeptide. In various embodiments, the protease cleavable linker consists of a thiolreactive maleimidocaproyl spacer, a valine–citrulline dipeptide, and a p-amino-benzyloxycarbonyl spacer.

[0074] In a preferred embodiment, the antibody drug conjugate is brentuximab vedotin, an antibody-drug conjugate which has the structure:



[0075] Brentuximab vedotin is a CD30-directed antibody-drug conjugate consisting of three components: (i) the chimeric IgG1 antibody cAC10, specific for human CD30, (ii) the microtubule disrupting agent MMAE, and (iii) a protease-cleavable linker that covalently attaches MMAE to cAC10. The drug to antibody ratio or drug loading is represented by "p" in the structure of brentuximab vedotin and ranges in integer values from 1 to 8. The average drug loading brentuximab vedotin in a pharmaceutical composition is about 4.

Methods of Use

[0076] Provided herein are improved methods for administering anti-CD30 antibody-drug conjugate to a subject suffering from a peripheral T cell lymphoma. In various embodiments, the chemotherapy regimen consists essentially of cyclophosphamide, doxorubicin and/or prednisone, preferably as A+CHP therapy.

[0077] Additional chemotherapeutic agents are disclosed in the following table and may be used alone or in combination with one or more additional chemotherapeutic agents, which in turn can also be administered in combination with an anti-CD30 antibody drug conjugate.

Chemotherapeutic Agents

Alkylating agents	**Natural products**
Nitrogen mustards	Antimitotic drugs
mechlorethamine	
cyclophosphamide	Taxanes
ifosfamide	paclitaxel
melphalan	Vinca alkaloids
chlorambucil	vinblastine (VLB)
	vincristine
Nitrosoureas	vindesine
carmustine (BCNU)	vinorelbin
lomustine (CCNU)	Taxotere® (docetaxel)
semustine (methyl-CCNU)	estramustine
Ethylenimine/Methyl-melamine	
thriethylenemelamine (TEM)	
triethylene thiophosphoramide	

(thiotepa) hexamethylmelamine (HMM, altretamine) Alkyl sulfonates busulfan Triazines dacarbazine (DTIC) **Antimetabolites** Folic Acid analogs methotrexate Trimetrexate Pemetrexed (Multi-targeted antifolate) Pyrimidine analogs 5-fluorouracil fluorodeoxyuridine gemcitabine cytosine arabinoside (AraC, cytarabine) 5-azacytidine 2,2´- difluorodeoxy-cytidine Purine analogs 6-mercaptopurine 6-thioguanine azathioprine 2'-deoxycoformycin (pentostatin) erythrohydroxynonyl-adenine (EHNA) fludarabine phosphate 2-chlorodeoxyadenosine (cladribine, 2-CdA) **Type I Topoisomerase Inhibitors** camptothecin topotecan irinotecan **Biological response modifiers** G-CSF GM-CSF **Differentiation Agents** retinoic acid derivatives **Hormones and antagonists** Adrenocorticosteroids/ antagonists	estramustine phosphate Epipodophylotoxins etoposide teniposide Antibiotics actimomycin D daunomycin (rubido-mycin) doxorubicin (adria-mycin) mitoxantrone idarubicin epirubicin valrubicin bleomycin splicamycin (mithramycin) mitomycinC dactinomycin aphidicolin Enzymes L-asparaginase L-arginase **Radiosensitizers** metronidazole misonidazole desmethylmisonidazole pimonidazole etanidazole nimorazole RSU 1069 EO9 RB 6145 SR4233 nicotinamide 5-bromodeozyuridine 5-iododeoxyuridine bromodeoxycytidine **Miscellaneous agents** bisphosphonates **RANKL inhibitor** denosumab Platinium coordination complexes cisplatin carboplatin oxaliplatin nthracenedione

calcitonin prednisone and equiv-alents dexamethasone ainoglutethimide Progestins hydroxyprogesterone caproate medroxyprogesterone acetate megestrol acetate Estrogens diethylstilbestrol ethynyl estradiol/ equivalents Antiestrogen tamoxifen Androgens testosterone propionate fluoxymesterone/equivalents Antiandrogens flutamide gonadotropin-releasing hormone analogs leuprolide Nonsteroidal antiandrogens flutamide **Histone Deacetylase Inhibitors** Vorinostat Romidepsin	mitoxantrone Substituted urea hydroxyurea Methylhydrazine derivatives N-methylhydrazine (MIH) procarbazine Adrenocortical suppressant mitotane (*o,p´*- DDD) ainoglutethimide **Cytokines** interferon (α, β, γ) interleukin-2 **Photosensitizers** hematoporphyrin derivatives Photofrin® benzoporphyrin derivatives Npe6 tin etioporphyrin (SnET2) pheoboride-a bacteriochlorophyll-a naphthalocyanines phthalocyanines zinc phthalocyanines **Radiation** X-ray ultraviolet light gamma radiation visible light infrared radiation microwave radiation

[0078] A peripheral T cell lymphoma (PTCL) refers to a hematologic cancer that expresses the CD30 antigen. The CD30 antigen is expressed in large numbers on tumor cells of select PTCLs, including, ALK-positive sALCL with an IPI score greater than or equal to 2, ALK-negative sALCL, PTCL-NOS, AITL, adult T-cell leukemia/lymphoma (ATLL; acute and lymphoma types only, must be positive for human T-cell leukemia virus 1), hepatosplenic T-cell lymphoma, and enteropathy-associated T-cell lymphoma.

