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# Tuberculosis screening guidelines should be updated and quantiferon test should be a prerequisite prior to the initiation of treatment of psoriasis with biological agents

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**Abstract. – OBJECTIVE: With the current study, we aimed at evaluating the quantiferon test results of psoriasis patients treated with biological agents.**

**PATIENTS AND METHODS: Between April 2019 and June 2021, medical records of patients with psoriasis who were evaluated for latent tuberculosis infection before the initiation of biological agent treatment were reviewed retrospectively.**

**RESULTS: This study included 132 patients, 50 (37.9%) female and 82 (62.1%) male. The mean disease duration was 16.42±10.99 years (range: 1-49 years). None of the patients had a previous history of tuberculosis. Quantiferon test was negative in 109 (82.6%) patients and positive in 23 (17.4%) patients. Patients with positive quantiferon test results were older than those who had negative quantiferon test results; the mean ages were 50.21±10.79 and 42.98±11.81 years, respectively ($p$=0.006).**

**CONCLUSIONS: Within this study, 17.4% of patients with psoriasis had positive quantiferon test results. We suggest that quantiferon test should be performed in all patients with psoriasis especially in the elderly for latent tuberculosis screening before the initiation of biological agent treatment. Moreover, we suggest that psoriasis treatment guidelines with biological agents should include detailed information on the necessity of chest radiograph, choosing tuberculin skin test or interferon gamma release assays such as quantiferon and T-spot test. In addition, controversies on the requirement of screening for latent tuberculosis and prophylactic tuberculosis treatment before the initiation of novel biological agents such as IL-17 and IL-23 inhibitors should be clarified. An international consensus on the duration of latent tuberculosis treatment and the interval between tuberculosis prophylaxis and the initiation of biological agents should be achieved.**

*Key Words:*
Biological agents, Latent tuberculosis, Psoriasis, Screening.

## Introduction

Psoriasis is a chronic inflammatory immune-mediated cutaneous disorder which affects 2-3% of the population all over the world[1,2]. Tumor necrosis factor alpha (TNF-α) antagonists, interleukin (IL)-17A inhibitors, IL-12/23 antagonist and IL-23p19 inhibitors are biological agents which are used in the treatment of psoriasis[3,4]. The treatment of psoriasis aims to suppress inflammation[1]. Biological agents inhibit inflammation by their effect on certain immune pathways which play an important role in the etiopathogenesis of psoriasis[1].

However, safety concerns have been reported due to both increasing, widespread, long-term use of biological agents and their immunosuppressive effects[2,4,5]. For instance, TNF-α inhibitors have been associated with increased risk for infections such as tuberculosis and reactivation of hepatitis B and hepatotoxicity. IL-17 inhibitors have been associated with candidiasis, neutropenia, and inflammatory bowel disease[2,4]. IL-12/23 antagonist has been associated with cardiovascular side effects and reactivation of latent tuberculosis[6,7]. However, data on adverse effects of novel biological agents such as IL-17 and IL-23 inhibitors are inadequate[4].

One of the most important opportunistic infections which may develop in patients under biological agent treatment is latent tuberculosis reactivation[7]. Since TNF-α is a crucial cytokine both in macrophage functions and in granulomatous reaction of tuberculosis, anti-TNF-α treatment may lead to the reactivation of latent tuberculosis[8]. Tuberculosis is included in the most prominent causes of infection related death worldwide[9]. It has been suggested that 25% of the world population might have been affected by latent tubercu-



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losis[10,11]. Furthermore, immigrants and refugees may increase the risk of tuberculosis globally and particularly in developed countries[12-14].

Early diagnosis and appropriate treatment of latent tuberculosis infection in patients receiving biological agents decrease the disease incidence[14]. Therefore, all patients with psoriasis should be evaluated carefully for latent tuberculosis infection before the initiation of treatment with biological agents[7,9]. Nevertheless, sign and symptoms of active tuberculosis infection should be kept in mind in the follow-up of psoriasis patients under any biological agent treatment.

