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Ustekinumab

Updated: April 20, 2020.

OVERVIEW

Introduction

Ustekinumab is a human monoclonal antibody to a polypeptide found on interleukin-12 and -23 that is used to treat autoimmune conditions and is approved for use in severe psoriasis. Ustekinumab is associated with a low rate of serum enzyme elevations during therapy, but has not been linked to cases of idiosyncratic, clinically apparent liver injury. Ustekinumab has immunomodulatory activity and may cause reactivation of hepatitis B in susceptible patients.

Background

Ustekinumab (us" te kin' ue mab) is a human monoclonal immunoglobulin G1 antibody to the p40 subunit polypeptide of both interleukin (IL)-12 and -23, cytokines that are important mediators of autoimmune reactions. IL-12 and IL-23 are found in the skin lesions of psoriasis and in the affected gastrointestinal mucosa of patients with inflammatory bowel disease. Ustekinumab was approved for use in psoriasis United States in 2010, and indications were subsequently expanded to include inflammatory bowel disease. Current indications include moderate-to-severe plaque psoriasis and active psoriatic arthritis, Crohn disease and ulcerative colitis. Ustekinumab has been evaluated in other autoimmune diseases including Crohn disease, but does not have official approval for use in other conditions. Ustekinumab is available in liquid solution in single use vials and prefilled syringes of 45 and 90 mg (90 mg/mL) under the brand name Stelara. The initial and maintenance dose and dose regimen varies by indication and body weight. After an initial loading doses, ustekinumab is typically given subcutaneously every 8 to 12 weeks. Side effects are usually mild, and may include infusion reactions, chills, fever, skin rash, fatigue, leukopenia and infections. Less common, but potentially severe side effects include serious infections, reactivation of tuberculosis, increased risk of malignancies and reversible posterior leukoencephalopathy syndrome (RPLS).

Hepatotoxicity

Mild-to-moderate serum aminotransferase elevations were reported to occur in 0.5% to 1.4% of patients during ustekinumab therapy. The elevations, however, were self-limited and resolved even with continuing cyclic therapy and were no more frequent than occurred with placebo. Neither during premarketing evaluation nor subsequently have there been case reports of clinically apparent, acute liver injury with symptoms or jaundice linked to ustekinumab therapy, but experience with its use has been limited.

Ustekinumab has immunosuppressive activity and it has been linked to rare instances of reactivation of hepatitis B. HBV reactivation typically occurs in patients with preexisting HBsAg and relatively inactive disease. Reactivation causes acute hepatocellular injury that can be severe and lead to acute liver failure and death or

need for emergency liver transplantation. Cases of reactivation attributed to ustekinumab, however, have generally been mild, self-limited and not associated with symptoms or even ALT elevations. Screening for hepatitis B before starting ustekinumab is not recommended in the product label, but screening has been considered to be "advisable" by academic societies in published guidelines on psoriasis therapy. Ustekinumab has not been linked convincingly to worsening of chronic hepatitis C in patients with psoriasis or to hepatic decompensation in patients with pre-existing cirrhosis. For these reasons, chronic liver disease and concurrent HCV infection are not considered contraindications to therapy.

Likelihood score: E* (unproven but suspected rare cause of clinically apparent liver injury, possibly reactivation of hepatitis B).

Mechanism of Injury

The mechanism of liver injury in reactivation of hepatitis B appears to be a brisk immunological response to newly expressed viral antigens. Injury generally arises between courses of immunosuppressive therapy, which for ustekinumab is given every 8 or 12 weeks after induction (at 0 and 4 weeks).

Outcome and Management

Ustekinumab is a rare cause of liver injury, but has been linked to occasional cases of reactivation of hepatitis B. The product label for ustekinumab does not recommend routine screening for hepatitis B before initiation of therapy. However, guidelines for management of patients who are to receive ustekinumab prepared by some academic societies have recommended routine screening before starting treatment. Screening should include tests for HBsAg and anti-HBc (and perhaps also anti-HBs as this may help in management). Prophylaxis with a potent oral, antiviral agent effective against hepatitis B is recommended for persons who have HBsAg in serum. An alternative approach, which is perhaps more appropriate for ustekinumab and particularly for patients with anti-HBc without HBsAg in serum, is careful monitoring for HBV DNA during therapy and early institution of antiviral therapy if levels rise.

Drug Class: Dermatological Agents, Psoriasis Agents; Antirheumatic Agents; Monoclonal Antibodies

PRODUCT INFORMATION

REPRESENTATIVE TRADE NAMES

Ustekinumab – Stelara®

DRUG CLASS

Dermatological Agents

COMPLETE LABELING

Product labeling at DailyMed, National Library of Medicine, NIH

CHEMICAL FORMULA AND STRUCTURE

DRUG	CAS REGISTRY NO.	MOLECULAR FORMULA	STRUCTURE
Ustekinumab	815610-63-0	Monoclonal Antibody	Not Available

ANNOTATED BIBLIOGRAPHY

References updated: 20 April 2020

Abbreviations: TNF, tumor necrosis factor; HER-2, human epidermal growth factor receptor 2; IL-17, interleukin 17.

Reuben A. Hepatotoxicity of immunosuppressive drugs. In, Kaplowitz N, DeLeve LD, eds. Drug-induced liver disease. 3rd ed. Amsterdam: Elsevier, 2011, pp. 569-91.

(Review of hepatotoxicity of immunosuppressive agents; does not mention ustekinumab specifically, but discusses the problems of reactivation of hepatitis B and states that "the biological immunosuppressants are largely free from hepatotoxicity, with the exception of the tumor necrosis factor [TNF] alpha antagonists").

Krensky AM, Azzi JR, Hafler DA. Immunosuppressants and tolerogens. In, Brunton LL, Hilal-Dandan R, Knollman BC, eds. Goodman & Gilman's the pharmacological basis of therapeutics. 13th ed. New York: McGraw-Hill, 2018, pp. 637-53.

(Textbook of pharmacology and therapeutics).

Leonardi CL, Kimball AB, Papp KA, Yeilding N, Guzzo C, Wang Y, Li S, et al. PHOENIX 1 study investigators. Efficacy and safety of ustekinumab, a human interleukin-12/23 monoclonal antibody, in patients with psoriasis: 76-week results from a randomised, double-blind, placebo-controlled trial (PHOENIX 1). Lancet. 2008;371(9625):1665–74. PubMed PMID: 18486739.

(Among 766 patients with psoriasis treated with 1 of 2 doses of ustekinumab or placebo for 12 weeks, response rates were 67% and 66% with ustekinumab vs 3% with placebo, and side effects were similar and "results of laboratory results were much the same" in the 3 groups).

Papp KA, Langley RG, Lebwohl M, Krueger GG, Szapary P, Yeilding N, Guzzo C, et al. PHOENIX 2 study investigators. Efficacy and safety of ustekinumab, a human interleukin-12/23 monoclonal antibody, in patients with psoriasis: 52-week results from a randomised, double-blind, placebo-controlled trial (PHOENIX 2). Lancet. 2008;371(9625):1675–84. PubMed PMID: 18486740.

(Among 1230 patients with psoriasis treated for 12 weeks with 1 of 2 doses of ustekinumab or placebo, clinical response rates were 67% and 76% with ustekinumab vs 4% with placebo, and "rates of laboratory abnormalities were similar between groups, and no differences were noted in liver aminotransferase concentrations").

Gottlieb A, Menter A, Mendelsohn A, Shen YK, Li S, Guzzo C, et al. Ustekinumab, a human interleukin 12/23 monoclonal antibody, for psoriatic arthritis: randomised, double-blind, placebo-controlled, crossover trial. Lancet. 2009;373(9664):633–40. PubMed PMID: 19217154.

(Among 146 patients with psoriatic arthritis treated with either ustekinumab or placebo, responses at week 12 were more frequent with ustekinumab [42% vs 10%] and, while overall rates of adverse events were similar [61% vs 63%], ALT elevations occurred in 4% of ustekinumab vs 1% of placebo recipients).

Griffiths CE, Strober BE, van de Kerkhof P, Ho V, Fidelus-Gort R, Yeilding N, Guzzo C, et al; ACCEPT Study Group. Comparison of ustekinumab and etanercept for moderate-to-severe psoriasis. N Engl J Med. 2010;362:118–28. PubMed PMID: 20071701.

(Among 903 patients with psoriasis treated with 1 of 2 doses of ustekinumab vs etanercept for 12 weeks, clinical response rates were higher with ustekinumab [68-74% vs 57%], while rates of ALT elevations were similar [0.5-0.9% vs 1.2%]).

Ustekinumab (Stelara) for psoriasis. Med Lett Drugs Ther. 2010;52(1330):7–8. PubMed PMID: 20208473.

(Concise summary of mechanism of action, efficacy, safety and costs of ustekinumab in patients with psoriasis, mentions possibility of reactivation of tuberculosis, but not reactivation of hepatitis B, ALT elevations or hepatotoxicity).

Tsai TF, Ho JC, Song M, Szapary P, Guzzo C, Shen YK, Li S, et al. PEARL Investigators. Efficacy and safety of ustekinumab for the treatment of moderate-to-severe psoriasis: a phase III, randomized, placebo-controlled trial in Taiwanese and Korean patients (PEARL). J Dermatol Sci. 2011;63:154–63. PubMed PMID: 21741220.

(Among 121 patients with psoriasis treated with ustekinumab or placebo for 12 weeks, response rates with greater with ustekinumab [67% vs 5%], while "abnormal hepatic function" was less [0% vs 3.3%], although with long term ustekinumab therapy enzyme elevations were more common [7.3-8.5%], most abnormalities however being attributed to concurrent isoniazid therapy).

Oketani M, Ido A, Tsubouchi H. Changing etiologies and outcomes of acute liver failure: A perspective from Japan. J Gastroenterol Hepatol. 2011;26 Suppl 1:65–71. PubMed PMID: 21199516.

(Analysis of from multicenter study in Japan lists reactivation of HBV as an increasing cause of acute liver failure).

Mastroianni CM, Lichtner M, Citton R, Del Borgo C, Rago A, Martini H, Cimino G, et al. Current trends in management of hepatitis B virus reactivation in the biologic therapy era. World J Gastroenterol. 2011;17:3881–7. PubMed PMID: 22025876.

(Review of the cause and risk factors for reactivation of HBV and the role of preventive strategies).

Opel D, Economidi A, Chan D, Wasfi Y, Mistry S, Vergou T, Antoniou C, Sofen H. Two cases of hepatitis B in patients with moderate to severe psoriasis with ustekinumab. J Drugs Dermatol. 2012;11:1498–501. PubMed PMID: 23377523.

(Two men, 33 and 40 years old, with severe psoriasis developed acute hepatitis B during ustekinumab therapy and recovered with clearance of HBsAg).

Lebwohl M, Leonardi C, Griffiths CE, Prinz JC, Szapary PO, Yeilding N, Guzzo C, et al. Long-term safety experience of ustekinumab in patients with moderate-to-severe psoriasis (Part I of II): results from analyses of general safety parameters from pooled Phase 2 and 3 clinical trials. J Am Acad Dermatol. 2012;66:731–41. PubMed PMID: 21930328.

(Analysis of aggregate safety data from 3219 patients in 4 controlled trials of ustekinumab in psoriasis with variable extension periods reported "no notable differences in routine laboratory parameters were observed between patients treated with ustekinumab or placebo").

Gordon KB, Papp KA, Langley RG, Ho V, Kimball AB, Guzzo C, Yeilding N, et al. Long-term safety experience of ustekinumab in patients with moderate to severe psoriasis (Part II of II): results from analyses of infections and malignancy from pooled phase II and III clinical trials. J Am Acad Dermatol. 2012;66:742–51. PubMed PMID: 21978572.

(Analysis of aggregate safety data from 4 controlled trials of ustekinumab with extension for up to 3 years demonstrated no increase in rates of serious and opportunistic infections or malignancy; no analysis of ALT elevations or mention of hepatotoxicity).

Sandborn WJ, Gasink C, Gao LL, Blank MA, Johanns J, Guzzo C, Sands BE, et al; CERTIFI Study Group. Ustekinumab induction and maintenance therapy in refractory Crohn's disease. N Engl J Med. 2012;367:1519–28. PubMed PMID: 23075178.

(Among 526 patients with Crohn disease treated with 1 of 3 doses of ustekinumab or placebo for 16 weeks, response rates were higher with ustekinumab [34-40% vs 24%] and rates of adverse events were similar; no mention of ALT elevations or hepatotoxicity).

Chiu HY, Chen CH, Wu MS, Cheng YP, Tsai TF. The safety profile of ustekinumab in the treatment of patients with psoriasis and concurrent hepatitis B or C. Br J Dermatol. 2013;169:1295–303. PubMed PMID: 23746170.

(Among 18 patients with psoriasis and concurrent hepatitis B or C treated with ustekinumab, reactivation of HBV occurred in 2 of 11 with HBsAg, but with a rise in HBV DNA levels only, without symptoms or ALT elevations, while reactivation of HCV occurred in 1 of 4 patients marked by a rise in HCV RNA without change in ALT).

Abuchar A, Vitiello M, Kerdel FA. Psoriasis treated with ustekinumab in a patient with hepatitis C. Int J Dermatol. 2013;52:381–2. PubMed PMID: 23414168.

(62 year old man with psoriatic arthritis and chronic hepatitis C was treated with ustekinumab after intolerance or failure of other therapies and had no change in serum HCV RNA or ALT levels during the first few months of therapy).

McInnes IB, Kavanaugh A, Gottlieb AB, Puig L, Rahman P, Ritchlin C, Brodmerkel C, et al. PSUMMIT 1 Study Group. Efficacy and safety of ustekinumab in patients with active psoriatic arthritis: 1 year results of the phase 3, multicentre, double-blind, placebo-controlled PSUMMIT 1 trial. Lancet. 2013;382(9894):780–9. PubMed PMID: 23769296.

(Among 615 patients with psoriatic arthritis treated with 1 of 2 doses of ustekinumab or placebo, response rates at 12 weeks were greater with ustekinumab [42-49% vs 23%], while rates of adverse events were similar).

Zhu X, Zheng M, Song M, Shen YK, Chan D, Szapary PO, Wang B. LOTUS Investigators. Efficacy and safety of ustekinumab in Chinese patients with moderate to severe plaque-type psoriasis: results from a phase 3 clinical trial (LOTUS). J Drugs Dermatol. 2013;12:166–74. PubMed PMID: 23377389.

(Among 322 Chinese patients with psoriasis treated with 2 injections of ustekinumab or placebo, responses at week 12 were 83% with ustekinumab vs 11% with placebo, while ALT elevations occurred in only 1 patient in each group (<1%) and resolved spontaneously).

Papp KA, Griffiths CE, Gordon K, Lebwohl M, Szapary PO, Wasfi Y, Chan D, et al. PHOENIX 1 Investigators; PHOENIX 2 Investigators; ACCEPT Investigators. Long-term safety of ustekinumab in patients with moderate-to-severe psoriasis: final results from 5 years of follow-up. Br J Dermatol. 2013;168:844–54. PubMed PMID: 23301632.

(Pooled analysis of 4 controlled trials of ustekinumab for psoriasis in 3117 patients found no excess in serious adverse events with long term ustekinumab therapy).

Navarro R, Vilarrasa E, Herranz P, Puig L, Bordas X, Carrascosa JM, Taberner R, et al. Safety and effectiveness of ustekinumab and antitumour necrosis factor therapy in patients with psoriasis and chronic viral hepatitis B or C: a retrospective, multicentre study in a clinical setting. Br J Dermatol. 2013;168:609–16. PubMed PMID: 22985451.

(A retrospective analysis identified 3 patients with psoriasis and chronic hepatitis C and 3 with chronic hepatitis B who were treated with ustekinumab, none of whom had a significant change in ALT or viral levels during treatment).

Meng Y, Dongmei L, Yanbin P, Jinju F, Meile T, Binzhu L, Xiao H, et al. Systematic review and meta-analysis of ustekinumab for moderate to severe psoriasis. Clin Exp Dermatol. 2014;39:696–707. PubMed PMID: 25039593.

(Systematic review of 9 controlled trials of ustekinumab which included 11,381 patients mentions that the rate of adverse events [including serious infections] with treatment was similar to that in placebo controls; no mention of ALT elevations, hepatotoxicity or reactivation of hepatitis B).

Tamori A, Hino M, Kawamura E, Fujii H, Uchida-Kobayashi S, Morikawa H, Nakamae H, et al. A prospective long-term study of hepatitis B virus reactivation in patients with hematologic malignancy. J Gastroenterol Hepatol. 2014;29:1715–21. PubMed PMID: 24730465.

(Among patients with anti-HBc without HBsAg not receiving prophylaxis, reactivation of HBV occurred in 26% of 19 patients undergoing HCT [onset at 9-36 months] and 10% of 30 patients given rituximab based chemotherapy [onset after 2-10 months], all of whom had anti-HBs titers below 200 mIU/mL before therapy and all of whom were successfully treated with entecavir).

Ritchlin C, Rahman P, Kavanaugh A, McInnes IB, Puig L, Li S, Wang Y, et al. PSUMMIT 2 Study Group. Efficacy and safety of the anti-IL-12/23 p40 monoclonal antibody, ustekinumab, in patients with active psoriatic arthritis despite conventional non-biological and biological anti-tumour necrosis factor therapy: 6-month and 1-year results of the phase 3, multicentre, double-blind, placebo-controlled, randomised PSUMMIT 2 trial. Ann Rheum Dis. 2014;73:990–9. PubMed PMID: 24482301.

(Among 312 patients with psoriatic arthritis in a 24 week controlled trial, clinical responses occurred in 44% of ustekinumab vs 20% of placebo recipients, and rates of side effects were similar without ustekinumab related severe adverse events or tuberculosis; no mention of ALT elevations or hepatotoxicity).

Certolizumab pegol (Cimzia) and ustekinumab (Stelara) for psoriatic arthritis. Med Lett Drugs Ther. 2014;56(1435):10–2. PubMed PMID: 24662976.

(Concise review of the mechanisms of action, clinical efficacy, safety and cost of ustekinumab and certolizumab shortly after their approval for use in psoriatic arthritis; no mention of hepatotoxicity or reactivation of hepatitis B).

Motaparthi K, Stanisic V, Van Voorhees AS, Lebwohl MG, Hsu S; Medical Board of the National Psoriasis Foundation. From the Medical Board of the National Psoriasis Foundation: Recommendations for screening for hepatitis B infection prior to initiating anti-tumor necrosis factor-alfa inhibitors or other immunosuppressive agents in patients with psoriasis. J Am Acad Dermatol. 2014;70:178–86. PubMed PMID: 24220724.

(Mentions that little is known about the effects of ustekinumab on HBV infection, but that screening for hepatitis B markers is "advisable" before its use).

Steglich RB, Meneghello LP, Carvalho AV, Cheinquer H, Muller FM, Reginatto FP. The use of ustekinumab in a patient with severe psoriasis and positive HBV serology. An Bras Dermatol. 2014;89:652–4. PubMed PMID: 25054756.

(53 year old man with psoriasis and anti-HBc without HBsAg in serum was given lamivudine prophylaxis and treated with ustekinumab for 3 years with an excellent response and no evidence of reactivation of hepatitis B).

Llamas-Velasco M, Concha-Garzón MJ, García-Diez A, Daudén E. Liver injury in psoriasis patients receiving ustekinumab: a retrospective study of 44 patients treated in the clinical practice setting. Actas Dermosifiliogr. 2015;106:470–6. PubMed PMID: 25912374.

(Among 44 patients with psoriasis treated with ustekinumab for 1 to 5 years, 6 developed minor ALT elevations on therapy [peak values 39 to 74 U/L], but all resolved without jaundice and without dose modifications).

Chalasani N, Bonkovsky HL, Fontana R, Lee W, Stolz A, Talwalkar J, Reddy KR, et al; United States Drug Induced Liver Injury Network. Features and outcomes of 899 patients with drug-induced liver injury: The DILIN Prospective Study. Gastroenterology. 2015;148:1340–52.e7. PubMed PMID: 25754159.

(Among 899 cases of drug induced liver injury enrolled in a US prospective study between 2004 and 2013, only four cases were attributed to a monoclonal antibody [3 to infliximab and 1 to adalimumab; no cases were attributed to ustekinumab).

Sanz-Bueno J, Vanaclocha F, García-Doval I, Torrado R, Carretero G, Daudén E, Patricia Ruiz-Genao D, et al. members of the BIOBADADERM group. Risk of reactivation of hepatitis B virus infection in psoriasis patients treated with biologics: a retrospective analysis of 20 cases from the BIOBADADERM database. Actas Dermosifiliogr. 2015;106:477–82. PubMed PMID: 25776200.

(Among 20 patients with psoriasis who had anti-HBc without HBsAg in serum and were treated with biologic agents, none developed evidence of reactivation of hepatitis B including 6 who received ustekinumab for an average of 18 months).

Hirschfield GM, Gershwin ME, Strauss R, Mayo MJ, Levy C, Zou B, Johanns J, et al; PURIFI Study Group. Ustekinumab for patients with primary biliary cholangitis who have an inadequate response to ursodeoxycholic acid: A proof-of-concept study. Hepatology. 2016;64:189–99. PubMed PMID: 26597786.

