Designation: E3002 – 15

Standard Practice for Assessing the Comparative Efficacy of Products Used for the Decontamination of Chemical Warfare Agents (CWAs) on Skin[1]

This standard is issued under the fixed designation E3002; 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.

1. Scope

1.1 This practice establishes an *in-vivo* method for assessing the comparative efficacy of products used for the decontamination of chemical warfare agents (CWAs) on the skin.

1.2 This practice provides a quantitative efficacy comparison of different skin decontamination products.

1.3 To minimize the number of animals used, this *in-vivo* practice should be performed only after rigorous *in-vitro* studies of the candidate decontaminant, which can show the implied claims including chemical neutralization, decontamination studies on surfaces and appropriate testing such as cytotoxicity.

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 the use of decontamination products or CWAs. 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. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *Chemical Warfare Agents (CWA), n*—toxic chemicals that have been used as chemical weapons, or have been developed for use as chemical weapons.

2.1.1.1 *Discussion*—The most common chemical warfare agents are: (**1 and 2**):[2] (*a*) nerve agents—tabun (GA), sarin (GB), soman (GD), cyclosarin (GF), VX; and (*b*) blister agents (or vesicants)—mustard and lewisite.

2.1.2 *decontamination, n*—the process of physical removal or chemical neutralization, or both, of CWAs to decrease or prevent health effects due to a dermal contamination.

2.1.3 *in-vitro study, n*—study or protocol performed outside of a living organism, either with or without the use of a biological material.

2.1.4 *in-vivo study, n*—study using a whole living organism.

2.1.5 *Organophosphate Agent (OP), n*—the general name for esters of phosphoric acid that are toxic through inhibition of the enzyme acetylcholinesterase.

2.1.6 *Protective Ratio (PR), n*—the LD_{50} of the decontaminated animals divided by the LD_{50} of the positive control (exposed to CWAs and not decontaminated) animals (**3-5**).

2.1.7 *vesicant agent*—a chemical agent that causes burns and destruction of tissue.

2.2 *Acronyms:*

2.2.1 *GA*—common name: Tabun; IUPAC name: (Ethyl dimethylphosphoramidocyanidate): Organophosphate nerve agent.

2.2.1.1 *Discussion*—This nerve agent is the easiest to manufacture. Consequently, it is more likely that developing countries start their CW arsenal with this nerve agent whereas industrialized countries consider Tabun to be out-of-date and of limited use.

2.2.2 *GB*—common name: Sarin; IUPAC name: ((*RS*)-Propan-2-yl methylphosphonofluoride) Organophosphate nerve agent.

2.2.2.1 *Discussion*—GB is a volatile substance mainly taken up through inhalation.

2.2.3 *GD*—common name: Soman; IUPAC name: (*O*-Pinacolyl methylphosphonofluoridate Organophosphate nerve agent.

[1] This practice is under the jurisdiction of ASTM Committee E54 on Homeland Security Applications and is the direct responsibility of Subcommittee E54.01 on CBRNE Detection and Decontamination.

Current edition approved June 15, 2015. Published June 2015. DOI: 10.1520/E3002-15.

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

2.2.3.1 *Discussion*—A moderately volatile substance which can be taken up by inhalation or skin contact.

2.2.4 *GF*—common name: Cyclohexyl sarin; IUPAC name: (Cyclohexyl methylphosphonofluoridate) Organophosphate nerve agent.

2.2.4.1 *Discussion*—A substance with low volatility which is taken up through skin contact and inhalation of the substance either as a gas or aerosol.

2.2.5 *HD*—common name: Mustard or Distilled Sulfur Mustard; IUPAC name: (bis(2-chloroethyl) sulfide); Vesicant.

2.2.5.1 *Discussion*—In its pure state, mustard agent is colorless and almost odorless.

2.2.6 *L*—common name: Lewisite: IUPAC name: (2-chloroethenylarsonous dichloride). Vesicant.

2.2.7 LD_{50}—a standard measure of toxicity. The individual dose required to kill 50 % of the animals in a test population.