The risk for reactivation of latent tuberculosis infection by IL-12/23 and IL-17 inhibitors has been proposed to be lower compared to TNF-α inhibitors[15,16]. However, the effect of biological agents except for TNF-α inhibitors on reactivation of latent tuberculosis remains controversial[14]. Data on tuberculosis screening in patients who received anti-IL-17, anti-IL-23 and anti-IL-12/23 are inadequate[16]. Furthermore, it has been suggested that requirement of screening for latent tuberculosis or initiation of prophylactic tuberculosis treatment may be controversial before the treatment with IL-17 and IL-23 inhibitors[9]. On the other hand, poor adherence to latent tuberculosis screening programmes and prophylactic treatment has also been reported in psoriasis patients receiving biological agents[17,18].

Within this study, we presented quantiferon test results of psoriasis patients who were screened for tuberculosis before the initiation of treatment with biological agents.

## Patients and Methods

Between April 2019 and June 2021, medical records of the patients with psoriasis who were evaluated for latent tuberculosis infection before the initiation of biological agent treatment were reviewed retrospectively. Gazi University Ethics Committee approval was obtained for this study (approval number: 2021-670). Quantiferon test, chest radiograph, respiratory symptoms such as cough, sputum, dyspnea, chest pain, B symptoms such as fever, night sweats and weight loss, respiratory rate, oxygen saturation, previous history of tuberculosis infection, exposure to individuals with tuberculosis infection and previous prophylactic tuberculosis treatment were evaluated.

### Statistical Analysis

Statistical analysis was performed using SPSS 22.0 statistical package programme (IBM Corp., Armonk, NY, USA). Continuous variables were defined as the mean±standard deviation and categorical variables were defined as percentages. The differences between two groups were evaluated by Mann-Whitney U test. The $p$-value <0.05 was considered significant.

## Results

The study included 132 patients, 50 (37.9%) female and 82 (62.1%) male. The mean age of the patients was 44.24±11.92 years (range: 18-65 years). 119 (90.2%) patients had psoriasis vulgaris, 7 (5.3%) patients had generalized pustular psoriasis, 4 (3.3%) patients had palmoplantar psoriasis and 2 (1.5%) patients had palmoplantar pustular psoriasis (Table I). The mean disease duration was 16.42±10.99 years (range: 1-49 years). 54 (40.9%) patients were treated with ustekinumab, 30 (22.7%) with adalimumab, 27 (20.5%) with ixekizumab, 9 (6.8%) with infliximab, 9 (6.8%) with secukinumab, 2 (1.5%) with etanercept and 1 (0.8%) patient received certolizumab pegol. 86 (65.2%) patients were biologic naive whereas, 46 (34.8%) patients were treated with biological agents previously. 127 (96.2%) patients had unremarkable past medical history for pulmonary diseases. However, 3 (2.3%) patients had chronic obstructive pulmonary disease and 2 (1.5%) patients had asthma. 7 (5.3%) patients had been diagnosed with Coronavirus disease 2019 (COVID-19) previously. None of the patients had a previous history of tuberculosis. Only 2 (1.5%) patients stated that they had been exposed to individuals with tuberculosis infection.

Quantiferon test was negative in 109 (82.6%) patients and positive in 23 (17.4%) patients (Table II). Quantiferon test was negative in both patients who have been exposed to individuals with tuberculosis infection. The mean age of the patients with positive and negative quantiferon test were 50.21±10.79 and 42.98±11.81 years, respectively ($p$=0.006). No significant difference was observed between quantiferon test results and disease duration ($p$=0.243). Among the evaluation of respiratory symptoms, cough was observed in 1 (12.5%) patient with positive and 7 (87.5%) patients with negative quantiferon test results ($p$=0.706). Expectoration was observed in 3 (42.9%) patients with positive and in 4 (57.1%)

**Table I.** Characteristics of patients with psoriasis.

| | | | | |
|---|---|---|---|---|
| Patients (n = 132) | Female 50 (37.9%) | Male 82 (62.1%) | | |
| Mean age (years) | 44.24 ± 11.92 | | | |
| Mean disease duration (years) | 16.42 ± 10.99 | | | |
| Psoriasis type (n/%) | Psoriasis vulgaris 119 (90.2%) | Generalized pustular 7 (5.3%) | Palmoplantar 4 (3.3%) | Palmoplantar pustular 2 (1.5%) |
| Treatment (n/%) | Anti-TNF-α 42 (31.8%) | Anti-IL-12/23 54 (40.9%) | Anti-IL-17 36 (27.3%) | |
| Medical history (n/%) | Chronic obstructive pulmonary disease 3 (2.3%) | Asthma 2 (1.5%) | | |
| Previous treatment (n/%) | Biologic naive 86 (65.2%) | Previous biologic 46 (34.8%) | | |
| | Negative | Positive | | |
| Quantiferon (n/%) | 109 (82.6%) | 23 (17.4%) | | |
| Previous history of tuberculosis (n) | 0 | | | |
| Exposure to patients with tuberculosis (n/%) | 2 (1.5%) | | | |
| Active tuberculosis (n) | 0 | | | |

17.4% patients had positive quantiferon test results, however, none of the patients were diagnosed with active tuberculosis.

patients with negative quantiferon test results ($p$=0.069). Chest pain was observed only in one patient who had a negative quantiferon test result. All eight patients with dyspnea had negative quantiferon test results. B symptoms such as fever, night sweats and weight loss were not observed in any patients with negative quantiferon test results. However, one patient with a positive quantiferon test result had a complaint of night sweats. Respiratory rate and oxygen saturation were within normal limits in all patients.

81 (61.4%) patients with negative quantiferon test results and 15 (11.4%) patients with positive quantiferon test results had normal chest radiograph. Hilar fullness was detected in 14 (10.6%) patients with negative quantiferon test results and in 4 (3%) patients with positive quantiferon test results. Pulmonary nodule was detected in 8 (6.1%) patients with negative quantiferon test results and in 1 (0.8%) patient with positive quantiferon test result. Chest radiograph showed increased reticular density in 3 (2.3%) patients with positive and in 1 (0.8%) patient with negative quantiferon test result. 2 (1.5%) patients with homogeneous density on chest radiograph, 1 (0.8%) patient with paratracheal heterogeneity, 1 (0.8%) patient with increased cardiothoracic ratio and 1 (0.8%) patient with left costophrenic

**Table II.** Patients with positive and negative quantiferon test results.

| | Positive quantiferon 23 (17.4%) | Negative quantiferon 109 (82.6%) | *p*-value |
|---|---|---|---|
| Mean age (years) | 50.21 ± 10.79 | 42.98 ± 11.81 | 0.006 |
| Mean disease duration (years) | 14.69 ± 12.10 | 16.78 ± 10.77 | 0.243 |
| Cough (n/%) | 1 (12.5%) | 7 (87.5%) | 0.706 |
| Expectoration (n/%) | 3 (42.9%) | 4 (57.1%) | 0.069 |
| Chest pain (n/%) | - | 1 (0.8%) | |
| Dyspnea (n/%) | - | 8 (6.1%) | |
| B symptoms | Night sweats 1 (0.8%) | - | |
| Exposure to patients with tuberculosis (n/%) | - | 2 (1.5%) | |

Patients with positive quantiferon test results were older than those who had negative quantiferon test results ($p$ = 0.006).

angle blunting had negative quantiferon test results.

Among the patients with positive quantiferon test results, 14 (60.9%) of them had not received prophylactic tuberculosis treatment previously. Therefore, these patients were recommended to use 300 mg/day isoniazid for 9 months. None of the patients had an active tuberculosis infection.

