*Disclosure: Dr Merola is consultant and/or investigator for AbbVie, Aclaris, Almirall, Arena, Avotres, Biogen, Celgene, Dermavant, Eli Lilly, EMD Serono, Incyte, Janssen, LEO Pharma, Merck, Novartis, Pfizer, Regeneron Pharmaceuticals, Inc., Sanofi, Sun Pharma, and UCB. Dr Sidbury is an investigator for Brickell Biotech, Pfizer, Regeneron Pharmaceuticals, Inc., and Scioderm; a continuing medical education participant in Medscape; and an advisory board member of Pfizer. Dr Wollenberg is an investigator for Eli Lilly, Galderma, LEO Pharma, MedImmune, Novartis, Pfizer, Regeneron Pharmaceuticals, Inc., and Sanofi Genzyme; is a consultant for Almirall, Anacor, Eli Lilly, Galderma, LEO Pharma, MedImmune, Novartis, Pfizer, Regeneron Pharmaceuticals, Inc., and Sanofi Genzyme; and has received research grants from Beiersdorf, LEO Pharma, and Pierre Fabre. Drs Chen and Shumel are employees and shareholders of Regeneron Pharmaceuticals, Inc. Drs Zhang and Rossi are employees of and may hold stock and/or stock options in Sanofi Genzyme.*

*IRB approval status: Reviewed and approved by IRBs/ethics committees at all centers.*

*Author Contributions: ABR conceived the idea of the analyses described in this manuscript. ZC conducted the statistical analyses of the data. ABR drafted the manuscript with the medical writer. All authors interpreted the data, provided critical feedback on the manuscript, approved the final manuscript for submission, and are accountable for the accuracy and integrity of the manuscript.*

*Reprints are not available from the authors.*

*Correspondence to: Ana B. Rossi, MD, Sanofi Genzyme, 50 Binney St, Cambridge, MA 02142*

*E-mail: Ana.Rossi@sanofi.com*

**REFERENCES**

1. Sidbury R, Tom WL, Bergman JN, et al. Guidelines of care for the management of atopic dermatitis: section 4. Prevention of disease flares and use of adjunctive therapies and approaches. *J Am Acad Dermatol*. 2014;71:1218-1233.
2. Wollenberg A, Oranje A, Deleuran M, et al. ETFAD/EADV Eczema task force 2015 position paper on diagnosis and treatment of atopic dermatitis in adult and paediatric patients. *J Eur Acad Dermatol Venereol*. 2016;30:729-747.
3. Wollenberg A, Barbarot S, Bieber T, et al. Consensus-based European guidelines for treatment of atopic eczema (atopic dermatitis) in adults and children: part I. *J Eur Acad Dermatol Venereol*. 2018;32:657-662.
4. Wollenberg A, Barbarot S, Bieber T, et al. Consensus-based European guidelines for treatment of atopic eczema (atopic dermatitis) in adults and children: part II. *J Eur Acad Dermatol Venereol*. 2018;32:850-878.
5. Blauvelt A, de-Bruin-Weller M, Gooderham M, et al. Long-term management of moderate-to-severe atopic dermatitis with dupilumab and concomitant topical corticosteroids (LIBERTY AD CHRONOS): a 1-year, randomised, double-blinded, placebo-controlled, phase 3 trial. *Lancet*. 2017;389:2287-2303.

https://doi.org/10.1016/j.jaad.2020.05.003

## Retrospective analysis of laboratory abnormalities in patients prescribed terbinafine for onychomycosis

*To the Editor:* Onychomycosis is a common nail condition with worldwide prevalence of 3% to 10%.[1,2] Oral terbinafine is frequently prescribed because of its efficacy and infrequent adverse events.[1] Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) baseline and interval testing are recommended, without supporting evidence.[1] Our objectives were to retrospectively analyze the frequency and severity of abnormal laboratory test results in adults without pre-existing hepatic and hematologic conditions prescribed terbinafine for onychomycosis.

Data from patients ages 19 years and older diagnosed with onychomycosis and prescribed oral terbinafine for 12 weeks, January 1, 2000, through February 1, 2019, were extracted after institutional review board approval. Patients with pre-existing liver or hematologic diseases and those taking taking oral ketoconazole, amphotericin, or itraconazole were excluded. Demographics, baseline and interval complete blood count (CBC), AST, and ALT measurements were recorded and analyzed.

Inclusion criteria were met by 944 patients; overall demographics are shown in the supplemental material (Supplemental Table 1; available via Mendeley at https://doi.org/10.17632/zd7gknwmdr.1). In total, 27 of 944 (2.9%) and 32 of 944 (3.4%) patients had abnormal results on baseline liver function tests (LFTs) and CBCs, respectively. In sum, 23 of 944 (2.4%) and 26 of 944 (2.8%) had abnormal monitoring LFT and CBC results, respectively. In all, 3 of 944 (0.3%) and 5 of 944 (0.5%) had abnormal baseline and monitoring LFT, and CBC results, respectively (Table I). Baseline LFT elevations resolved in 24 of 27 patients, and 3 of 27 completed treatment despite mildly elevated LFTs. Elevated monitoring LFTs resolved in 17 of 23 patients after therapy or after stopping terbinafine (4/23), and 2 of 23 discontinued medication and were lost to follow-up (Table II).

In this study, abnormal LFT and CBC results in adults without pre-existing hepatic or hematologic conditions who were prescribed 3 months of

**Table I.** Numbers and percentages of patients with each abnormal laboratory test result with grading*

| Tests | Patients, n (%) |
|---|---|
| Baseline tests | |
| LFT test results (n = 27) | |
| Patients with only abnormal AST grade 1 | 2 (7.4) |
| Patients with only abnormal AST grade 2 | 0 (0) |
| Patients with only abnormal ALT grade 1 | 5 (18.5) |
| Patients with only abnormal ALT grade 2 | 0 (0) |
| Patients with abnormal AST and ALT grade 1 | 20 (74.1) |
| Patients with abnormal AST and ALT grade 2 | 0 (0) |
| CBC test results (n = 32) | |
| Patients with only abnormal anemia grade 1 | 27 (84.3) |
| Patients with only abnormal anemia grade 2 | 2 (6.3) |
| Patients with only abnormal neutropenia grade 1 | 0 (0) |
| Patients with only abnormal neutropenia grade 2 | 0 (0) |
| Patients with only abnormal lymphopenia grade 1 | 2 (6.3) |
| Patients with only abnormal lymphopenia grade 2 | 0 (0) |
| Patients with abnormal anemia and neutropenia grade 1 | 0 (0) |
| Patients with abnormal anemia and neutropenia grade 2 | 0 (0) |
| Patients with abnormal anemia and lymphopenia grade 1 | 1 (3.1) |
| Patients with abnormal anemia and lymphopenia grade 2 | 0 (0) |
| Patients with abnormal neutropenia and lymphopenia grade 1 | 0 (0) |
| Patients with abnormal neutropenia and lymphopenia grade 1 | 0 (0) |
| Patients with abnormal anemia, neutropenia, and lymphopenia grade 1 | 0 (0) |
| Patients with abnormal anemia, neutropenia, and lymphopenia grade 2 | 0 (0) |
| Monitoring tests | |
| LFT test results (n = 23) | |
| Patients with only abnormal AST grade 1 | 2 (8.7) |
| Patients with only abnormal AST grade 2 | 0 (0) |
| Patients with only abnormal ALT grade 1 | 5 (21.7) |
| Patients with only abnormal ALT grade 2 | 0 (0) |
| Patients with abnormal AST and ALT grade 1 | 15 (65.2) |
| Patients with abnormal AST and ALT grade 2 | 1 (4.4) |
| CBC test results (n = 26) | |
| Patients with only abnormal anemia grade 1 | 13 (57.7) |
| Patients with only abnormal anemia grade 2 | 2 (7.7) |
| Patients with only abnormal neutropenia grade 1 | 1 (3.8) |
| Patients with only abnormal neutropenia grade 2 | 0 (0) |
| Patients with only abnormal lymphopenia grade 1 | 2 (7.7) |
| Patients with only abnormal lymphopenia grade 2 | 1 (3.8) |
| Patients with abnormal anemia and neutropenia grade 1 | 0 (0) |
| Patients with abnormal anemia and neutropenia grade 2 | 0 (0) |
| Patients with abnormal anemia and lymphopenia grade 1 | 2 (7.7) |
| Patients with abnormal anemia and lymphopenia grade 2 | 0 (0) |
| Patients with abnormal neutropenia and lymphopenia grade 1 | 5 (19.2) |
| Patients with abnormal neutropenia and lymphopenia grade 2 | 0 (0) |
| Patients with abnormal anemia, neutropenia, and lymphopenia grade 1 | 0 (0) |
| Patients with abnormal anemia, neutropenia, and lymphopenia grade 2 | 0 (0) |

*ALT,* Alanine aminotransferase; *AST,* aspartate aminotransferase; *CBC,* complete blood count; *LFT,* liver function test.
*Baseline was defined as testing 90 days before to 7 days after starting terbinafine, and monitoring was defined as testing more than 7 days after starting the medication to completion of the treatment course. Laboratory test result abnormalities were defined as being outside the normal reference range and were assigned a grade based on the National Cancer Institute Common Terminology Criteria for Adverse Events.

terbinafine for onychomycosis were uncommon, were mild, and resolved at completion of treatment. Our findings are consistent with a retrospective study of 4985 healthy patients prescribed terbinafine for dermatophytosis; 3.5% had monitoring ALT elevations, 3.1% had AST elevations, 7% had anemia, 2.1% had neutropenia, and 3.2% had lymphopenia. Grade 2 or higher changes were rare, with most cases resolving with medication discontinuation.[3]