[0079] In any of the aspects or embodiments herein, the methods herein provide for treating a subject who is newly diagnosed and/or has not previously been treated for a peripheral T cell

lymphoma, or a subject who has previously been treated for a peripheral T cell lymphoma, but has relapsed or the PTCL is refractory.

[0080] In various embodiments, the disclosure provides a method of treating a subject having newly diagnosed peripheral T cell lymphoma comprising administering an effective amount of a combination therapy comprising brentuximab vedotin in combination with a chemotherapy consisting essentially of cyclophosphamide, doxorubicin, and prednisone (CHP therapy), wherein the brentuximab vedotin is administered at 1.8 mg/kg, cyclophosphamide is administered at 750 mg/m^2, doxorubicin is administered at 50 mg/m^2, and prednisone is administered at 100 mg on days 1 to 5 of a 21 day cycle. It is contemplated that the methods herein provide progression free survival (PFS) of the subject after therapy is maintained for greater than 6 months or 1 year. In various embodiments, the progression free survival (PFS) of the subject after therapy is maintained for approximately 2 years. In certain embodiments, after six to eight cycles of A+CHP therapy the subject has a Deauville score of 3 or less, or 2 or less.

[0081] It is further contemplated that upon completion of therapy with anti-CD30 antibody drug conjugate as described herein, optionally in combination with a chemotherapy regimen, the subject may receive an additional treatment to address one or more symptoms of cancer that remains at the end of treatment, or may be refractory to the therapy herein. Such treatments include, but are not limited to surgery, radiation therapy, proton beam therapy, stem cell transplant, and/or additional chemotherapeutic regimens.

[0082] *Formulations*

[0083] Various delivery systems can be used to administer antibody-drug conjugates. In certain preferred embodiments of the present invention, administration of the antibody-drug conjugate compound is by intravenous infusion. In some embodiments, administration is by a 30 minute, 1 hour or two hour intravenous infusion.

[0084] The antibody-drug conjugate compound can be administered as a pharmaceutical composition comprising one or more pharmaceutically compatible ingredients. For example, the pharmaceutical composition typically includes one or more pharmaceutically acceptable carriers, for example, water-based carriers (e.g., sterile liquids). Water is a more typical carrier when the pharmaceutical composition is administered intravenously.

[0085] The composition, if desired, can also contain, for example, saline salts, buffers, salts, nonionic detergents, and/or sugars. Examples of suitable pharmaceutical carriers are described

in "Remington's Pharmaceutical Sciences" by E. W. Martin. The formulations correspond to the mode of administration.

[0086] The present disclosure provides, for example, pharmaceutical compositions comprising a therapeutically effective amount of the antibody-drug conjugate, a buffering agent, optionally a cryoprotectant, optionally a bulking agent, optionally a salt, and optionally a surfactant. Additional agents can be added to the composition. A single agent can serve multiple functions. For example, a sugar, such as trehalose, can act as both a cryoprotectant and a bulking agent. Any suitable pharmaceutically acceptable buffering agents, surfactants, cyroprotectants and bulking agents can be used in accordance with the present invention.

[0087] In addition to providing methods for treating a CD30-expressing cancer, the present invention provides antibody drug conjugate formulations including drug conjugate formulations that have undergone lyophilization, or other methods of protein preservation, as well as antibody drug formulations that have not undergone lyophilization.

[0088] In some embodiments, the antibody drug conjugate formulation comprises (i) about 1-25 mg/ml, about 3 to about 10 mg/ml of an antibody-drug conjugate, or about 5 mg/ml (e.g., an antibody-drug conjugate of formula I or a pharmaceutically acceptable salt thereof), (ii) about 5-50 mM, preferably about 10 mM to about 25 mM of a buffer selected from a citrate, phosphate, or histidine buffer or combinations thereof, preferably sodium citrate, potassium phosphate, histidine, histidine hydrochloride, or combinations thereof, (iii) about 3% to about 10% sucrose or trehalose or combinations thereof, (iv) optionally about 0.05 to 2 mg/ml of a surfactant selected from polysorbate 20 or polysorbate 80 or combinations thereof; and (v) water, wherein the pH of the composition is from about 5.3 to about 7, preferably about 6.6.

[0089] In some embodiments, an antibody drug conjugate formulation will comprise about 1-25 mg/ml, about 3 to about 10 mg/ml, preferably about 5 mg/ml of an antibody-drug conjugate, (ii) about 10 mM to about 25 mM of a buffer selected from sodium citrate, potassium phosphate, histidine, histidine hydrochloride or combinations thereof, (iii) about 3% to about 7% trehalose or sucrose or combinations thereof, optionally (iv) about 0.05 to about 1 mg/ml of a surfactant selected from polysorbate 20 or polysorbate 80, and (v) water, wherein the pH of the composition is from about 5.3 to about 7, preferably about 6.6.

[0090] In some embodiments, an antibody drug conjugate formulation will comprise about 5 mg/ml of an antibody-drug conjugate, (ii) about 10 mM to about 25 mM of a buffer selected from sodium citrate, potassium phosphate, histidine, histidine hydrochloride or combinations thereof, (iii) about 3% to about 7% trehalose, optionally (iv) about 0.05 to about 1 mg/ml of a surfactant

selected from polysorbate 20 or polysorbate 80, and (v) water, wherein the pH of the composition is from about 5.3 to about 7, preferably about 6.6.

[0091] Any of the formulations described above can be stored in a liquid or frozen form and can be optionally subjected to a preservation process. In some embodiments, the formulations described above are lyophilized, i.e., they are subjected to lyophilization. In some embodiments, the formulations described above are subjected to a preservation process, for example, lyophilization, and are subsequently reconstituted with a suitable liquid, for example, water. By lyophilized it is meant that the composition has been freeze-dried under a vacuum. Lyophilization typically is accomplished by freezing a particular formulation such that the solutes are separated from the solvent(s). The solvent is then removed by sublimation (i.e., primary drying) and next by desorption (i.e., secondary drying).

[0092] The formulations of the present disclosure can be used with the methods described herein or with other methods for treating disease. The antibody drug conjugate formulations may be further diluted before administration to a subject. In some embodiments, the formulations will be diluted with saline and held in IV bags or syringes before administration to a subject. Accordingly, in some embodiments, the methods for treating a mature T cell lymphoma in a subject will comprise administering to a subject in need thereof a weekly dose of a pharmaceutical composition comprising antibody-drug conjugates having formula I wherein the administered dose of antibody-drug conjugates is from about 1.8 mg/kg or 1.2 mg/kg of the subject's body weight to 0.9 mg /kg of the subject's body weight and the pharmaceutical composition is administered for at least three weeks and wherein the antibody drug conjugates, prior to administration to a subject, were present in a formulation comprising (i) about 1-25 mg/ml, preferably about 3 to about 10 mg/ml of the antibody-drug conjugate (ii) about 5-50 mM, preferably about 10 mM to about 25 mM of a buffer selected from sodium citrate, potassium phosphate, histidine, histidine hydrochloride, or combinations thereof, (iii) about 3% to about 10% sucrose or trehalose or combinations thereof, (iv) optionally about 0.05 to 2 mg/ml of a surfactant selected from polysorbate 20 or polysorbate 80 or combinations thereof; and (v) water, wherein the pH of the composition is from about 5.3 to about 7, preferably about 6.6.

[0093] Formulations of chemotherapeutics contemplated for use herein, including cyclophosphamide, doxorubicin and prednisone are provided as typically used in the treatment of cancers. For example, cyclophosphamide, doxorubicin, and prednisone are commercially available and approved by the United States FDA and other regulatory agencies for use in treating patients with multiple types of cancer. Vincristine is commercially available and

approved by the United States FDA and other regulatory agencies for use in patients with multiple types of cancer.

[0094] Administration of study treatment should be according to the institutional standard. Dosing should be based on the patient's baseline (predose, Cycle 1 Day 1) height and weight or per institutional standards at the site. Vincristine is typically administered as an IV push, and will be given on Day 1 of each 21-day cycle. Dosing should be based on the patient's baseline (predose, Cycle 1 Day 1) height and weight or per institutional standards at the site.

[0095] The present disclosure also provides kits for the treatment of a mature T cell lymphoma. The kit can comprise (a) a container containing the antibody-drug conjugate and optionally, containers comprising one or more of cyclophosphamide, doxorubicin and/or prednisone. Such kits can further include, if desired, one or more of various conventional pharmaceutical kit components, such as, for example, containers with one or more pharmaceutically acceptable carriers, additional containers, etc., as will be readily apparent to those skilled in the art. Printed instructions, either as inserts or as labels, indicating quantities of the components to be administered, guidelines for administration, and/or guidelines for mixing the components, can also be included in the kit.

EXAMPLES

[0096] The clinical safety and activity of brentuximab vedotin administered sequentially and concurrently with multiagent chemotherapy were previously evaluated in a phase 1 study in patients with newly diagnosed CD30-positive mature T- and NK-cell neoplasms, including sALCL (Study SGN35-011). This phase 1 study was implemented to determine the safety and activity of sequential and combination frontline treatment approaches of brentuximab vedotin with CHOP or CHP chemotherapy. The maximum tolerated dose of brentuximab vedotin was 1.8 mg/kg given concomitantly with CHP. At an interim analysis in this study (data presented at the T-Cell Lymphoma Forum 2012), 20 patients in this study had been treated with brentuximab vedotin 1.2 or 1.8 mg/kg given concomitantly with CHP for 6 cycles, followed by continued brentuximab vedotin every 3 weeks for up to 10 additional cycles for responding patients.

[0097] Given the results of treatment with brentuximab vedotin in the relapsed and refractory setting, and its demonstrated safety when combined with CHP in a Phase I study, it is hypothesized that a treatment approach in adults that incorporates brentuximab vedotin as part of multiagent frontline induction therapy may yield a progression free survival (PFS) and overall survival (OS) benefit. It is also reasonable to evaluate the replacement of vincristine with brentuximab vedotin because of the activity previously observed. By replacing a non-targeted

microtubule-disrupting agent with a CD30-directed ADC that delivers a potent microtubule-disrupting agent, the potential overlapping toxicities of peripheral neuropathy that would be inherent to delivering both agents in the same regimen are avoided.