## Discussion

Latent tuberculosis is a common, asymptomatic tuberculosis infection that occurs following exposure to tuberculosis bacilli. Therefore, diagnosis of latent tuberculosis is not always easy to make and immunosuppressive drugs such as biological agents may lead to active tuberculosis infection[5]. It has been suggested that the risk for the progress of latent tuberculosis to active disease that is transmissible and symptomatic was 10%[19]. Since patients with latent tuberculosis infection are substantial reservoir for active tuberculosis, early diagnosis, and appropriate treatment of latent tuberculosis infection in high-risk populations such as immunocompromised individuals or individuals contacted with active tuberculosis patients are mandatory to control this public health problem worldwide[20,21].

Tuberculin skin test and interferon gamma release assays such as quantiferon and T-spot tests can be used to detect latent tuberculosis. Higher sensitivity and specificity for the diagnosis of latent tuberculosis have been reported in interferon gamma release assays compared to tuberculin skin test[19,21,22]. False positive tuberculin skin test results can be obtained in Bacillus Calmette-Guerin (BCG) vaccinated individuals[23]. Therefore, interferon gamma release assays are convenient particularly in BCG vaccinated individuals[22,24].

Joint American Academy of Dermatology-National Psoriasis Foundation (AAD-NPF) guidelines of care for the management and treatment of psoriasis with biologics recommends performing purified protein derivative (PPD), T-spot or quantiferon test before treatment with TNF-α inhibitors and IL-12/23 antagonist in order to exclude latent tuberculosis. PPD or quantiferon test have also been recommended before treatment of psoriasis with IL-17 inhibitors. Furthermore, chest radiograph is recommended in patients with positive tuberculosis test results[1]. EuroGuiDerm guideline on the systemic treatment of psoriasis vulgaris published by European Dermatology Forum recommends performing interferon gamma release assays before the treatment of psoriasis with TNF-α inhibitors, IL-12/23 antagonist, IL-17 inhibitors and IL-23p19 inhibitors[25]. British Association of Dermatologists recommends interferon gamma release assay or interferon gamma release assay accompanied by tuberculin skin test for latent tuberculosis screening before biological agent treatment. Chest radiograph might be performed if local policies required[3]. Swiss S1 guidelines on the systemic treatment of psoriasis vulgaris stated that before etanercept, infliximab, adalimumab, ustekinumab, secukinumab, patients should be screened for tuberculosis including chest radiograph[26]. Japanese guidance for biologic use in psoriasis recommends performing tuberculin skin test, quantiferon or T-spot test and chest radiograph to exclude latent tuberculosis in psoriasis patients before biological agent treatment[27].

Studies conducted in different countries and even different studies conducted in the same country reported different rate of positive quantiferon test results in patients with psoriasis before biological agent treatment. Positive quantiferon test results have been reported in 8.2% of patients with psoriasis vulgaris who were candidates for biological agent treatment in Italy[19]. However, Bua et al[28] reported that 39% of Italian patients with psoriasis had positive quantiferon test results before biological agent treatment. It has been reported that 13.4% of psoriasis patients who were evaluated for latent tuberculosis before treatment with ustekinumab had positive quantiferon test results in Taiwan[22]. Positive quantiferon test results have also been reported in 18% of psoriasis patients treated with IL-17 inhibitors in Taiwan[29]. In China, Shu et al[30] reported positive quantiferon test results in 45.2% of psoriasis patients before receiving secukinumab. In a study from Portugal, Ramos et al[31] reported positive tuberculosis screening results with tuberculin skin test and quantiferon in 45.2% of the patients with diseases such as psoriasis, Crohn's disease, multiple sclerosis, ankylosing spondylitis before treatment with biological agents. Georgieva et al[32] detected latent tuberculosis in 10.1% patients with Crohn's disease before anti-TNF-α treatment in Bulgaria. Medina-Gil et al[33] evaluated latent tuberculosis prevalence in patients with psoriasis before biological agent treatment in Miami, Florida

and they reported positive tuberculin skin test in 4.5% of the patients. Neema et al[34] detected latent tuberculosis infection in 29.5% of the patients and active tuberculosis in 1.9% of the patients with psoriasis prior to systemic treatment by tuberculin skin test and chest radiograph in India. In Spain, prevalence of latent tuberculosis has been found 20.5% in psoriasis patients by tuberculin skin test and chest radiograph performed for biological agent treatment[35].

In many countries such as Sweden, Spain, Denmark, Germany, Austria, France, United Kingdom and in the United States, BCG vaccine is not routinely administered[36,37]. Furthermore, immigrants from countries with high tuberculosis rate lead to increased incidence of tuberculosis infection in European countries[38,39]. Since 80% of the cases with active tuberculosis occur as a result of progression of latent tuberculosis, treatment should focus on untreated individuals with latent tuberculosis[21].

Moreover, there are discrepancies between psoriasis treatment guidelines about the duration of latent tuberculosis treatment and time to start biological agent following tuberculosis treatment[3,26,27]. British Association of Dermatologists recommends combination of isoniazid and rifampicin for 3 months or isoniazid alone for 6 months in the treatment of latent tuberculosis. These drugs should be initiated 2 months before the administration of biological agents[3]. Swiss S1 guidelines on the systemic treatment of psoriasis vulgaris recommends using isoniazid for 9 months for the treatment of latent tuberculosis and to start biological agents 1 month after the initiation of isoniazid[26]. According to Japanese guidance for biologic use in psoriasis, latent tuberculosis should be treated with isoniazid for 6 months and biological agents should be received 3 weeks after the initiation of isoniazid treatment[27]. However, no information about treatment of latent tuberculosis has been included in Joint AAD-NPF guidelines of care for the management and treatment of psoriasis and EuroGuiDerm guideline on the systemic treatment of psoriasis vulgaris[1,25].

## Conclusions

Within this study, 17.4% patients with psoriasis had positive quantiferon test result performed for screening biological agent treatment. We suggest that quantiferon test should be performed in all patients with psoriasis especially in elderly for latent tuberculosis screening before the initiation of biological agent treatment. Immigrants from countries with high tuberculosis rate may lead to increased incidence of tuberculosis infection especially in countries where BCG vaccine is not administered routinely such as in Europe and in the United States. Psoriasis treatment guidelines with biological agents should include detailed information on the requirement of chest radiograph, choosing tuberculin skin test or interferon gamma release assays such as quantiferon and T-spot test and latent tuberculosis screening intervals during the treatment with biologic agents. Controversies on the requirement of screening for latent tuberculosis and prophylactic tuberculosis treatment before novel biological agents such as IL-17 and IL-23 inhibitors should also be clarified. Consensus on duration of latent tuberculosis treatment and the most convenient interval between tuberculosis prophylaxis and initiation of the biological agents should be reached.

### Conflict of Interest

The Authors declare that they have no conflict of interests.

### Funding

None.

### Ethics Approval

The research meets the ethical guidelines and Gazi University Ethics Committee. The approval was obtained prior to this study (approval number: 2021-670).

### Informed Consent

Informed consent was obtained from all participants included in the study.

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## References

1) Menter A, Strober BE, Kaplan DH, Kivelevitch D, Prater EF, Stoff B, Armstrong AW, Connor C, Cordoro KM, Davis DMR, Elewski BE, Gelfand JM, Gordon KB, Gottlieb AB, Kavanaugh A, Kiselica M, Korman NJ, Kroshinsky D, Lebwohl M, Leonardi CL, Lichten J, Lim HW, Mehta NN, Paller AS, Parra SL, Pathy AL, Rupani RN, Siegel M, Wong

EB, Wu JJ, Hariharan V, Elmets CA. Joint AAD-NPF guidelines of care for the management and treatment of psoriasis with biologics. J Am Acad Dermatol 2019; 80: 1029-1072.

2) Silfvast-Kaiser A, Menter MA. How can we manage the safety concerns associated with the increase in biologics for psoriasis? Expert Opin Drug Saf 2020; 19: 361-364.
3) Smith CH, Yiu ZZN, Bale T, Burden AD, Coates LC, Edwards W, MacMahon E, Mahil SK, McGuire A, Murphy R, Nelson-Piercy C, Owen CM, Parslew R, Uthman OA, Woolf RT, Manounah L, Ezejimofor MC, Exton LS, Mohd Mustapa MF; British Association of Dermatologists' Clinical Standards Unit. British Association of Dermatologists guidelines for biologic therapy for psoriasis 2020: a rapid update. Br J Dermatol 2020; 183: 628-637.
4) Kamata M, Tada Y. Efficacy and safety of biologics for psoriasis and psoriatic arthritis and their impact on comorbidities: a literature review. Int J Mol Sci 2020; 21: 1690.
5) Drago L, Nicola L, Signori V, Palazzi E, Garutti C, Spadino S, Altomare G. Dynamic QuantiFERON response in psoriasis patients taking long-term biologic therapy. Dermatol Ther (Heidelb) 2013; 3: 73-81.
6) Kamata M, Tada Y. Safety of biologics in psoriasis. J Dermatol 2018; 45: 279-286.
7) Snast I, Bercovici E, Solomon-Cohen E, Avni T, Shitenberg D, Hodak E, Pavlovsky L. Active tuberculosis in patients with psoriasis receiving biologic therapy: a systematic review. Am J Clin Dermatol 2019; 20: 483-491.
8) Amerio P, Amoruso G, Bardazzi F, Campanati A, Cassano N, Conti A, Gisondi P, Guarneri C, Mazzotta A, Piaserico S, Prestinari F, Prignano F, Zane C, de Simone C. Detection and management of latent tuberculosis infections before biologic therapy for psoriasis. J Dermatolog Treat 2013; 24: 305-311.
9) Nogueira M, Warren RB, Torres T. Risk of tuberculosis reactivation with interleukin (IL)-17 and IL-23 inhibitors in psoriasis-time for a paradigm change. J Eur Acad Dermatol Venereol 2021; 35: 824-834.
10) Behr MA, Edelstein PH, Ramakrishnan L. Revisiting the timetable of tuberculosis. BMJ 2018; 362: k2738.
11) Carranza C, Pedraza-Sanchez S, de Oyarzabal-Mendez E, Torres M. Diagnosis for latent tuberculosis infection: new alternatives. Front Immunol 2020; 11: 2006.
12) Rustage K, Lobe J, Hayward SE, Kristensen KL, Margineanu I, Stienstra Y, Goletti D, Zenner D, Noori T, Pareek M, Greenaway C, Friedland JS, Nellums LB, Hargreaves S; ESGITM and ESGMYC study groups. Initiation and completion of treatment for latent tuberculosis infection in migrants globally: a systematic review and meta-analysis. Lancet Infect Dis 2021; 21: 1701-1712.
13) Proença R, Mattos Souza F, Lisboa Bastos M, Caetano R, Braga JU, Faerstein E, Trajman A. Active and latent tuberculosis in refugees and asylum seekers: a systematic review and meta-analysis. BMC Public Health. 2020; 20: 838.
14) Kaneko S, Tsuruta N, Yamaguchi K, Miyagi T, Takahashi K, Higashi Y, Morizane S, Nomura H, Yamaguchi M, Hino R, Sawada Y, Nakamura M, Ohyama B, Ohata C, Yonekura K, Hayashi H, Yanase T, Matsuzaka Y, Sugita K, Kikuchi S, Mitoma C, Nakahara T, Furue M, Okazaki F, Koike Y, Imafuku S; Western Japan Inflammatory Disease Research Group. Mycobacterium tuberculosis infection in psoriatic patients treated with biologics: real-world data from 18 Japanese facilities. J Dermatol 2020; 47: 128-132.
15) Elewski BE, Baddley JW, Deodhar AA, Magrey M, Rich PA, Soriano ER, Soung J, Bao W, Keininger D, Marfo K, Patekar M, Sharma A, Shete A, Lebwohl MG. Association of secukinumab treatment with tuberculosis reactivation in patients with psoriasis, psoriatic arthritis, or ankylosing spondylitis. JAMA Dermatol 2021; 157: 43-51.
16) Daniel VT, Blankenship KC, Daly RF, Tkachenko E, Morss-Walton PC, Levin NA. Low rate of conversion to positive tuberculosis status among patients with psoriasis on biologic therapies: A retrospective study from a US academic medical center. J Am Acad Dermatol 2021; 84: 830-833.
17) Martínez-López A, Rodriguez-Granger J, Ruiz-Villaverde R. Screening for latent tuberculosis in the patient with moderate to severe psoriasis who is a candidate for systemic and/or biologic therapy. Actas Dermosifiliogr 2016; 107: 207-214.
18) Conti A, Piaserico S, Gisondi P, Odorici G, Galdo G, Lasagni C, Pellacani G. Management of long-term therapy with biological drugs in psoriatic patients with latent tuberculosis infection in real life setting. Dermatol Ther 2017; 30: e12503.
19) Gisondi P, Pezzolo E, Lo Cascio G, Girolomoni G. Latent tuberculosis infection in patients with chronic plaque psoriasis who are candidates for biological therapy. Br J Dermatol 2014; 171: 884-890.
20) Kiazyk S, Ball TB. Latent tuberculosis infection: an overview. Can Commun Dis Rep 2017; 43: 62-66.
21) Zellweger JP, Sotgiu G, Corradi M, Durando P. The diagnosis of latent tuberculosis infection (LTBI): currently available tests, future developments, and perspectives to eliminate tuberculosis (TB). Med Lav 2020; 111: 170-183.
22) Hsiao CY, Chiu HY, Wang TS, Tsai TF. Serial QuantiFERON-TB Gold testing in patients with psoriasis treated with ustekinumab. PLoS One 2017; 12: e0184178.
23) Cantini F, Nannini C, Niccoli L, Iannone F, Delogu G, Garlaschi G, Sanduzzi A, Matucci A, Prignano F, Conversano M, Goletti D; SAFEBIO (Italian multidisciplinary task force for screening of tuber-

culosis before and during biologic therapy). Guidance for the management of patients with latent tuberculosis infection requiring biologic therapy in rheumatology and dermatology clinical practice. Autoimmun Rev 2015; 14: 503-509.

24) Doherty SD, Van Voorhees A, Lebwohl MG, Korman NJ, Young MS, Hsu S. National Psoriasis Foundation consensus statement on screening for latent tuberculosis infection in patients with psoriasis treated with systemic and biologic agents. J Am Acad Dermatol 2008; 59: 209-217.

25) Nast A, Smith C, Spuls PI, Avila Valle G, Bata-Csörgö Z, Boonen H, De Jong E, Garcia-Doval I, Gisondi P, Kaur-Knudsen D, Mahil S, Mälkönen T, Maul JT, Mburu S, Mrowietz U, Reich K, Remenyik E, Rønholt KM, Sator PG, Schmitt-Egenolf M, Sikora M, Strömer K, Sundnes O, Trigos D, Van Der Kraaij G, Yawalkar N, Dressler C. EuroGuiDerm Guideline on the systemic treatment of psoriasis vulgaris-part 1: treatment and monitoring recommendations. J Eur Acad Dermatol Venereol 2020; 34: 2461-2498.

26) Kolios AG, Yawalkar N, Anliker M, Boehncke WH, Borradori L, Conrad C, Gilliet M, Häusermann P, Itin P, Laffitte E, Mainetti C, French LE, Navarini AA. Swiss S1 guidelines on the systemic treatment of psoriasis vulgaris. Dermatology 2016; 232: 385-406.