**Table II.** Outcomes of patients with abnormal testing results

| Outcome | Patients, n (%) |
|---|---|
| Patients with baseline LFT abnormalities | 27 (2.9) |
| Patients with baseline LFT abnormalities that resolved with monitoring tests | 24 (2.5) |
| Patients with baseline LFT abnormalities who completed treatment despite continued abnormalities | 3 (0.3) |
| Patients with baseline CBC abnormalities | 32 (3.4) |
| Patients with baseline CBC abnormalities that resolved on monitoring tests | 27 (2.9) |
| Patients with baseline CBC abnormalities who completed treatment despite continued abnormalities | 5 (0.5) |
| Patients with monitoring LFT abnormalities | 23 (2.4) |
| Patients with monitoring LFT abnormalities that resolved after completion of therapy | 17 (1.8) |
| Patients with monitoring LFT abnormalities that resolved upon premature discontinuation of therapy | 4 (0.4) |
| Patients with monitoring LFT abnormalities who were lost to follow-up | 2 (0.2) |
| Patients with monitoring CBC abnormalities | 26 (2.8) |
| Patients with monitoring CBC abnormalities that resolved after completion of therapy | 23 (2.4) |
| Patients with monitoring CBC abnormalities that resolved upon premature discontinuation of therapy | 3 (0.3) |

*CBC,* Complete blood count; *LFT,* liver function test.

In our study, patients with laboratory test result abnormalities were, on average, 14.8 years older and about 3 times more likely to be 65 years and older (86.1%) compared to the overall study population (28.6%). Of patients with LFT elevations, 92.6% and 91.3% had either AST and ALT or ALT elevations alone, at baseline and monitoring, respectively. ALT elevations are more likely to be detected than AST elevations because of differential half-lives: 36 and 18 hours, respectively.[4]

Therefore, testing for baseline and monitoring ALTs alone would capture the majority of elevated transaminases, thereby reducing costs.[5]

Limitations include the fact that this was a single-center study with only adults, mostly white/non-Hispanic, and it excluded patients with pre-existing conditions.

In sum, laboratory test result abnormalities in healthy adults prescribed terbinafine for onychomycosis are uncommon, mild, and more likely to occur in older adults. Mild baseline laboratory test result abnormalities (grade 1) are not necessarily contraindications for prescribing terbinafine, but these patients would benefit from interval laboratory monitoring. Baseline and interval laboratory monitoring is not recommended for adults without pre-existing hematologic and hepatic abnormalities younger than 65 years who are prescribed terbinafine for onychomycosis. Older patients would benefit from monitoring because of the higher rate of laboratory test result abnormalities in this population.

*Yu Wang, BA,*[a] *Solomon Geizhals, BA,*[b] *and Shari R. Lipner, MD, PhD*[c]

*From State University of New York Stonybrook Medical School, Stonybrook, New York*[a]*; State University of New York Downstate Medical School, Brooklyn, New York*[b]*; and Weill Cornell Medicine, Department of Dermatology, New York, New York.*[c]

*Funding sources: None.*

*Conflicts of interest: None disclosed.*

*IRB approval status: Not applicable.*

*Reprints not available from the authors.*

*Correspondence to: Shari R. Lipner MD, PhD, 1305 York Ave, New York, NY 10021*

*E-mail: shl9032@med.cornell.edu*

**REFERENCES**

1. Lipner SR, Scher RK. Onychomycosis: treatment and prevention of recurrence. *J Am Acad Dermatol*. 2019;80(4):853-867.
2. Gupta, A.K., Stec N, Summerbell RC, et al., Onychomycosis: a review [e-pub ahead of print]. *J Eur Acad Dermatol Venereol*. https://doi.org/10.1111/jdv.16394, Accessed June 8, 2020.
3. Stolmeier DA, Stratman HB, McIntee TJ, Stratman EJ. Utility of laboratory test result monitoring in patients taking oral terbinafine or griseofulvin for dermatophyte infections. *JAMA Dermatol*. 2018;154(12):1409-1416.
4. Botros M, Sikaris KA. The de ritis ratio: the test of time. *Clin Biochem Rev*. 2013;34(3):117-130.
5. Kanzler MH. Reevaluating the need for laboratory testing in the treatment of onychomycosis: safety and cost-effectiveness considerations. *JAMA Dermatol*. 2016;152(3):263-264.

https://doi.org/10.1016/j.jaad.2020.04.172

## Feasibility and implementation of portable confocal microscopy for point-of-care diagnosis of cutaneous lesions in a low-resource setting

*To the Editor:* In resource-limited settings, portable diagnostic devices could potentially reduce the delay in obtaining histopathologic diagnoses.[1] Reflectance