2.2.8 *VX*—common name: VX, IUPAC name: (*O*-ethyl *S*-[2-(diisopropylamino)ethyl] methylphosphonothioate).

2.2.8.1 *Discussion*—Organophosphate nerve agent, a persistent substance which can remain on material, equipment and terrain for long periods. Update is mainly through the skin but also through inhalation of the substance as a gas or aerosol.

3. Summary of Practice

3.1 Due to the extreme hazards of the chemical warfare agents, the efficacy of decontamination products cannot be evaluated in a human clinical study. This practice has been used to support FDA clearance (for example, RSDL®[3] **(6 and 7)** 510k – K023969) for decontamination devices for use on human skin **(3-5)**.

3.2 Determination of the efficacy of decontamination products for use on the skin against these toxic compounds requires *in-vivo* data, which are more physiologically relevant than *in-vitro* studies. This practice provides a methodology for obtaining comparative *in-vivo* data.

3.3 The practice is used in order to calculate the Protective Ratio of the decontaminant. The Protective Ratio is the LD_{50} of animals treated with the chemical agent and decontaminated, divided by the LD_{50} of control animals (animals treated with the contaminant and not decontaminated) measured 24 hours after exposure to the CWA.

3.4 This practice is based on decontamination efficacy of decontamination products against two nerve agents and one blister agent, for a total of three CWAs. The nerve agents are either G-agents or V-agents based on their chemical structures. The two nerve agents included in the practice are GD (from G-agents) and VX (from V-agents). The blister agent included in this practice is HD.

[3] The sole source of supply of RSDL known to the committee at this time is Emergent BioSolutions, 400 Professional Drive, Suite 400, Gaithersburg, MD, 20879. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

4. Significance and Use

4.1 This practice specifies an *in-vivo* measurement of CWA decontamination on the skin.

4.2 CWA skin decontaminants will have different modes of action including absorption, adsorption, removal, chemical neutralization or some combination of the above. There is, therefore, no single representative *in-vitro* method for validation of decontamination efficacy of products for skin decontamination. For example, measuring the presence of a radiolabelled chemical warfare agent after chemical neutralization, may give a false positive results. It has been shown that if the agent has been chemically neutralized, the radiolabel may still be present in a non-toxic molecule. In addition, some chemical neutralization methods may break down the original agent, but the breakdown product is highly toxic. In the case of VX, hydrolysis produces a highly toxic product, EA2192 (S-(2-diisopropylaminoethyl) methylphosphonothioic acid **(8)**.

4.3 This standard practice is of significance in that efficacy is thoroughly evaluated to the extent possible to represent use on human skin. *In-vivo* studies have demonstrated that simple chemical monitoring for disappearance of the chemical agent may not be sufficient to measure decontamination and neutralization effectiveness. A standard practice is needed for determining actual decontamination and neutralization by measuring the decrease in mortality or lesion size caused by the agent.

5. Reagents

5.1 All the CWAs for these experiments shall be synthesized in the laboratory where the experiments will be performed or obtained from a legitimate external source which shall be included in the report.

5.2 All test materials shall be at the same temperature as that of the room where the test is conducted at the time of application to the animals.

5.3 Appropriate solvents shall be purchased from legitimate vendors as required and disclosed in the report.

5.4 The standard decontaminant used for comparison should be the product currently accepted for use by the majority of Defense Forces and First Responders in the world, which at this point in time is the RSDL® skin decontamination system.

6. Procedure

6.1 A reputable laboratory animal supplier must be used for any specified species or strain. Only a single constant source of supply for each species should be used by the testing laboratory to maintain genetically homogenous test subjects.

6.2 *Animal Care*—All animal care should conform to the appropriate standards (Association for Assessment and Accreditation of Laboratory Animal Care International AAALAC; http://www.aaalac.org/) and all animal test protocols must have appropriate approvals.

6.3 As required by the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC), animal care and recording of the information including, but not limited to, the following will be expected: