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Draft – Not for Implementation

## Draft Guidance on Dapsone

October 2022

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**Active Ingredient:** Dapsone

**Dosage Form; Route:** Gel; topical

**Recommended Studies:** Two options: (1) two in vitro bioequivalence studies, one in vivo bioequivalence study with pharmacokinetic endpoints, and other characterization tests or (2) one in vivo bioequivalence study with clinical endpoint

**I. Option 1: Two in vitro bioequivalence studies, one in vivo bioequivalence study with pharmacokinetic endpoints, and other characterization tests**

To demonstrate bioequivalence for dapsone topical gel, 7.5% using a combination of in vitro studies and an in vivo study with pharmacokinetic endpoints, the following criteria should be met:

1. The test product should contain no difference in inactive ingredients or in other aspects of the formulation relative to the reference standard that may significantly affect the local or systemic availability of the active ingredient. For example, if the test product and reference standard are qualitatively (Q1) and quantitatively (Q2) the same, as defined in the most recent version of the FDA guidance for industry on *ANDA Submissions – Refuse-to-Receive Standards*<sup>a</sup>, and the criteria below are also satisfied, the bioequivalence of the test product may be established using a characterization-based bioequivalence approach.
2. The test product and reference standard should have the same physicochemical and structural (Q3) attributes, based upon acceptable comparative Q3 characterization tests with a minimum of three batches of the test product and three batches (as available) of the reference standard. The test product and reference standard batches should ideally

represent the product at different ages throughout its shelf life. Refer to the most recent version of the FDA guidance for industry on *Physicochemical and Structural (Q3) Characterization of Topical Drug Products Submitted in ANDAs*<sup>a</sup> for additional information regarding comparative Q3 characterization tests. The comparison of the test product and reference standard should include characterizations of the following Q3 attributes:

- a. Characterization of visual appearance and texture
  - b. Characterization of phase states and structural organization of matter
    - Microscopic examination with representative high-resolution microscopic images at multiple magnifications
    - Analysis of particle size distribution, crystal habit, and polymorphic form of dapsone in the drug product
  - c. Characterization of rheological behavior which may be characterized using a rheometer that is appropriate for monitoring the non-Newtonian flow behavior of semi-solid dosage forms. The following evaluations are recommended:
    - A characterization of shear stress vs. shear rate and viscosity vs. shear rate. At minimum, this should consist of numerical viscosity data at three shear rates (low, medium, and high).
    - A complete flow curve across the range of attainable shear rates, until low or high shear plateaus are identified.
    - Yield stress values should be reported if the material tested exhibits plastic flow behavior.
  - d. Characterization of pH
  - e. Characterization of specific gravity
  - f. Characterization of any other potentially relevant Q3 attributes
3. The test product and reference standard should have an equivalent rate of dapsone release based upon an acceptable in vitro release test (IVRT) bioequivalence study comparing a minimum of one batch each of the test product and reference standard using an appropriately validated IVRT method.

Type of study: Bioequivalence study with IVRT endpoint

Design: Single-dose, two-treatment, parallel, multiple-replicate per treatment group study design using an occluded pseudo-infinite dose, in vitro

Strength: 7.5%

Test system: A synthetic membrane in a diffusion cell system

Analyte to measure: Dapsone in receptor solution

Equivalence based on: Dapsone (IVRT endpoint: drug release rate)

Additional comments: Refer to the most recent version of the FDA guidance for industry on *In Vitro Release Test Studies for Topical Drug Products Submitted in ANDAs*<sup>a</sup> for additional information regarding the development, validation, conduct and analysis of acceptable IVRT methods/studies. The batches of test product and reference standard evaluated in the IVRT bioequivalence study should be included among those for which the Q3 attributes are characterized.

4. The test product and reference standard should have an equivalent rate and extent of dapsone permeation through excised human skin based upon an acceptable in vitro permeation test (IVPT) bioequivalence study comparing a minimum of one batch each of the test product and reference standard using an appropriately validated IVPT method.

Type of study: Bioequivalence study with IVPT endpoints

Design: Single-dose, two-treatment, parallel, multiple-replicate per treatment group study design using an unoccluded finite dose, in vitro

Strength: 7.5%

Test system: Barrier-competent human skin from male and/or female donors of at least 18 years of age in a diffusion cell system

Analyte to measure: Dapsone in receptor solution

Equivalence based on: Dapsone (IVPT endpoints: total cumulative amount (AMT) and maximum flux ( $J_{max}$ ))

Additional comments: Refer to the most recent version of the FDA guidance for industry on *In Vitro Permeation Test Studies for Topical Drug Products Submitted in ANDAs<sup>a</sup>* for additional information regarding the development, validation, conduct and analysis of acceptable IVPT methods/studies. The batches of test product and reference standard evaluated in the IVPT bioequivalence study should be the same as those evaluated in the IVRT bioequivalence study.

5. The test product and reference standard should demonstrate bioequivalence based upon an acceptable in vivo pharmacokinetic study with one batch each of the test product and reference standard.

