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Concise Communication

Design and validation of an anatomically based assessment scale for handwashing with alcohol-based hand rub

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Abstract

An anatomically based assessment scale of handwashing quality with alcohol-based hand rub was designed. Contents of the scale divided each hand into 40 zones. Psychometric measurements were studied in 30 participants (120 hand sides). The scale was both valid (Cronbach α: 0.83 dorsal side and 0.73 palmar side) and reproducible (linear regression R2, 0.91; intraclass correlation coefficient, 0.99).

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Nosocomial infections are an undesirable result of treatment in a hospital or healthcare service unit unrelated to the patient's original condition.[1] Hand hygiene is a key element in reducing nosocomial infections. Handwashing with alcohol-based hand rub (ABHR) has emerged as the most effective method in terms of the quality and efficiency of hand hygiene.[2] This efficacy is dependent on correct performance of washing in terms of duration and number of steps.[3] Currently, the most widely used assessment and training method for hand hygiene technique is based on ultraviolet (UV)-dyed ABHR. This method monitors the marker's distribution under UV light.[4] A fluorescent component (Aniosgel 85 NPC with Tinopal CBS-CL, Anios Laboratories, Lille-Hellemmes, France) emits blue fluorescence under UV-A radiation in an educational box.[5] Blue fluorescence on the hands attests to the efficient application of ABHR and disinfection of the corresponding zone.[6] Handwashing is closely associated with hand anatomy and function. Therefore, different zones should not be considered identical. The hand is not a flat surface, and handwashing implies the biomechanical functioning of the hands.

In this study, we aimed to design and validate an anatomically based assessment scale of the quality of handwashing with ABHR. The goal of this validation was to ensure a reliable and reproducible scale with accuracy between scores and performance, independent of professional status.

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Methods

Study

This prospective study took place in the Pediatric Department of the University Hospital of Poitiers, France. The local ethics committee and the hygiene committee approved this study (no. 2016-5). All participants signed an informed consent form. All results remained anonymous.

Creation of the instrument

We implemented the 5-step Downing framework to create an instrument for psychometric testing.[7] An anatomist, 2 hygiene specialists, and 2 simulation experts divided the hands into 18 anatomical zones for the palmar side and 22 zones for the dorsal side (Figure 1a). Handwashing was performed using the 7-step method[8] for 20–30 seconds, based on ultraviolet (UV)-dyed ABHR (see the Supplemental Material). Both sides of both hands were photographed. At total 80 possible points were possible, 2 independent observers (observers 1 and 2) assigned a score for each area: 0 for dark (unclean) or 1 for white (clean). The observers were provided training on the use of the scale.

Psychometric testing

Analysis of the internal structure of the scale was performed in 30 participants including physicians, residents, nurses, and students (120 hand sides).

Statistics

Our analysis was conducted using Statview version 4.5 software (SAS Institute, Cary, NC). Our descriptive analysis used mean and standard deviation (SD) of every variable. The internal

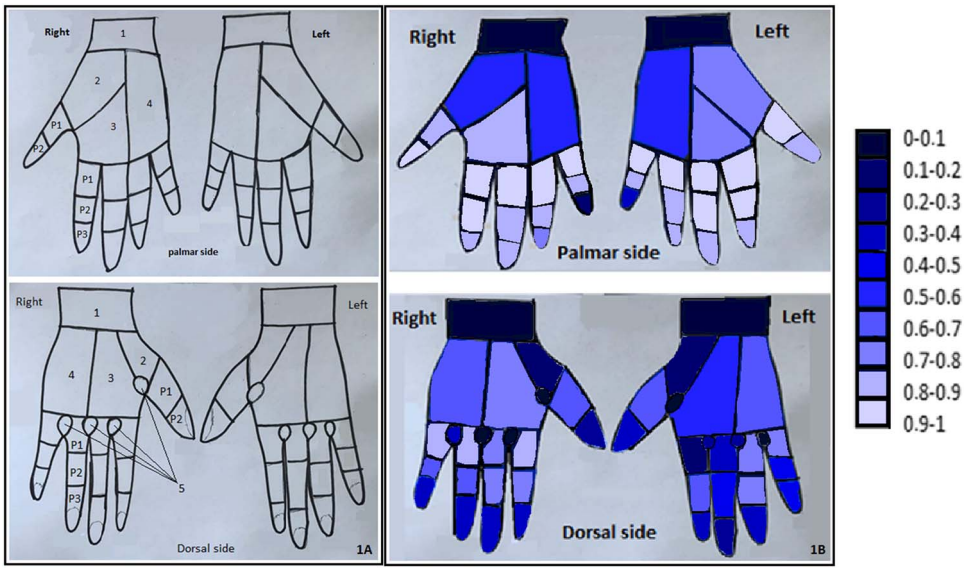

Fig. 1. Anatomically based assessment scale. (A) Anatomic scale: palmar and dorsal sides. NOTE. 1, wrist; 2, thenar eminence; 3, intermediate zone; 4, hypothenar eminence; 5, interdigital space; for the thumb: P1: proximal phalanx; P2: distal phalanx; for other fingers: P1: proximal phalanx; P2: intermediate phalanx; P3: distal phalanx. (B) Frequency of handwashing for each side: palmar and dorsal sides. NOTE. Frequency of handwashing for each zone from 0 (0% = not cleaned) to 1 (100% cleaned zone); results for 30 participants.