27) Saeki H, Terui T, Morita A, Sano S, Imafuku S, Asahina A, Komine M, Etoh T, Igarashi A, Torii H, Abe M, Nakagawa H, Watanabe A, Yotsuyanagi H, Ohtsuki M; Biologics Review Committee of the Japanese Dermatological Association for Psoriasis: Chair: Mamitaro Ohtsuki. Japanese guidance for use of biologics for psoriasis (the 2019 version). J Dermatol 2020; 47: 201-222.

28) Bua A, Zanetti S, Peigottu MF, Montesu MA, Molicotti P. Limitations of quantiferon-TB gold assay for screening of psoriasis patients prior to anti-tumour necrotic factor treatment. Infect Dis (Lond) 2018; 50: 317-319.

29) Wu CY, Chiu HY, Tsai TF. The seroconversion rate of QuantiFERON-TB Gold In-Tube test in psoriatic patients receiving secukinumab and ixekizumab, the anti-interleukin-17A monoclonal antibodies. PLoS One 2019; 14: e0225112.

30) Shu D, Zhang Z, Zhou EY, Ma X, Zhao Y. Is chemoprophylaxis necessary for all latent tuberculosis infection patients receiving IL-17 inhibitors? A cohort study. Dermatol Ther 2020; 33: e14512.

31) Ramos S, Nogueira A, Dias A, Gonçalves AF, Gaio AR, Duarte R. Tuberculosis screening in patients receiving biological therapy. Acta Reumatol Port 2015; 40: 234-240.

32) Georgieva A, Atanassova A, Mirchev M. Rates of latent and active tuberculosis in BGC vaccinated, immunosuppressed Crohn's disease patients form Bulgaria before and during anti-tumor necrosis factor therapy. Eur Rev Med Pharmacol Sci 2022; 26: 2399-2407.

33) Medina-Gil C, Dehesa L, Vega A, Kerdel F. Prevalence of latent tuberculosis infection in patients with moderate to severe psoriasis taking biologic therapies in a dermatologic private practice in Miami, Florida. Int J Dermatol 2015; 54: 846-852.

34) Neema S, Radhakrishnan S, Dabbas D, Vasudevan B. Latent tuberculosis in psoriasis patients planned for systemic therapy-a prospective observational study. Indian Dermatol Online J 2021; 12: 429-432.

35) Sánchez-Moya AI, García-Doval I, Carretero G, Sánchez-Carazo J, Ferrandiz C, Herrera Ceballos E, Alsina M, Ferrán M, López-Estebaranz JL, Gómez-García F, De la Cueva Dobao P, Carrascosa JM, Vanaclocha F, Belinchón I, Peral F, Dauden E; BIOBADADERM Study Group. Latent tuberculosis infection and active tuberculosis in patients with psoriasis: a study on the incidence of tuberculosis and the prevalence of latent tuberculosis disease in patients with moderate-severe psoriasis in Spain. BIOBADADERM registry. J Eur Acad Dermatol Venereol 2013; 27: 1366-1374.

36) Zwerling A, Behr MA, Verma A, Brewer TF, Menzies D, Pai M. The BCG world atlas: a database of global BCG vaccination policies and practices. PLOS Medicine 2011; 8: e1001012.

37) Sur DK, Wallis DH, O'Connell TX. Vaccinations in pregnancy. Am Fam Physician 2003; 68: 299-304.

38) Jackson S, Kabir Z, Comiskey C. Effects of migration on tuberculosis epidemiological indicators in low and medium tuberculosis incidence countries: A systematic review. J Clin Tuberc Other Mycobact Dis 2021; 23: 100225.

39) Fiorani CM, Tiberi R. Tuberculosis today: evolution of a disease. Eur Rev Med Pharmacol Sci 1998; 2: 3-9.