Type of study: Fasting, in vivo pharmacokinetic study

Design: Single-application, two-way crossover study design

Strength: 7.5%

Analyte to measure: Dapsone in plasma

Equivalence based on: Dapsone

Subjects: Males and non-pregnant, non-lactating females, general population

Additional comments: The study conditions such as the dose of the test product and reference standard, the site of dose application, etc. should be consistent across the study and the bioanalytical method should be sufficiently sensitive to be able to adequately characterize the pharmacokinetic profiles of the test product and reference standard. Refer to the most recent version of the FDA guidance for industry on *Bioequivalence Studies with Pharmacokinetic Endpoints for Drugs Submitted Under an ANDA<sup>a</sup>* for additional information regarding the analysis of the pharmacokinetic bioequivalence study. The batches of test product and reference standard evaluated in the in vivo pharmacokinetic study should be the same as those evaluated in the IVRT and IVPT bioequivalence studies.

## II. Option 2: One in vivo bioequivalence study with clinical endpoint

1. Type of study: Bioequivalence study with clinical endpoint  
Design: Randomized, double blind, parallel, placebo controlled, in vivo  
Strength: 7.5%  
Subjects: Males and non-pregnant, non-lactating females with acne vulgaris  
Additional comments: Specific recommendations are provided below.

### Additional comments regarding the bioequivalence study with clinical endpoint:

1. FDA recommends conducting a bioequivalence study with clinical endpoint in the treatment of acne vulgaris. Subjects are to be randomized to receive the test product, reference standard, or placebo (vehicle). The study treatment is to be administered once daily for 12 weeks. The two primary endpoints are to be evaluated at the end of treatment (Study Week 12).
2. Inclusion Criteria (the sponsor may add additional criteria):
  - a. Males or non-pregnant, non-lactating females aged  $\geq 12$  and  $\leq 40$  years with a clinical diagnosis of acne vulgaris.
  - b. On the face,  $\geq 25$  non-inflammatory lesions (i.e., open and closed comedones) and  $\geq 20$  inflammatory lesions (i.e., papules and pustules) and  $\leq 2$  nodulocystic lesions (i.e., nodules and cysts).
  - c. Investigator's Global Assessment (IGA) of acne severity Grade 2, 3, or 4 (per Table 1).

**Table 1. Sample IGA Scale for Acne Vulgaris<sup>1</sup>**

Grade	Description
0	Clear skin with no inflammatory or non-inflammatory lesions
1	Almost clear; rare non-inflammatory lesions with no more than one small inflammatory lesion
2	Mild severity; greater than Grade 1; some non-inflammatory lesions with no more than a few inflammatory lesions (papules/pustules only, no nodular lesions)
3	Moderate severity; greater than Grade 2; up to many non-inflammatory lesions and may have some inflammatory lesions, but no more than one small nodular lesion
4*	Severe; greater than Grade 3; up to many non-inflammatory lesions and may have some inflammatory lesions, but no more than a few nodular lesions

\* The Case Report Forms for acne studies can allow for reporting by investigators of lesion worsening beyond Grade 4 with treatment. It is recommended that enrollment of acne vulgaris subjects not include subjects with nodulocystic acne. Subjects who worsen beyond Grade 4 are to be described in the safety evaluation.

<sup>1</sup> Guidance for industry on *Acne Vulgaris: Establishing Effectiveness of Drugs Intended for Treatment*. For the most recent version of a guidance, check the FDA guidance web page at <https://www.fda.gov/regulatory-information/search-fda-guidance-documents>.

- d. Willing to refrain from use of all other topical acne medications or antibiotics during the 12-week treatment period.
  - e. If female of childbearing potential, willing to use an acceptable form of birth control during the study.
3. Exclusion Criteria (the sponsor may add additional criteria):
- a. Pregnant, breast feeding or planning a pregnancy.
  - b. Presence of any skin condition that would interfere with the diagnosis or assessment of acne vulgaris (e.g., on the face: rosacea, dermatitis, psoriasis, squamous cell carcinoma, eczema, acneform eruptions caused by medications, steroid acne, steroid folliculitis, or bacterial folliculitis).
  - c. Excessive facial hair (e.g., beards, sideburns, moustaches, etc.) that would interfere with diagnosis or assessment of acne vulgaris.
  - d. History of hypersensitivity or allergy to dapsone or any of the study medication ingredients.
  - e. Use within 6 months prior to baseline of oral retinoids (e.g., Accutane<sup>®</sup>) or therapeutic vitamin A supplements of greater than 10,000 units/day (multivitamins are allowed).
  - f. Use for less than 3 months prior to baseline of estrogens or oral contraceptives; use of such therapy must remain constant throughout the study.
  - g. Use on the face within 1 month prior to baseline of 1) cryodestruction or chemodestruction, 2) dermabrasion, 3) photodynamic therapy, 4) acne surgery, 5) intralesional steroids, or 6) x-ray therapy.
  - h. Use within 1 month prior to baseline of 1) spironolactone, 2) systemic steroids, 3) systemic antibiotics, 4) systemic treatment for acne vulgaris (other than oral retinoids, which require a 6-month washout), or 5) systemic anti-inflammatory agents.
  - i. Use within 2 weeks prior to baseline of 1) topical steroids, 2) topical retinoids, 3) topical acne treatments, including over-the-counter preparations, 4) topical anti-inflammatory agents, or 5) topical antibiotics.
  - j. Case reports<sup>2,3</sup> have described cases of methemoglobinemia following topical dapsone, 5% application. Consider excluding subjects with known G6PD deficiency, or congenital or idiopathic methemoglobinemia. All enrolled subjects should be monitored for adverse effects consistent with hemolysis or methemoglobinemia.
4. One scientific publication has reported greater efficacy in females (compared to males) with facial acne vulgaris treated with dapsone topical gel, 5%,<sup>4</sup> and similar results were

