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DRUG PROFILE

Veltuzumab, an anti-CD20 mAb for the treatment of non-Hodgkin's lymphoma, chronic lymphocytic leukemia and immune thrombocytopenic purpura

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Veltuzumab is a humanized, second-generation anti-CD20 mAb currently under development by Immunomedics Inc for the potential treatment of B-cell non-Hodgkin's lymphoma (NHL) and chronic lymphocytic leukemia (CLL). Licensee Nycomed is developing veltuzumab for the potential treatment of rheumatoid arthritis and immune thrombocytopenic purpura (ITP). Veltuzumab contains 90 to 95% human antibody sequences with identical antigen framework regions to epratuzumab (a humanized anti-CD22 mAb) and similar antigen-binding determinants to rituximab (chimeric, anti-CD20 mAb and the first-line treatment of aggressive and indolent NHL). In vitro studies have demonstrated that veltuzumab has enhanced binding avidities and a stronger effect on complement-dependent cytotoxicity compared with rituximab in selected cell lines. In dose-finding phase I/II clinical trials in patients with low-grade NHL, intravenous veltuzumab demonstrated a substantial rate of complete responses in concurrence with shorter and more tolerable infusions compared with rituximab. Currently there has been no evidence of an immune response to repeated administrations, and no serious adverse events related to veltuzumab treatment in patients with NHL. Veltuzumab is undergoing clinical trials using a low-dose subcutaneous formulation in patients with NHL, CLL and ITP. Prospective, randomized clinical trials are needed to clarify the role veltuzumab will play in a market where the therapy of B-cell lymphoproliferative disorders is dominated by rituximab.

Introduction

Lymphoproliferative disorders, such as non-Hodgkin's lymphoma (NHL) and chronic lymphocytic leukemia (CLL), comprise a group of heterogeneous malignant disorders originating from clonal proliferation of lymphocytes. NHL represents the most prevalent adult hematological malignancy in the US with greater than 66,000 cases expected to have occurred in 2008 [917051]. The majority of NHLs (approximately 90%) occur in the B-cell lineage and range from incurable indolent disease to highly aggressive, but treatable, malignancies [973867]. The most frequent subtypes are diffuse large B-cell lymphoma (DLBCL) and follicular lymphoma (FL) [977003].

Similarly, CLL is a B-cell clonal lymphoid disease characterized by proliferation and accumulation of small CD5/CD19-positive lymphocytes. Many patients are asymptomatic at diagnosis and usually require no treatment [977004]. Approximately 95,000 Americans are living with this disease, which represents a higher prevalence of CLL than any other type of leukemia [973865]. CLL is an incurable disease; thus, over the last 30 years, the treatment of this condition has focused on symptom palliation. Failure of the traditional cytotoxic agents to cure CLL is because of the indolent nature of the disease, as well as intrinsic resistance mechanisms to chemotherapy that are the result of defective apoptosis in B-cells [977010]. Hence, mAbs to induce apoptosis are being developed as a potential enhancement of palliative treatment in patients with CLL.

The ability of novel mAbs to target functional receptors in both NHL and CLL can enhance therapeutic efficacy.

Therapeutic Veltuzumab

Originator Immunomedics Inc

Licensee Nycomed

Status Phase II Clinical

Indications Chronic lymphocytic leukemia, Immune thrombocytopenic purpura, Non-Hodgkin's lymphoma, Rheumatoid arthritis

Actions Anticancer, B-lymphocyte antigen CD20 inhibitor, Immunomodulator

Technologies Humanized mAb, Intravenous formulation, Subcutaneous formulation

Synonym IMMU-106

In 1997, the introduction of the mAb rituximab (Rituxan) shifted the paradigm of treatment for NHL. Rituximab is a chimeric, anti-CD20 mAb that induces lysis and apoptosis in both normal and malignant human B-cells [971538], and sensitizes malignant B-cells to the cytotoxic effect of chemotherapy [447273]. In phase III clinical trials in patients with indolent or aggressive NHL, intravenous rituximab in combination with chemotherapy was more effective than chemotherapy alone at increasing tumor remission and patient survival [900095], [971555]. Rituximab is currently approved for the first-line treatment of aggressive and indolent subtypes of NHL (DLBCL and FL, respectively), and for the treatment of relapsed or refractory CD20-positive NHL. Although not approved by the FDA for the treatment of CLL, rituximab is commonly used in this setting in general practice. As with NHL, phase III clinical trials in patients with CLL have demonstrated similar benefits of rituximab in combination with chemotherapy [899707], [899708], [977024], [977026].

Nevertheless, there are limitations associated with rituximab treatment. For example, rituximab requires at least a minimal amount of CD20 antigen expression in order to be effective [979521]. In addition, rituximab is associated with high levels of infusion reactions and, although rare, in some instances treatment has instigated potentially life-threatening side effects [979529]. As a result, there are sustained efforts to further explore the mAb treatment modality to identify a viable, long-term option for both NHL and CLL. Comparison of various therapeutic anti-B-cell mAbs has delineated key factors that are instrumental in achieving a treatment response. Potential mechanisms of action of mAbs include complement-dependent cytotoxicity (CDC), antibody-dependent cell-mediated cytotoxicity (ADCC) and the direct induction of apoptosis [977035], [977038]. The individual composition of a mAb could potentially be crucial in eliciting these mechanisms and augmenting cell-killing properties.

Veltuzumab is a second-generation, intravenously or subcutaneously administered, humanized anti-CD20 mAb, which is currently under evaluation for the treatment of NHL and CLL by Immunomedics Inc. Licensee Nycomed is also developing veltuzumab for non-cancer indications, including rheumatoid arthritis (no data available) and idiopathic thrombocytopenic purpura (ITP), although Immunomedics has retained an option to co-promote veltuzumab for ITP, which, at the time of publication, was undergoing a phase I/II clinical trial [924993]. ITP is an acquired disorder characterized by isolated thrombocytopenia caused by increased peripheral destruction and, to a lesser degree, decreased production of platelets. ITP, which has an estimated prevalence of 10 cases per 100,000 population per year [977044], appears to have an autoimmune etiology. Anti-CD20 mAb therapy has been used with success in adult patients with chronic forms of the disorder who failed therapy with corticosteroids, immunoglobulin and/or splenectomy [977039], [977041]. This report reviews the available literature for veltuzumab to date, with specific focus on the oncology indications.

Synthesis and SAR

Veltuzumab consists of 90 to 95% human antibody sequences. In terms of structure, veltuzumab exhibits complementarity-determining regions (CDRs) identical to rituximab, except for one residue at position 101 (Kabat numbering) in the CDR3 of the variable heavy chain, where aspartic acid is present in veltuzumab instead of asparagine in rituximab. The framework regions of veltuzumab are identical to epratuzumab (Immunomedics Inc/UCB SA), a humanized anti-CD22 antibody [977614].

The generation of veltuzumab is similar to that of epratuzumab (see [441322], [969604]). The genes of the CDR-grafted variable heavy and light chains of veltuzumab were inserted into the pdHL2 plasmid vector, a dihydrofolate reductase (DHFR)-based amplifiable expression system, and then transfected into the Sp2/0-Ag14 murine myeloma cell line to generate veltuzumab-producing clones [472404], [784950].

Preclinical development

In vitro

Initial preclinical studies compared the antigen detection, inhibition of proliferation and induction of apoptosis of veltuzumab against rituximab across a range of human NHL cell lines (including Daudi, Raji, Ramos, DoHH2, Karpas422, RL, SU-DHL-4, SU-DHL-6, SU-DHL-10 and WSU-FSCCL) [472404], [491149], [516974], [784950], [912498]. In competitive binding assays using Raji cells, the apparent binding avidity of veltuzumab was slightly higher than that for rituximab (apparent dissociation constants of 3.6 ± 0.6 and 3.1 ± 0.4 nM, respectively). Veltuzumab also demonstrated slightly longer residence times (ie, reduced off-rates) than did rituximab in Daudi and WSU-FSCCL cells. Further similarities were apparent between the two mAbs when comparing antigen expression and binding with human peripheral blood leukocytes [784950], [912498].

To assess the apoptotic and antiproliferative effects of veltuzumab, NHL cell lines were cultured with veltuzumab or rituximab for 48 h, with or without crosslinking (to simulate the role of effector cells *in vivo*) [784950]. To induce apoptosis, all cell lines tested (except SU-DHL-06) required the use of a crosslinker with the mAb. With crosslinking, the growth of the SU-DHL-6 cell line was most effectively inhibited by veltuzumab, yielding approximately 98% inhibition of proliferation compared with 88% without crosslinking. Inhibition was not directly related to antigen density. For example, in the Raji line, where the antigen density of veltuzumab was highly prominent, only approximately 40% inhibition was observed following treatment with a crosslinker (20% without crosslinker). All these outcomes were similar to those observed for rituximab [784950].

Further data demonstrated that veltuzumab effectively induced ADCC and CDC in NHL cell lines in the presence of human PBMCs or human complement, respectively. Results varied between different cell lines; for example, ADCC with veltuzumab caused approximately 60% lysis in SU-DHL-6 cells compared with approximately 20% in Raji cells. CDC was slightly less varied, with approximately 80% lysis in SU-DHL-6 cells compared with almost 100% in Raji cells. In Daudi cells, veltuzumab induced CDC more potently than did rituximab, although no data were available; ADCC/CDC was comparable between veltuzumab and rituximab in all other cell lines [784950], [912498].

In vivo

In CD20/CD22 cross-reactive cynomolgus monkeys treated with veltuzumab (8, 24, 80 and 240 mg/kg ip or sc, once weekly for 4 weeks), 85 to 95% depletion of B-cells was observed by 6 days after initiation of dosing compared with 30 to 50% with epratuzumab (10, 60, 160 mg/kg ip, once-weekly for 4 weeks) on day 3 [638703]. There was a trend toward dose-related depletion following veltuzumab treatment, while after epratuzumab treatment, there was no apparent dose response. More recently, it was reported that doses of veltuzumab as low as 6.7 mg/kg (equivalent to 80 mg/m^2 in humans) caused full peripheral and splenic B-cell depletion when administered intravenously or subcutaneously in healthy cynomolgus monkeys [977614].

The efficacy of veltuzumab (50 μg ip, twice weekly) compared with epratuzumab (50 μg ip, twice weekly) and combination of the two mAbs (each at 50 μg ip, twice weekly) was investigated in SCID mice bearing Raji lymphoma. Epratuzumab-treated mice had a median survival time of 15 days, which was identical to the control treatment of labetuzumab (Immunomedics Inc). Veltuzumab treatment increased median survival to 25 days. Although median survival was only slightly increased through combination of the mAbs, prolonged survival (≥ 35 days) was achieved in 30% of mice compared with 17% on veltuzumab alone ($p = 0.0515$). These findings suggest that, potentially, the efficacy of veltuzumab may be enhanced by synergism with other mAbs [784950]. The same mouse model was used to assess veltuzumab against rituximab (both at 100 μg ip, 5 times weekly for 2 weeks, then twice weekly for 3 weeks). While both mAbs significantly improved ($p < 0.0001$) upon the control median survival time of 16.5 days, the effect was greatest with rituximab (increased survival time to 98 days compared with 70 days for veltuzumab) [784950].

The effects of veltuzumab (up to 3 mg iv, administered when tumor size was between 0.1 to 0.5 cm^3), ^{90}Y-conjugated epratuzumab (100 or 175 μCi iv, applied when tumor size was between 0.2 to 1 cm^3) or combination were assessed in nude mice xenografted with Ramos cell lymphoma (at day 0) [959953]. By day 14, all tumors had regressed following treatment with 175 μCi ^{90}Y-epratuzumab; however, within 2 to 5 weeks, all tumors had rapidly regrown. In mice treated with veltuzumab, tumors grew at the same rate as control and there was no indication of tumor regression or stabilization. With the combination treatment, veltuzumab was administered on day 0 and ^{90}Y-epratuzumab on day 1 followed by three additional weekly doses of veltuzumab, each at half the original dose. By day 168, 12 of 15 mice demonstrated no sign of visible tumor, and survival was significantly improved compared with the individual mAb groups ($p < 0.001$). Slow, steady tumor growth was observed in the remaining 3 mice, with the first appearance of tumor occurring at days 10, 65 and 140. A veltuzumab total dose of 250 μg (100 μg + 3 weekly 50-μg doses) when administered in combination with epratuzumab was sufficient to induce maximum therapeutic effect [959953].

Toxicity

In the study in CD20/CD22 cross-reactive cynomolgus monkeys, veltuzumab was well tolerated with no changes in body or organ weights, food intake, ophthalmic condition, ECGs, blood pressure and standard hematology, serum chemistry, coagulation or urinalysis parameters, histopathology or gross necropsy. Veltuzumab demonstrated minimal effects on T-cells, monocytes or plasma cells, and no primate antibodies against veltuzumab were detected [638703].

Metabolism and pharmacokinetics

For the study in cynomolgus monkeys (see above), veltuzumab exhibited a $t_{1/2}$ of 5 to 8 days after the first intravenous infusion and 6 to 13 days after subcutaneous administration. With both routes, T_{max} ranged between 2 and 5 days [638703], [977614].

In a phase I/II multicenter, dose-escalation, open-label clinical trial (NCT00285428; NCT00596804; NCT00112970; IM-T-hA20-01) of veltuzumab (80, 120, 200, 375 or 750 mg/m^2 iv, once weekly for 4 weeks) in patients (n = 82) with relapsed grade 1 and 2 FL or other relapsed CD20-positive B-cell lymphomas (non-FL), mean serum veltuzumab levels increased with dose and number of infusions. At the 375-mg/m^2 dose, the mean antibody serum $t_{1/2}$ was 3 to 5 days after one infusion, extending to 12 days after four infusions [639819], [671216]. The clearance of veltuzumab at this dose was similar to that observed with rituximab (no data available). As with epratuzumab, where low doses can be quickly infused, 80 mg/m^2 veltuzumab was administered within 2 h for the first infusion and within 1 h in subsequent infusions [750587], [796144], [912498], [926817].

Preliminary pharmacokinetic data of veltuzumab were reported from an open-label, dose-comparison, multicenter phase I/II clinical trial (NCT00547066; IM-T-hA20-07) of veltuzumab (80, 120 or 200 mg iv, once every 2 weeks for a total of 4 weeks) in patients with ITP (expected total enrollment of 66 patients). In data from six evaluable patients, C_{max} values of 20.3 and 46 μg/ml at 80 and 120 mg, respectively, were recorded, which were within

the expected serum range. There were no signs of rapid clearance and the mean post-treatment $t_{1/2}$ was approximately 1 week. All infusions were completed within 60 to 90 min [967967].

Clinical development

NHL and CLL

The phase I/II multicenter, dose-escalation, open-label clinical trial IM-T-hA20-01 evaluated the safety and efficacy of veltuzumab in patients with grade 1 and 2 FL (n = 50) or non-FL (n = 32) [796144], [912498], [926817], [926877]. Patients, who had all previously received one to seven chemotherapeutic treatments (primarily rituximab-containing regimens) and were without progression for 6 months, were enrolled to one of five dose groups (outlined above). In patients with FL, 44% had an objective response (depletion of circulating B-cells) and 28% had a durable complete response, with the median duration of response being 19.7 months. In the non-FL group, the objective response rate was 35%, with a complete response rate of 27%. At the lowest dose of 80 mg/m^2, there were objective responses in 63% (5 of 8 patients) of patients, with a 25% complete response rate. In both sets of patients and across all doses, the objective response rate was 41% (partial and complete responses) with a complete response rate of 21% [912276], [912498], [926877].

At the time of publication, a non-randomized, open label, dose-comparison phase I/II clinical trial (NCT00546793; IM-T-hA20-08) to assess the safety, tolerability and efficacy of subcutaneous veltuzumab was ongoing in patients with NHL and CLL (expected total enrollment of 72 patients) [894922], [944414]. The trial would examine different doses of veltuzumab administered weekly for 4 weeks. Initial preliminary data suggested that, after receiving a single 80 mg dose of veltuzumab, circulatory B-cell levels were reduced to less than 1% compared with baseline [894922]; further data have not been reported at the time of publication.

ITP

In the IM-T-hA20-07 phase I/II clinical trial of veltuzumab in patients with ITP, preliminary efficacy data have been reported. To be eligible for enrollment, patients must have platelet counts less than 30,000 (30 K) μl and a prior history of platelet counts of less than 150 K/μl for more than 6 months, and in whom more than one standard therapy has previously failed. Efficacy was assessed over 12 weeks. Of the six evaluable patients, all four non-splenectomized patients responded to treatment with at least a 2-fold increase of their baseline platelet counts, with two achieving complete responses (> 150 K/μl), one partial response (50 to 150 K/μl) and one minor response (30 to 50 K/μl). At 16 and 24 weeks post-treatment, the two patients with complete responses still had platelet counts greater than 100 K/μl. In the patient with a partial response, platelet counts decreased to less than 30 K/μl by 11 weeks post-treatment; however, subsequent retreatment with 120 mg veltuzumab achieved a second partial response, which was still present 6 weeks later. In the patient with the minor response, platelet counts were still double the baseline value. The two splenectomized patients did not respond to treatment. Veltuzumab quickly depleted B-cells after the first dose, with decreases sustained for more than 12 weeks [967967]. The route of administration in this clinical trial has now been transitioned from intravenous infusions to subcutaneous injections [944414].

Side effects and contraindications

In the phase I/II, IM-T-hA20-01 clinical trial in patients (n = 82) with relapsed NHL, veltuzumab was generally well tolerated, with transient, infusion-associated adverse events that were grade 1 to 2 in severity and predominantly occurred at first infusion. One preliminary report from this trial, with results from 57 patients, stated that drug-related adverse events occurred in 29 patients (50.8%) and included fatigue, fever, pain/discomfort, chills/rigors, nausea, urticaria and pruritus, but were transient and infusion-related. Serious adverse events were reported in six patients but were not drug-related; these included fibrillation before treatment, trauma and pneumonia during treatment, back pain 1 month after treatment and bladder tumor and anemia 2 months after treatment [926817]. In other reports, one patient developed a visible and palpable large neck mass during the trial [944414], and one patient had an allergic reaction (this patient had already experienced a similar episode with rituximab) and treatment was discontinued [796144]. There were no human anti-human antibody (HAHA) responses and standard laboratory values obtained at each infusion demonstrated no drug-related effects [639819]. At the time of publication, there was no information on the safety of subcutaneously administered veltuzumab.

In the phase I/II, IM-T-hA20-07 clinical trial of veltuzumab in patients with ITP, one patient withdrew after receiving 100 mg veltuzumab and experiencing a grade 3 infusion reaction. Of the remaining six patients, two developed low-level positive HAHA results of uncertain clinical significance after treatment had finished [967967].

Patent summary

In October 2008, Immunomedics announced the grant of US-07435803 covering the composition of matter and the use of humanized, chimeric and human anti-CD20 antibodies (including veltuzumab) and antibody fusion proteins or fragments thereof, for the treatment and diagnosis of B-cell disorders. The patent also protects the subcutaneous formulation of veltuzumab and has an expiry date of February 2023. Patent US-07435803 shares priority data with a similar patent, US-07151164, which has been granted an expiry extension to February 2024 under US 154 (because of time spent by the resulting product in regulatory review). An equivalent European patent application was pending grant at the time of publication.

Current opinion

The treatment of NHL and CLL has undergone great changes since the development of mAbs, which have impacted positively upon patient response rates and survival times. This is despite the fact that mAb therapy is insufficient and cannot be considered curative; in patients with indolent entities, the development of resistance almost always ensues following repetitive exposure to mAbs. Furthermore, almost 50% of patients with aggressive NHL histologies will present with primary resistant or relapsed disease [977045]. Some of these patients can be salvaged with high-dose chemotherapy followed by hematopoietic stem cell transplantation (HSCT), but some will have clinical characteristics such as advanced age, poor performance status or multiple comorbidities that preclude them from undergoing or responding to HSCT [977046]. For these reasons, mAb therapy needs to be improved.

The CD20 antigen is an almost ideal therapeutic target as it does not shed into the bloodstream, does not undergo internalization, is expressed almost universally in malignant B-cell lymphocytes and is not expressed in non-hematological cells [429396], [482687], [971574]. Although the function of CD20 is still unclear, its modulation with mAbs induces ADCC, CDC and apoptosis of the CD20-harboring cell [971538]. Rituximab has been used alone and in combination with chemotherapeutic agents to treat NHL and CLL, and has demonstrated improved response rates and prolonged survival times compared with chemotherapy alone. In preclinical analysis, veltuzumab induced higher binding avidities and a stronger effect on CDC compared with rituximab in selected cell lines [639819], [671216], [750587], [796144], [912498], [977614].

A humanized mAb, such as veltuzumab, will be less likely to induce formation of human anti-chimera antibodies and infusion reactions than chimeric compounds such as rituximab, allowing for safer and shorter intravenous infusions. The formation of HAHA is a potential concern with humanized mAbs, and, although this effect was not apparent in the NHL clinical trial of veltuzumab, there have already been two reports of positive HAHA responses from only six patients in the ITP clinical trial. There have been no reports of transient reactivation of hepatitis B following veltuzumab treatment, which has occasionally been reported with rituximab [977047], [977048]. Importantly, no deaths from veltuzumab treatment have been reported to date.

Other anti-CD20 mAbs are under clinical development. Ofatumumab (GlaxoSmithKline plc/Genmab A/S) is a second-generation, fully-human anti-CD20 mAb that binds to a different epitope of the CD20 antigen to veltuzumab, and has demonstrated a high CDC effect with slow off-rates that are similar to those reported for veltuzumab, although no direct comparisons have been made [893195], [893196]. Ofatumumab is currently in phase III clinical trials to examine its potential in combination with various chemotherapeutic agents, including chlorambucil in patients with untreated CLL (NCT00748189), cyclophosphamide plus doxorubicin, vincristine and prednisolone (CHOP) in patients with FL (NCT00494780), and with fludarabine plus cyclophosphamide (FC) in patients with CLL (NCT00410163).

Further advancements in mAb developmental technology have led to the production of the third-generation anti-CD20 mAb afutuzumab (Glycart Biotechnology AG/F Hoffmann-La Roche Ltd/Genentech Inc/Biogen Idec Inc). Afutuzumab is a humanized glyco-engineered mAb for the treatment of B-cell NHL and CLL. *In vitro* models have demonstrated that the antitumor effect of rituximab is strongly dependent on CDC, while afutuzumab remained active when complement was depleted. In addition, afutuzumab enhanced ADCC and exhibited superior caspase-independent apoptosis compared with rituximab [967210]. The clinical implications of these findings are yet to be validated. To date, preliminary data from 24 patients have demonstrated afutuzumab to be safe and tolerable with similar pharmacokinetics to rituximab [968146].

The next steps in the clinical development of veltuzumab for the treatment of cancer are likely to include combination studies with various chemotherapeutic agents (eg, with cyclophosphamide plus vincristine and prednisone, or CHOP for NHL, and with FC for CLL). Combination with other mAbs (such as the chimeric anti-CD23 antibody lumiliximab [Biogen Idec Inc] and humanized anti-CD52 antibody alemtuzumab for CLL) to investigate the synergistic effects of veltuzumab should also be explored (eg, veltuzumab and epratuzumab for NHL [971576], [971577]). Further combinatory clinical trials could examine veltuzumab with other immunotherapeutic agents such as immunomodulators (eg, thalidomide and lenalidomide for CLL and indolent NHL subtypes) and proteasome inhibitors (for mantle cell lymphoma or Waldenstrom's macroglobulinemia). Finally, veltuzumab in addition to radioimmunotherapy could also prove beneficial in patients with NHL.

Lymphoproliferative disorders affect one or more different biological pathways that play a role in lymphomagenesis, leading to wide heterogeneity in clinicopathological features. This suggests the need for personalized therapy. There are multiple second-generation anti-CD20 antibodies in development and they will differ in pharmacokinetic properties that influence the effect on CDC, ADCC and/or apoptosis. Which antibody will provide the best therapeutic efficacy in which setting is something for future research to resolve. This process is made even more challenging by the varied way in which different mAbs affect different patients and diseases, giving rise to the tailoring of individual therapies. Furthermore, basic and translational research is required to increase our understanding of the mechanisms of action of these compounds.

Veltuzumab has demonstrated promising results as a single agent in various NHL histologies, while there are few data available in patients with CLL or ITP, and no data for the treatment of rheumatoid arthritis. At this time, the role of veltuzumab in the therapy of NHL and CLL is not defined, as it is unclear how this agent will compare with rituximab in phase III randomized, controlled clinical trials. It is also unclear if the interaction of veltuzumab and combination chemotherapy will be feasible and synergistic, as it is with rituximab. The development of veltuzumab for ITP and rheumatoid arthritis may prove another avenue for marketing if this product is proved non-superior to rituximab.

Deals

In July 2008, Nycomed entered an agreement to develop subcutaneous formulations of Immunomedics' humanized anti-CD20 antibody, veltuzumab, for the potential treatment of all non-cancer indications, including rheumatoid arthritis [924993].

Development status

Developer	Country	Status	Indication	Date	Reference
Immunomedics Inc	US	Phase II	Chronic lymphocytic leukemia	23-JAN-08	873898
Immunomedics Inc	Europe	Phase II	Non-Hodgkin's lymphoma	13-DEC-05	639819
Immunomedics Inc	US	Phase II	Non-Hodgkin's lymphoma	13-DEC-05	639819
Nycomed	US	Phase II	Immune thrombocytopenic purpura	14-JUL-08	924993
Nycomed	US	Discovery	Rheumatoid arthritis	14-JUL-08	924993

Associated patent

Title Anti-CD20 antibodies and fusion proteins thereof and methods of use.
Assignee Immunomedics Inc
Publication WO-03068821 21-AUG-03
Inventors Hansen H, Qu Z, Goldenberg DM.

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