consistency of the scale was analyzed using the Cronbach α coefficient. Interobserver reproducibility was analyzed using intraclass correlation coefficient (ICC), comparison of means, number of incorrect items between 2 independent observers, and linear regression analysis (R2). The paired Student *t* test was used to compare the mean of the scores obtained by the 2 observers. The F test was used to compare the variance of scores of the 2 observers. A comparison between the palmar and dorsal sides for right and left hands was analyzed using the paired Student *t* test. The efficacy of hand washing was determined for each zone between zero (not cleaned) to 1 (100% cleaned). An analysis of difference in the washing of each zone was conducted using the analysis of variance (ANOVA) test for all zones and each hand separately. The correlation of scores with professional status was analyzed using a linear regression analysis. A *P* value of $< .05$ was considered significant.

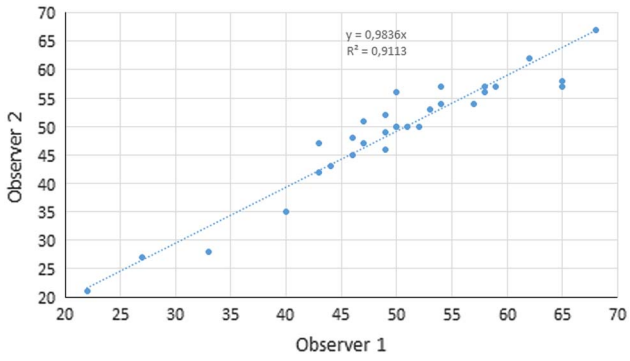

Fig. 2. Linear regression analysis with equation to analyze interobserver reproducibility between the 2 observers to assess hand hygiene using the anatomically based assessment scale.

Results

The average observation scores were 49.7 ± 10.17 for observer 1 and 49.10 ± 10.23 for observer 2. The Cronbach α coefficient was 0.73 for the palmar side and 0.83 for the dorsal side. No differences were detected in mean score ($P = .78$) or variance ($P = .94$) between the observers. Our linear regression analysis resulted in an R2 of 0.91, and the ICC was 0.99 (Figure 2). The comparison between the 2 hands showed some differences. For the palmar sides, the scores were 17.5 ± 2.0 for the right hand and 17.8 ± 2.0 for the left hand ($P = .001$). For the dorsal sides, the scores were 11.6 ± 3.2 for the right hand and 12.4 ± 3.1 for the left hand ($P < .0001$). We also detected a difference in washing for different zones of the hands ($F = 13.2$; $P < .0001$): F values were 5.5 for the palmar side of the right hand, 7.6 for the dorsal side of the right hand, 6.5 for the palmar side of the left hand, and 7.4 for the dorsal side of the left hand ($P < .0001$ for all of these). Among the washed zones, wrists, finger extremities, and interdigital spaces had the lowest scores (Figure 1b). Scores depended only on the performance, without correlation to professional status ($F = 0.0005$; $P = .94$).

Discussion

We designed an anatomically based assessment scale of the quality of handwashing with ABHR. This scale showed good internal consistency, and it was reproducible, with excellent interobserver reproducibility and a strong correlation between observers' mean scores. The good internal consistency of the anatomical scale may allow adequate assessment of the recommended handwashing procedure. A valid instrument is crucial to the assessment of handwashing because fundamental problems with hand hygiene lead to the spread of nosocomial infections.[1] The excellent interobserver reproducibility of this assessment tool reflects the objectivity of the anatomical scale as well as its potential for further use by a single observer. This scale can be used to assess hand hygiene score regardless of the professional status of the participant. Recently, Lehotsky et al[4] analyzed the correlation of ultraviolet (UV)-dyed ABHR-treated hand areas and the reduction of microbiological contamination on the specific parts of the hand. They demonstrated that UV markers can highlight the areas of the hand surface that are adequately disinfected with acceptable accuracy

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(95.05% sensitivity and 98.01% specificity). Thus, this anatomically based scale is a suitable tool based on ultraviolet (UV)-dyed ABHR use in an educational setting to objectively assess trainees by supervisors, or in a clinical setting to assess quality of hand hygiene in the hospital by a hygiene committee.

Moreover, we detected a difference in washing between the right and left hands and the anatomical zones of the hands. These findings strongly support the efficacy of an anatomically based scale as a mean of analyzing handwashing procedures. Focusing on the zones with the lowest scores assessed using this scale should improve learning and performance of handwashing procedures. Education on hand hygiene is part of a larger policy to impact on behavioral determinants such as negative attitude toward hand hygiene, poor self-efficacy, and social pressure.[9] Beyond this pedagogical action, it is important to optimize environmental conditions, such as the availability of alcohol dispensers, that might affect caregiver behavior.[10]

This study has several limitations. For example, the scale presented some challenges. First, this assessment tool required the user to learn the coding, and the reliefs of the hands created shadows. Second, this scale did not include other criteria of hand hygiene quality such as fingernail evaluation or the wearing of jewelry.

We have reported on the design and validation of a coherent and reproducible scale for handwashing evaluation. Based on psychometric properties, this anatomically based assessment scale is useful for quantifying the quality of handwashing with ABHR and assessing the efficacy of handwashing procedures. To our knowledge, the present scale is the first to distinguish the different anatomical zones of the hands.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2018.119

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