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<sup>2</sup> Graff DM, Bosse GM, Sullivan J. Case report of methemoglobinemia in a toddler secondary to topical dapsone exposure. *Pediatrics*. 2016;138(2):e20153186.

<sup>3</sup> Swartzentruber GS, Yanta JH, Pizon AF. Methemoglobinemia as a complication of topical dapsone. *N Engl J Med*. 2015;372(5):491–2.

<sup>4</sup> Tanghetti E et al. The efficacy and tolerability of dapsone 5% gel in female vs. male patients with facial acne vulgaris: gender as a clinically relevant outcome variable. *J Drugs Dermatol*. 2012 Dec; 11 (12): 1417-21.

observed in a study of subjects using the 7.5% gel<sup>5</sup>; thus, consider randomizing approximately equal numbers of male and female subjects to each of the three arms in the study.

5. Once daily, subjects should wash their face with a mild or soapless, non-medicated cleanser, gently pat skin dry with a clean towel, and then apply a thin layer of study medication, approximately a pea-sized amount, to cover the entire affected skin areas of the face. The subject should be instructed to avoid contact of the study product with the mouth, eyes and open wounds, and to wash their hands after application.
6. Subjects should not apply moisturizers, new brands of make-up, creams, lotions, powders or any topical product other than the assigned treatment to the treatment area. Subjects should minimize exposure to sunlight, including sunlamps, while using the product. Use of sunscreen products and protective clothing over treated areas is recommended when sun exposure cannot be avoided.
7. The protocol should include a list of the prescription and over-the-counter drug products, procedures, and activities that are prohibited during the study, such as:
  - a. Any other topical products applied to face
  - b. Medicated soaps used on face
  - c. Spironolactone
  - d. Oral retinoids, therapeutic vitamin A supplements of greater than 10,000 units/day (multivitamins are allowed) or other systemic treatment for acne vulgaris
  - e. Systemic (e.g., oral or injectable) antibiotics
  - f. Systemic steroids, systemic anti-inflammatory agents or immunosuppressive drugs
  - g. Antipruritics, including antihistamines, within 24 hours of study visits
  - h. Use on the face of 1) cryodestruction or chemodestruction, 2) dermabrasion, 3) photodynamic therapy, 4) acne surgery, 5) intralesional steroids, or 6) x-ray therapy
  - i. Use of hormonal contraceptives should not be initiated or changed during the study
  - j. Use of tanning booths, sunbathing, or excessive exposure to the sun
8. The two primary endpoints of the study are: 1) mean percent change from baseline to Week 12 (Study Day 84) in the inflammatory (papules and pustules) lesion count and 2) mean percent change from baseline to Week 12 in the non-inflammatory (open and closed comedones) lesion count. The protocol should clearly define papules, pustules, open comedones, closed comedones, nodules and cysts. When counting facial acne lesions, it is important that all lesions be counted, including those present on the nose. Counts of nodules and cysts should be reported separately and not included in the inflammatory or non-inflammatory lesion counts.

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<sup>5</sup> Draelos ZD, Rodriguez DA, Kempers SE, et al. Age and gender as predictors of treatment outcomes with once-daily dapsone 7.5% topical gel for acne vulgaris [abstract no. 3244 plus poster]. J Am Acad Dermatol. 2016;74(5 Suppl 1):AB2.

9. Application site reactions such as erythema, dryness, burning/stinging, erosion, edema, pain and itching are to be recorded at each visit to allow a comparison between treatment groups. A descriptive analysis comparing the application site reactions for each treatment group is recommended. It is important to ensure that the test product is not worse than the reference standard with regard to the expected and unexpected application site reactions.
  10. Refer to the most recent version of the FDA product-specific guidance on *Adapalene; Benzoyl Peroxide Topical Gel* (NDA 207917)<sup>b</sup> for a recommended approach to statistical analysis and study design for BE studies with clinical endpoint.
  11. Refer to the study data standards resources, <https://www.fda.gov/industry/fda-resources-data-standards/study-data-standards-resources>.
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<sup>a</sup> For the most recent version of a guidance, check the FDA guidance web page at <https://www.fda.gov/regulatory-information/search-fda-guidance-documents>.

<sup>b</sup> For the most recent version of a product-specific guidance, check the FDA product-specific guidance web page at <https://www.accessdata.fda.gov/scripts/cder/psg/index.cfm>.