Designation: E2276 – 10 (Reapproved 2019)

Standard Test Method for Determining the Bacteria-Eliminating Effectiveness of Hygienic Handwash and Handrub Agents Using the Fingerpads of Adults[1]

This standard is issued under the fixed designation E2276; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Hands can spread many types of pathogens directly (**1**)[2] or by transfer of such organisms to other surfaces and objects during casual contact (**2**,**3**). Therefore, regular and proper decontamination of hands by caregivers and food-handlers in particular is crucial for infection control. Hygienic hand antisepsis is meant to reduce the load of transient microflora on hands, thereby reducing the risk of disease transmission. Such reduction in the bacterial load may be due to a combination of bacterial inactivation and removal of viable bacteria from the skin. In this method the test bacterial suspension is placed on the thumb- and fingerpads of adults to simulate the contamination of hands with transient microflora, the inoculum on the fingerpads is allowed to dry and is then treated with test and control solutions. Since in each test all ten digits on any given subject can be used, the protocol permits the inclusion of the required controls and several replicates of the test formulation in the same trial.

1. Scope

1.1 This test method is designed to determine the activity of hygienic handwash and handrub (**4**) agents against transient bacterial flora on hands and is not meant for use with surgical hand scrubs or preoperative skin preps.

1.2 Performance of this procedure requires the knowledge of regulations pertaining to the protection of human subjects.[3]

1.3 The test method should be performed by persons with training in microbiology in facilities designed and equipped for work with infectious agents at biosafety level 2 (**5**).

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[4]

D1129 Terminology Relating to Water

E1115 Test Method for Evaluation of Surgical Hand Scrub Formulations

E1173 Test Method for Evaluation of Preoperative, Precatheterization, or Preinjection Skin Preparations

E1174 Test Method for Evaluation of the Effectiveness of Health Care Personnel Handwash Formulations

E1838 Test Method for Determining the Virus-Eliminating Effectiveness of Hygienic Handwash and Handrub Agents Using the Fingerpads of Adults

E2613 Test Method for Determining Fungus-Eliminating Effectiveness of Hygienic Handwash and Handrub Agents Using Fingerpads of Adults

[1] This test method is under the jurisdiction of ASTM Committee E35 on Pesticides, Antimicrobials, and Alternative Control Agents and is the direct responsibility of Subcommittee E35.15 on Antimicrobial Agents.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[3] *Federal Register*, Vol 46, No. 17, Jan. 27, 1991.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 *Definitions*—For definitions of general terms used in this test method, refer to Terminology D1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *active ingredient, n*—a substance added to a formulation specifically for the inhibition or inactivation of microorganisms.

3.2.2 *dry control, n*—a control to determine the number of colony forming units of the test bacterium remaining viable after the initial drying of the inoculum on the skin.

3.2.3 *handrub, n*—a liquid or gel which is applied by rubbing to decontaminate lightly soiled hands between handwashings and generally do not require a post-treatment water rinse; such agents usually contain alcohol alone or with other active ingredients.

3.2.4 *hard water, n*—water with a standard hardness of calcium carbonate.

3.2.5 *hygienic handwash agent, n*—an agent generally used for handwashing by personnel in hospitals, other health-care facilities, day-care centers, nursing homes, and food-handling establishments to eliminate transient microorganisms from intact skin.

3.2.6 *input control, n*—a control to determine the number of colony forming units of the test bacterium placed on each digit.

3.2.7 *neutralization, n*—a process which results in quenching the antimicrobial activity of a test substance. This may be achieved through dilution of the test substance to reduce the antimicrobial activity, or through the use of chemical agents, called neutralizers, to eliminate antimicrobial activity.

3.2.8 *nonmedicated soap, n*—a soap or detergent that is mild to the skin and does not contain any antimicrobial chemicals.

3.2.9 *soil load, n*—a solution of one or more organic and/or inorganic substances added to the suspension of the test organism to simulate the presence of body secretions, excretions or other extraneous substances.

3.2.10 *test substance or test formulation, n*—a formulation which incorporates antimicrobial ingredients.

3.2.11 *test organism, n*—an applied inoculum of an organism that has characteristics which allow it to be readily identified. The test organism is used to simulate a transient topical microbial contaminant. It may also be referred to as a marker organism, bacterial simulant/surrogate or bacterial contaminant.

3.2.12 *test vehicle, n*—the test formulation without an active ingredient.

3.2.13 *transient microbiota, n*—microorganisms from the environment that contaminate but do not normally colonize the skin.

4. Summary of Test Method

4.1 This test method is conducted on a group of adults who have provided informed consent and the skin of whose hands has been determined to be free from any apparent damage. Subjects are to refrain from using any products containing antimicrobial agents for one week prior to the test. A known volume of the test bacterial suspension is placed on a demarcated area on each fingerpad and the inoculum allowed to dry. The contaminated area then is exposed to the control (standard hard water) or test substance for the desired contact time and organisms remaining on the fingerpad are eluted and the eluates assayed for viable bacteria. Percent or $\log_{10}$ reductions in the numbers of viable bacteria after treatment with the control and test substance are then determined. The fingerpad method gives results that are comparable to those obtained using a whole-hand procedure (**6**). If two different formulations are being compared in the same test, one of them may be designated as a reference and used in place of the hard water control. If desired, one also may use tap water in parallel with the hard water control to determine the influence of water hardness on the test product's bacteria-eliminating activity.

5. Significance and Use

5.1 This *in vivo* procedure is designed to test the ability of hygienic handwash or handrub agents to eliminate selected types of bacteria from experimentally contaminated skin of the hands of adult subjects. Since the two thumbpads and all eight fingerpads can be used in any given test, it allows for the incorporation of an input control (two), control for viable bacteria remaining after the inoculum has been allowed to dry (two), bacteria eliminated after treatment with a control or reference solution (two), and up to four replicates to assess the bacteria-eliminating efficiency of the product under test. No more than 100 µL of the test bacterial suspension is required to complete one test. The results of testing with this test method may form the basis for confirmatory tests using a suitable whole-hand test protocol, such as Test Method E1174.

5.2 Whereas this test method relates to testing with bacteria, it can be readily adapted to work with protozoa and bacteriophages. Similar methods for work with fungi (Test Method E2613) and viruses of human origin (Test Method E1838) are already ASTM standards.

5.3 Potentially infectious microorganisms left on hands after washing can be reduced further by drying the washed hands with paper, cloth, or warm air (**7**). A step for the drying of fingerpads after exposure to the control or test solution, therefore, has not been included to avoid bacterial removal by the drying process itself.

5.4 This test method is not meant for use with surgical hand scrubs (Test Method E1115) or preoperative skin preps (Test Method E1173).

5.5 The level of contamination with viable bacteria on each fingerpad after the drying of the inoculum should be five- to ten-fold higher than the product performance criterion required. For example, the titer in the dried inoculum on each fingerpad should be about 10^5 colony forming units of the test bacterium when a $>10^4$ reduction is required under the conditions of this test method.

6. Equipment and Apparatus

6.1 *Colony Counter*—Any of several types may be used, for example, Quebec Colony Counter.

6.2 *Freezers*—A freezer at -20 ± 2 °C is required for the storage of culture media. A second freezer at -70 °C or lower is required to store bacterial stocks.

6.3 *Handwashing Sink*—A sink of sufficient size to permit subjects to wash hands without touching hands to sink surface.

6.4 *Incubator*—Any incubator capable of maintaining a temperature of 36 ± 1 °C. *Serratia marcescens* requires incubation at 25 ± 2 °C for pigment formation.

6.5 *Laminar Flow Cabinet*—A Class II biological safety cabinet is required for this work. The procedures for the proper maintenance and use of such cabinets are given in Ref **(2)**.

6.6 *Magnetic Stirrer and Magnets*—Large enough to hold a 5-L beaker or Erlenmeyer flask for preparing culture media or other solutions.

6.7 *Membrane Filtration System*—A membrane filtration system and membranes with a pore diameter of 0.22-µm are required to sterilize heat-sensitive media/solutions and to capture and culture viable test bacteria in control samples and eluates.

6.8 *Positive Displacement Pipette*—A pipette and pipette tips that accurately can dispense 10-µL volumes.

6.9 *Refrigerator*—A refrigerator at 4 ± 2 °C for storage of prepared culture media and reagents.

6.10 *Sterilizer*—Any suitable steam sterilizer capable of producing the conditions of sterilization is acceptable.

6.11 *Timer*(Stop-clock)—One that can be read for minutes and seconds.

6.11.1 *Tap Water Temperature Regulator and Temperature Monitor*—to monitor and regulate water temperature at 40 ± 2 °C.

6.11.2 *Water Faucet(s)*—to be located above the sink at a height that permits the hands to be held higher than the elbow during the washing procedure. Faucets with electronic sensors or those that are wrist-, elbow-, knee-, or foot-operated are preferred to avoid recontamination of the washed hands.

7. Materials and Reagents

7.1 *Serological Pipettes*—Sterile reusable or single-use pipettes of 10.0, 5.0, and 1.0-mL capacity.

7.2 *Culture Plates*—Petri plates of 100 mm diameter for culturing bacteria.

NOTE 1—Plastic culture ware may be purchased from most laboratory supply houses.

7.3 *Culture Media and Supplements*—Culture media and the types and ratios of supplements will vary depending on the type of test bacterium being used.

7.4 *Soil Load:*

7.4.1 *Fetal Bovine Serum,* at a final concentration of 5 % in the bacterial inoculum.

7.4.2 *Tripartite Soil Load,* as an alternative to serum.

7.4.2.1 Add 0.5 g of tryptone or yeast extract to 10 mL of phosphate buffer.

7.4.2.2 Add 0.5 g of bovine serum albumin (BSA) to 10 mL of phosphate buffer.

7.4.2.3 Add 0.04 g of bovine mucin to 10 mL of phosphate buffer.

7.4.3 Prepare the stock solutions separately and sterilize by passage through a 0.22 µm pore diameter membrane filter, aliquot and store at either 4 ± 2 °C or –20 ± 2 °C; the stock solution of bovine mucin can be autoclave-sterilized.

7.4.4 To obtain a 500-µL inoculum of the test inoculum, add to 340 µL of the bacterial suspension, 35 µL of tryptone or yeast extract (7.4.2.1), 25 µL BSA (7.4.2.2) , and 100 µL mucin (7.4.2.3) stock solutions. This mixture contains approximately 2 g of total protein/L, which is roughly equivalent to the protein content of a 5 % solution of fetal bovine serum.

7.5 *Standard Hard Water*—The quality and disinfectant (for example, chlorine) residual in tap water can vary from site to site and also at different times at the same site. The use of standard hard water, therefore, is recommended here to avoid variations in results due to differences in tap water quality. Water prepared in accordance with AOAC 960.09 E and F **(8)** to a standard hardness of at least 200 ppm as calcium carbonate is used for dilution of the test substance, as the control solution to determine the baseline level of bacterial elimination, and to rinse the fingerpads after exposure to the test product. The standard hard water and tap water (if used) must first be tested to ensure that they do not have any activity against the test bacterium. If water with a different level of hardness is used for making the use-dilution of the test formulation, this change must be clearly justified and documented in the report.

7.6 *Test Agents*—At least two samples of the product shall be tested.

7.7 *Diluent for Bacterial Titration*—Normal saline (0.85 % NaCl) at pH 7.2 – 7.4, or appropriate buffer.

7.8 *Eluent for Bacterial Recovery from Fingerpads*—Normal saline or another suitable eluent.

7.9 *Plastic Vials*—Sterile screw-capped 2.0-mL vials with an inside diameter of about 8 mm will be required for demarcation of the fingerpads and to hold various test solutions.

7.10 *Miscellaneous Laboratory Ware*—Automatic pipettes, pipette tips, plastic vials for storing stock cultures.

7.11 *Broth*—Tryptose phosphate broth (TPB) or equivalent, to prepare the inoculum of the test organisms.

7.12 *Agar*—Trypticase soy agar (TSA) or equivalent, to recover and count the colonies of the test organism in control and test samples. The addition of any neutralizer(s) in such recovery media must first be properly validated. The use of selective-differential media for the detection of the test bacteria in such studies is not recommended because cells stressed or injured after germicide exposure may not form colonies on such agars.

8. Test Bacteria

8.1 Appendix X1 contains a list of suggested test bacteria. (**Warning—**The application of microorganisms to the skin may involve a health risk. Prior to applying the test organism to the skin, the antibiotic sensitivity profile of the strain should