[0098] Described below is a randomized, double-blind, placebo-controlled, multicenter, Phase 3 clinical trial designed to evaluate the efficacy and safety of including brentuximab vedotin in the treatment of newly diagnosed, CD30-positive peripheral T-cell lymphomas as a frontline therapy.

[0099] The primary endpoint was progression-free survival per independent review facility, defined as the time from the date of randomization to the date of first documentation of progressive disease[17], death due to any cause, or receipt of subsequent anticancer therapy to treat residual or progressive T-cell lymphoma as determined by the investigator, whichever comes first. The latter outcome was considered an event because it represents a failure of the curative intent of frontline treatment of PTCL. Post treatment radiotherapy, post treatment chemotherapy for the purpose of mobilizing peripheral blood stem cells, or consolidative autologous or allogeneic SCT in the absence of progressive disease were not considered as an event. The key secondary endpoints were progression-free survival per independent review facility for subjects with sALCL, complete remission rate per independent review facility following the completion of study treatment, overall survival, and objective response rate (complete response + partial response).

[00100] PFS was defined as the time from the date of randomization to the date of first documentation of progressive disease (PD), death due to any cause, or receipt of subsequent anticancer chemotherapy to treat residual or progressive disease, whichever occurred first. PFS is a direct reflection of tumor growth and can be assessed before determination of a survival benefit. Furthermore, because PFS includes deaths from any cause it may be a correlate to OS, a secondary endpoint of this study. An additional advantage of PFS is that its determination is not confounded by subsequent therapy. In this study, post-treatment consolidative radiotherapy, post-treatment chemotherapy for the purpose of mobilizing peripheral blood stem cells, or consolidative autologous or allogeneic SCT were not considered subsequent new anticancer treatments because they are not administered to treat progressive disease.

[0100] Lymphoma response and progression were assessed using the Revised Response Criteria for Malignant Lymphoma (Cheson 2007). To ensure consistent unbiased application of these criteria, all imaging studies performed to confirm disease status and to assess progression during the study will be submitted to an independent third-party imaging core

laboratory for blinded review and all patients will have evaluations for progression performed on the same schedule.

Materials and Methods

[0101] TRIAL DESIGN: In this randomized, double-blind, active-controlled, multicenter, phase 3 trial, subjects with previously untreated, CD30-positive PTCL were randomized 1:1 to receive 6 to 8, 21-day cycles of either brentuximab vedotin plus cyclophosphamide, doxorubicin, and prednisone (A+CHP) or cyclophosphamide, doxorubicin, vincristine, and prednisone (CHOP). A target of 6 to 8 treatment cycles was to be administered per investigator decision, based on subject-specific characteristics, including stage of disease and International Prognostic Index (IPI) score.

[0102] IPI is a scoring system useful to help predict outcome of treatment. Points are given for each of the following factors a patient exhibits: age over 60, Stage III of IV cancer, more than one lymph node involved in disease, elevated serum lactate dehydrogenase; and performance scale of daily activity performance.

[0103] PATIENTS: Patients with newly diagnosed, CD30-positive peripheral T-cell lymphomas per the Revised European-American Lymphoma WHO 2008 classification by local assessment are included in the study. Eligible histologies are limited to the following: ALK-positive sALCL with an IPI score greater than or equal to 2; ALK-negative sALCL; PTCL-NOS; AITL; Adult T-cell leukemia/lymphoma (ATLL; acute and lymphoma types only, must be positive for human T-cell leukemia virus 1); Enteropathy-associated T-cell lymphoma (EATL); Hepatosplenic T-cell lymphoma; Fluorodeoxyglucose (FDG)-avid disease by PET and measurable disease of at least 1.5 cm by CT, as assessed by the site radiologist, and age greater than or equal to 18 years. Patients were required to have an Eastern Cooperative Oncology Group performance status ≤2, and satisfactory absolute neutrophil and platelet counts, hemoglobin levels, and liver and kidney function marker levels.

[0104] Exclusion criteria includes history of another primary invasive cancer, hematologic malignancy, or myelodysplastic syndrome that has not been in remission for at least 3 years. No subjects should have current diagnosis of any of the following: Primary cutaneous CD30-positive T-cell lymphoproliferative disorders and lymphomas. Cutaneous ALCL with extracutaneous tumor spread beyond locoregional lymph nodes is eligible (previous single-agent treatment to address cutaneous and locoregional disease is permissible), Mycosis fungoides (MF), including transformed MF, History of progressive multifocal leukoencephalopathy (PML), Cerebral/meningeal disease related to the underlying malignancy,

Prior treatment with brentuximab vedotin, Baseline peripheral neuropathy ≥ Grade 2 (per the NCI CTCAE, Version 4.03) or patients with the demyelinating form of Charcot-Marie-Tooth syndrome.

[0105] ENDPOINTS: The primary endpoint is modified progression-free survival (PFS), defined as time to progression, death, or evidence of non-CR after completion of frontline therapy per independent review facility (IRF). Timing of the modified event is the date of the first PET scan post-completion of frontline therapy demonstrating the absence of CR, defined as Deauville score of ≥3. In the absence of disease progression a switch to an alternative frontline therapy, for any reason, prior to completion of treatment with the randomized regimen was not considered an event.

[0106] Secondary endpoints include PFS per IRF for patients with sALCL, Complete remission (CR) rate per IRF following the completion of study treatment, Overall survival (OS) defined as time from randomization to death due to any cause, Objective response rate (ORR) per IRF following the completion of study treatment, Type, incidence, severity, seriousness, and relatedness of adverse events. Complete remission (CR) rate is defined as the proportion of patients with CR at the end of treatment per IRF according to the Revised Response Criteria for Malignant Lymphoma (Cheson 2007). Patients whose disease response cannot be assessed will be scored as nonresponders for calculating the CR rate.

[0107] Overall survival (OS) is defined as the time from randomization to death due to any cause. Specifically, OS = Date of death – Date of randomization + 1. For a patient who is not known to have died by the end of study follow-up, observation of OS is censored on the date the patient was last known to be alive (i.e., date of last contact). Patients lacking data beyond the day of randomization will have their survival time censored on the date of randomization (i.e., OS duration of 1 day). ORR per IRF is defined as the proportion of patients with CR or partial remission (PR) per IRF following the completion of study treatment (at EOT) according to the Revised Response Criteria for Malignant Lymphoma (Cheson 2007).

[0108] Additional Endpoints include incidence of anti-therapeutic antibodies (ATA) to brentuximab vedotin (defined as the proportion of patients that develop ATA at any time during the study), Medical Resource Utilization based on the number of medical care encounters, Quality of life measured by the European Organisation for Research and Treatment of Cancer (EORTC) core quality of life questionnaire (QLQ-C30) and European Quality of Life 5-Dimensional (EQ-5D).

[0109] ASSESSMENTS: Response and progression are evaluated as set out above. Computed tomography scans are performed at screening, after Cycle 4, after the last dose of frontline therapy and, during the follow-up period, every 3 months for the first two years and 6 months thereafter. PET scans are conducted at screening, at the end of Cycle 4 and end of treatment.

[0110] Safety is evaluated by the incidence of adverse events, using the Medical Dictionary for Regulatory Activities (MedDRA; v19.0), and National Cancer Institute Common Terminology Criteria for Adverse Events v4.03, and by changes in vital signs, and clinical laboratory results.

[0111] Patient reported outcome questionnaires are performed periodically throughout treatment, e.g., during every cycle. The European Quality of Life (EuroQOL) EQ-5D is a 5-item questionnaire with a "thermometer" visual analog scale ranging from 0 (worst imaginable health state) to 100 (best imaginable health state).

[0112] The FACT/GOG-NTX is a self-administered questionnaire for assessing changes in quality of life and assessment of treatment-induced neurologic symptoms (sensory, hearing, motor, and dysfunction). Patients score their well-being by selecting the frequency with which they associate with a given statement (0 being "not at all", up to 4 being "very much"). The neurotoxicity subscale consists of 11 questions.

[0113] The EORTC QLQ-C30 is a questionnaire developed to assess the quality of life of cancer patients. The QLQ-C30 incorporates 9 multi-item scales: 5 functional scales (physical, role, cognitive, emotional, and social), 3 symptom scales (fatigue, pain, and nausea and vomiting), and a global health and quality of life scale (Aaronson 1993).

[0114] All efficacy evaluations are conducted using the intent-to-treat population unless otherwise specified. Safety is analyzed in patients who received at least one dose of study drug (safety population).

[0115] *Statistical Analysis*

[0116] Formal statistical tests were performed for progression-free survival and for the key secondary endpoints per independent review facility A fixed sequence testing procedure[18], where testing was carried out sequentially at an unadjusted alpha level as long as all preceding null hypotheses were rejected, was used to ensure type I error control for key secondary endpoints (testing order: 1] progression-free survival per independent review facility for subjects with centrally confirmed sALCL; 2] complete response per independent review facility; 3] overall survival; and 4] objective response rate per independent review facility).

[0117] *Results and Discussion*

[0118] A total of 452 subjects were randomized on study: 226 to the A+CHP arm and 226 to the CHOP arm. A total of 370 subjects (82%) completed treatment; 192 subjects (85%) on the A+CHP arm and 178 subjects (79%) on the CHOP arm. As of the 15 August 2018 data cutoff date, 296 subjects (65%) remained in long-term follow up; 157 subjects (69%) on the A+CHP arm and 139 subjects (62%) on the CHOP arm. The overall median age was 58 years (range, 18 to 85). Most subjects were male (63%) and white (62%). The protocol required 75% ± 5% of subjects to have a diagnosis of sALCL to support the secondary endpoint of PFS in this population; therefore, 316 of 452 enrolled subjects (70%) had a diagnosis of sALCL per local assessment. Of the 316 subjects with sALCL, 218 (69%) were ALK-negative (48% of the total population of randomized subjects). The median time from initial disease diagnosis to first dose of study treatment was 0.9 months (range, 0 to 19 months). Overall, 53% of subjects had Stage IV disease at initial diagnosis. There were no meaningful differences in demographics and baseline characteristics between the treatment arms.

[0119] Subjects were randomly assigned in a 1:1 ratio to receive 21-day cycles of either A+CHP or CHOP for 6 or 8 cycles, with the number of cycles determined at the outset and based on investigator discretion. Vincristine was omitted from combination treatment with brentuximab vedotin to eliminate the potential for additional neurotoxicity. All subjects were administered the CHP components of the CHOP regimen (cyclophosphamide 750 mg/m^2 and doxorubicin 50 mg/m^2 administered IV on Day 1 of each cycle; prednisone 100 mg daily administered orally on Days 1 to 5 of each cycle). Brentuximab vedotin (A+CHP arm; 1.8 mg/kg administered IV on Day 1 of each cycle) or vincristine (CHOP arm; 1.4 mg/m2 [maximum 2.0 mg] administered IV on Day 1 of each cycle) were dispensed after CHP to subjects in a double-blind, active-controlled manner (subjects received either brentuximab vedotin and a vincristine placebo or vincristine and a brentuximab vedotin placebo). Post treatment consolidative SCT or radiotherapy was permitted at the investigator's discretion after at least 6 cycles of study treatment were administered (intent was pre-specified).

[0120] Randomization was stratified by histologic subtype per local pathology assessment (ALK-positive sALCL vs. all other histologies) and baseline International Prognostic Index (IPI) score[16] (0-1 vs. 2-3 vs. 4-5).

[0121] The primary and all key secondary endpoints of this study were met and were statistically significant. The primary endpoint of this study, Progression-free survival (PFS) per independent review facility (IRF), was defined as the time from the date of randomization to the

date of first documentation of progressive disease (PD), death due to any cause, or receipt of subsequent anticancer chemotherapy to treat residual or progressive disease, whichever occurred first. Receipt of post-treatment consolidative radiotherapy, post treatment chemotherapy for the purpose of mobilizing peripheral stem cells, or consolidative autologous or allogeneic SCT was not considered disease progression or as having started new anticancer therapy.

[0122] The study results show that PFS per IRF was significantly improved on the A+CHP arm compared with the CHOP arm (stratified HR 0.71 [95% CI: 0.54, 0.93], P=0.011). The difference equates to a 29% reduction in the risk of PFS events (disease progression, death, or receipt of new therapy) for A+CHP versus CHOP.

[0123] *Secondary Endpoint Analysis*

[0124] There was a 41% reduction in risk of PFS events per IRF for the subset of subjects with sALCL on the A+CHP arm compared to the CHOP arm (HR 0.59 [95% CI: 0.42, 0.84], P=0.0031), consistent with the results of the primary analysis.

[0125] The complete response (CR) rate at end of treatment (EOT) by IRF assessment was 68% (95% CI: 61.2, 73.7) for subjects on the A+CHP arm compared with 56% (95% CI: 49.0, 62.3) for subjects on the CHOP arm. The CR rate difference between the arms was statistically significant by stratified Cochran-Mantel-Haenszel (CMH) test (P=0.0066). Overall survival (OS) was significantly improved with A+CHP versus CHOP (P=0.024). The stratified HR was 0.66 (95% CI: 0.46, 0.95), which equates to a 34% reduction in the risk of death for subjects treated with A+CHP versus CHOP. As of the time of the primary analysis, 124 subjects (27%) had died; 51 subjects (23%) on the A+CHP arm versus 73 subjects (32%) on the CHOP arm.

[0126] The overall response rate (ORR) at EOT by IRF assessment was 83% (95% CI: 77.7, 87.8) for subjects on the A+CHP arm compared with 72% (95% CI: 65.8, 77.9) for subjects on the CHOP arm. The response rate difference was statistically significant by stratified CMH test (P=0.0032).

[0127] The following Tables 1-6 show the detailed analysis on PFS per IRF and OS for various subgroups:

Table 1. Analysis on PFS per IRF and OS based on IPI Scores

IPI Score	PFS per IRF Subgroup Analysis			Overall Survival Subgroup Analysis		
	Event/N		Hazard Ratio (95% CI)	Event/N		Hazard Ratio (95% CI)
	A+CHP	CHOP		A+CHP	CHOP	
0-1	18/52	27/48	0.53 (0.29, 0.97)	5/52	10/48	0.46 (0.16, 1.33)
2-3	56/141	77/145	0.71 (0.50, 1.00)	29/141	48/145	0.56 (0.35, 0.89)
4-5	21/33	20/33	1.03 (0.55, 1.92)	17/33	15/33	1.15 (0.58, 2.31)

Table 2. Analysis on PFS per IRF and OS based on Age

Age	PFS per IRF Subgroup Analysis			Overall Survival Subgroup Analysis		
	Event/N		Hazard Ratio (95% CI)	Event/N		Hazard Ratio (95% CI)
	A+CHP	CHOP		A+CHP	CHOP	
<65 years	54/157	75/156	0.67 (0.47, 0.95)	26/157	37/156	0.64 (0.39, 1.06)
≥65 years	41/69	49/70	0.70 (0.46, 1.08)	25/69	36/70	0.64 (0.38, 1.08)

Table 3. Analysis on PFS per IRF and OS based on Gender

Gender	PFS per IRF Subgroup Analysis			Overall Survival Subgroup Analysis		
	Event/N		Hazard Ratio (95% CI)	Event/N		Hazard Ratio (95% CI)
	A+CHP	CHOP		A+CHP	CHOP	
Male	59/133	80/151	0.80 (0.57, 1.13)	32/133	49/151	0.68 (0.43, 1.06)
Female	36/93	44/75	0.49 (0.31, 0.78)	19/93	24/75	0.66 (0.36, 1.22)

Table 4. Analysis on PFS per IRF and OS based on Baseline ECOG Status

Baseline ECOG Status	PFS per IRF Subgroup Analysis			Overall Survival Subgroup Analysis		
	Event/N		Hazard Ratio (95% CI)	Event/N		Hazard Ratio (95% CI)
	A+CHP	CHOP		A+CHP	CHOP	
0/1	76/174	105/179	0.66 (0.49, 0.89)	34/174	61/179	0.51 (0.34, 0.78)
2	19/51	19/47	0.98 (0.51, 1.87)	17/51	12/47	1.48 (0.70, 3.11)

Table 5. Analysis on PFS per IRF and OS based on Disease Stage

Disease Stage	PFS per IRF Subgroup Analysis			Overall Survival Subgroup Analysis		
	Event/N		Hazard Ratio (95% CI)	Event/N		Hazard Ratio (95% CI)
	A+CHP	CHOP		A+CHP	CHOP	
I or II	15/42	19/46	0.95 (0.48, 1.88)	7/42	12/46	0.66 (0.25, 1.71)
III	29/57	35/67	0.69 (0.42, 1.14)	13/57	17/67	0.71 (0.33, 1.49)
IV	51/127	70/113	0.64 (0.45, 0.93)	31/127	44/113	0.68 (0.43, 1.07)

Table 6. Analysis on PFS per IRF and OS based on Disease Indication

Disease Indication	PFS per IRF Subgroup Analysis			Overall Survival Subgroup Analysis		
	Event/N		Hazard Ratio (95% CI)	Event/N		Hazard Ratio (95% CI)
	A+CHP	CHOP		A+CHP	CHOP	
ALK-positive sALCL	5/49	16/49	0.29 (0.11, 0.79)	4/49	10/49	0.38 (0.12, 1.22)
ALK-negative sALCL	50/113	60/105	0.65 (0.44, 0.95)	25/113	34/105	0.58 (0.35, 0.98)
AITL	18/30	13/24	1.40 (0.64, 3.07)	8/30	6/24	0.87 (0.29, 2.58)
PTCL-NOS	19/29	31/43	0.75 (0.41, 1.37)	11/29	20/43	0.83 (0.38, 1.80)

* The Hazard Ratio in the above tables compares clinical benefits of one treatment arm versus another in the clinical trial. A Hazard Ratio of less than 1 means the A+CHP treatment arm provided better clinical benefits than the CHOP treatment arm

[0128] Results from the trial demonstrated that combination treatment with ADCETRIS plus CHP was superior to the control arm for PFS as assessed by an Independent Review Facility (IRF; hazard ratio=0.71; p-value=0.0110). The ADCETRIS plus CHP arm also demonstrated superior overall survival, a key secondary endpoint, compared with CHOP (hazard ratio=0.66; p-value=0.0244). All other key secondary endpoints, including PFS in patients with systemic anaplastic large cell lymphoma (sALCL), complete remission rate and objective response rate were statistically significant in favor of the ADCETRIS plus CHP arm. The safety profile of ADCETRIS plus CHP in this clinical trial was comparable to CHOP and consistent with the well-established safety profile of ADCETRIS in combination with chemotherapy.

[0129] Numerous modifications and variations of the invention as set forth in the above illustrative examples are expected to occur to those skilled in the art. Consequently only such limitations as appear in the appended claims should be placed on the invention.

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What is Claimed:

1. A method for treating a subject having a peripheral T cell lymphoma (PTCL) comprising administering a composition comprising an anti-CD30 antibody drug conjugate every three weeks in combination with a chemotherapy consisting essentially of cyclophosphamide, doxorubicin and prednisone (CHP).

2. The method of claim 1 wherein the PTCL is selected from the group consisting of systemic anaplastic large cell lymphoma (sALCL), angioimmunoblastic T-cell lymphoma (AITL), peripheral T-cell lymphoma-not otherwise specified (PTCL-NOS), Adult T-Cell Leukemia/Lymphoma (ATLL), Enteropathy-associated T-cell lymphoma (EATL) and Hepatosplenic T-cell lymphoma.

3. The method of claim 1 or 2 wherein the PTCL is a sALCL.

4. The method of claim 3 wherein the sALCL is selected from the group consisting of anaplastic lymphoma kinase positive (ALK+) sALCL and anaplastic lymphoma kinase negative (ALK-) sALCL.

5. The method of claim 4 wherein the sALCL is an ALK+ sALCL.

6. The method of claim 1 or 2 wherein the PTCL is not a sALCL.

7. The method of claim 1 or 2 wherein the PTCL is selected from the group consisting of angioimmunoblastic T-cell lymphoma (AITL), peripheral T-cell lymphoma-not otherwise specified (PTCL-NOS), Adult T-Cell Leukemia/Lymphoma (ATLL), Enteropathy-associated T-cell lymphoma (EATL) and Hepatosplenic T-cell lymphoma..

8. The method of claim 1 or 2 wherein the PTCL is not an AITL.

9. The method of claim 1 or 2 wherein the PTCL is selected from the group consisting of systemic anaplastic large cell lymphoma (sALCL), peripheral T-cell lymphoma-not otherwise specified (PTCL-NOS), Adult T-Cell Leukemia/Lymphoma (ATLL), Enteropathy-associated T-cell lymphoma (EATL) and Hepatosplenic T-cell lymphoma.

10. The method of any one of claims 1-9, wherein the subject has an International Prognostic Index (IPI) score ≥ 2.

11. The method of any one of claims 1-10, wherein the subject has not previously been treated for a hematologic cancer.

12. The method of any one of claims 1-10, wherein the subject has previously been treated for a hematologic cancer and the cancer has relapsed or is refractory.

13. The method of any one of claims 1-11, wherein the PTCL is a stage III or stage IV PTCL.

14. The method of any one of claims 1-13 wherein the PTCL is a CD30-expressing PTCL.

15. The method of any one of claims 1-14 wherein the PTCL is a CD30-expressing PTCL and the CD30 expression is ≥10%.

16. The method of claim 15 wherein the CD30 expression is measured by a FDA approved test.

17. The method of any one of claims 1 to 16 wherein the combination therapy is administered every three weeks.

18. The method of claim 17 wherein the combination therapy is administered on day 1 of a 21 day cycle.

19. The method of claim 17 or 18 wherein the combination therapy is administered for no more than six to eight cycles.

20. The method of claim 17 or 18 wherein the combination therapy is administered for eight cycles.

21. The method of any one of claims 17 to 20 wherein the subject receives single-agent anti-CD30 antibody drug conjugate for eight to 10 additional cycles for a total of 16 cycles.

22. The method of any one of claims 1 to 21 wherein the anti-CD-30 antibody drug conjugate is administered at a dose of 1.8 mg/kg.

23. The method of any one of claims 1 to 22 wherein the combination therapy is administered until a PET scan determines there is no tumor or progression of tumor.

24. The method of any one of claims 1 to 23 wherein the anti-CD30 antibody of the anti-CD30 antibody drug conjugate comprises

i) a heavy chain CDR1 set out in SEQ ID NO: 4, a heavy chain CDR2 set out in SEQ ID NO: 6, a heavy chain CDR3 set out in SEQ ID NO: 8; and

ii) a light chain CDR1 set out in SEQ ID NO: 12, a light chain CDR2 set out in SEQ ID NO: 14, and a light chain CDR13 set out in SEQ ID NO: 16.

25. The method of any one of claims 1 to 24 wherein the anti-CD30 antibody of the anti-CD30 antibody drug conjugate comprises

i) an amino acid sequence at least 85% identical to a heavy chain variable region set out in SEQ ID NO: 2 and

ii) an amino acid sequence at least 85% identical to a light chain variable region set out in SEQ ID NO: 10.

26. The method of any one of claims 1 to 25 wherein the anti-CD30 antibody of the anti-CD30 antibody drug conjugate is a monoclonal anti-CD30 antibody.

27. The method of any one of claims 1 to 26 wherein the anti-CD30 antibody of the anti-CD30 antibody drug conjugate is a chimeric AC10 antibody.

28. The method of any one of claims 1 to 27 wherein the antibody drug conjugate comprises monomethyl auristatin E and a protease-cleavable linker.

29. The method of claim 28 wherein the protease cleavable linker comprises a thiolreactive spacer and a dipeptide.

30. The method of claim 28 or 29, wherein the protease cleavable linker consists of a thiolreactive maleimidocaproyl spacer, a valine–citrulline dipeptide, and a p-amino-benzyloxycarbonyl spacer.

31. The method of any one of claims 1 to 30 wherein the anti-CD30 antibody drug conjugate is brentuximab vedotin.

32 The method of anyone of claims 1 to 31 wherein the anti-CD30 antibody drug conjugate is brentuximab vedotin and is administered at 1.8 mg/kg, cyclophosphamide is administered at 750 mg/m^2, doxorubicin is administered at 50 mg/m^2, and prednisone is administered at 100 mg on days 1 to 5 of a 21 day cycle.

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SEQUENCE LISTING

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Gln Arg Ala Thr Ile Ser Cys Lys Ala Ser Gln Ser Val Asp Phe Asp
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Gly Asp Ser Tyr Met Asn Trp Tyr Gln Gln Lys Pro Gly Gln Pro Pro
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aaa gtc ctc atc tat gct gca tcc aat cta gaa tct ggg atc cca gcc 192
Lys Val Leu Ile Tyr Ala Ala Ser Asn Leu Glu Ser Gly Ile Pro Ala
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Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr Leu Asn Ile His
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Pro Val Glu Glu Glu Asp Ala Ala Thr Tyr Tyr Cys Gln Gln Ser Asn
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Lys Val Leu Ile Tyr Ala Ala Ser Asn Leu Glu Ser Gly Ile Pro Ala
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Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr Leu Asn Ile His
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