(Among 20 patients with primary biliary cirrhosis treated with ustekinumab for up to 28 weeks, drop outs were frequent and serum alkaline phosphatase, ALT and AST improved minimally [9%-11%], no patients achieving criteria for a response, but also no patients developing worsening of blood test results; one subject had a variceal hemorrhage).

Snast I, Atzmony L, Braun M, Hodak E, Pavlovsky L. Risk for hepatitis B and C virus reactivation in patients with psoriasis on biologic therapies: A retrospective cohort study and systematic review of the literature. J Am Acad Dermatol. 2017;77:88–97.e5. PubMed PMID: 28495497.

(Among 25 patients with psoriasis and anti-HBc without HBsAg in serum who were treated with biologic agents, including 9 treated with ustekinumab, none developed serum ALT elevations or evidence of HBV reactivation).

Lovero R, Losurdo G, Mastromauro M, Castellaneta NM, Mongelli A, Gentile A, Di Leo A, et al. A case of severe transaminase elevation following a single ustekinumab dose with remission after drug withdrawal. Curr Drug Saf. 2018;13:221–3. PubMed PMID: 30027852.

(61 year old woman with psoriasis developed marked ALT elevations after a single, initial injection of ustekinumab [ALT 1212 U/L] and recovered but was not retreated).

Ting SW, Chen YC, Huang YH. Risk of hepatitis B reactivation in patients with psoriasis on ustekinumab. Clin Drug Investig. 2018;38:873–80. PubMed PMID: 29968197.

(Among 93 patients with psoriasis treated with ustekinumab, 10 with HBsAg [2 given prophylaxis], 24 with anti-HBc without HBsAg, and 59 with no HBV markers [n=59], 2 with HBsAg, 1 with anti-HBc and none without markers developed reactivation of HBV during therapy, but all cases were asymptomatic with only minor and transient elevations in HBV DNA).

Begon E, Beneton N, Poiraud C, Droitcourt C, Jacobzone C, Vermersch-Langlin A, Descamps V, et al. Groupe d'Etudes Multicentrique GEM RESOPSO. Safety and efficacy of biological therapies in patients with psoriasis with alcoholic cirrhosis: a French retrospective study of 23 cases. Br J Dermatol. 2018;179:512–3. PubMed PMID: 29480522.

(Among 23 patients with alcoholic cirrhosis and psoriasis who were treated with biologic agents [10 with ustekinumab], therapy was often effective and was well tolerated and although 5 developed infections, all were able to continue or resume therapy).

AlMutairi N, Abouzaid HA. Safety of biologic agents for psoriasis in patients with viral hepatitis. J Dermatolog Treat. 2018;29:553–6. PubMed PMID: 29345515.

(Among 39 patients with psoriasis and chronic viral hepatitis treated with biologic agents for at least 24 months, all were monitored but none developed clinical, biochemical or virologic evidence of reactivation [4 with HBsAg were given prophylaxis; 28 with anti-HBc without HBsAg and 7 with chronic hepatitis C]).

Piaserico S, Messina F, Russo FP. Managing psoriasis in patients with HBV or HCV infection: practical considerations. Am J Clin Dermatol. 2019;20:829–45. PubMed PMID: 31222626.

(Review of the risks of reactivation of hepatitis B from biologic agents used to treat psoriasis mentions that ustekinumab has a moderate risk and recommends monitoring of HBV DNA levels during therapy if prophylaxis with antiviral agents is not used).

Drugs for psoriatic arthritis. Med Lett Drugs Ther. 2019;61(1588):203–10. PubMed PMID: 31999665.

(Concise review of the mechanism of action, clinical efficacy, safety and costs of drugs for psoriatic arthritis mentions that common adverse events from secukinumab include injection site reactions, respiratory and candida infections, nausea and diarrhea ad uncommon but severe adverse events include tuberculosis, Crohn disease and hypersensitivity reactions).

Drugs for psoriasis. Med Lett Drugs Ther. 2019;61(1574):89–96. PubMed PMID: 31381544.

(Concise review of the mechanism of action, clinical efficacy, safety and costs of drugs for psoriasis mentions three IL-17A antagonists – secukinumab, ixekizumab and brodalumab – all of which are highly effective and relatively well tolerated; no mention of ALT elevations or hepatotoxicity).