Improving compliance with hand antisepsis without decreased efficacy by shortening the rub-in time of alcohol-based handrubs to 15 seconds

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Abstract

Background

A previous study with neonatal intensive care unit (NICU) nurses showed that the antibacterial effectiveness of alcohol-based handrubs (ABHR) can be achieved in 15s instead of 30s with a significant increase in the frequency of hand antisepsis. This study seeks to examine 15s vs 30s antisepsis performance by measuring microbial load on fingertips and compliance using nurses in a low risk gynaecological ward.

Methods

An independent trained observer monitored the frequency and compliance of hand antisepsis during shifts in a crossover design. Fingertips including thumbs were rinsed in soy broth before hand rubbing at the beginning of shift and then hourly to determine the bacterial load. Performance activity was assigned to the contamination class of the Fulkerson scale. Immediately before the lunch break, volunteers cleaned their hands using a randomly determined exposure time of 15 or 30 seconds.

Results

For participants rubbing for 15 seconds, both the frequency of hand antisepsis and compliance were significantly higher ($p < 0.05$) compared with the 30 seconds rub-in. Hourly examination of bacterial load on fingertips revealed no difference between 15 vs. 30 seconds exposure time.

Controlled hand antisepsis before the lunch break also showed no difference in efficacy for either test series.

Discussion

The observed improvement in compliance from shortening ABHRs application time confirms that time acts as a psychological barrier for optimal compliance with handrubbing. Therefore, shortening application time to 15 s should be considered within the critical components of a

successful multimodal intervention strategy to improve compliance with hand hygiene in clinical practice.

Introduction

Healthcare workers (HCW) hands become contaminated with pathogens during patient care or by contact with the patient and his/her environment [1, 2]. Hand hygiene is considered to be the most effective single action for preventing infections in health care facilities worldwide [3-7]. Hand hygiene also leads to a reduction in infection-related morbidity in kindergartens, schools, and employees with ongoing public contact [8-12]. In healthcare settings, in the absence of an intervention to promote hand hygiene, compliance varied between 16- 81% [5], averaging 40-50% [13-19], with observed rates as low as 8% in some instances [20]. The recourse to alcohol-based hand rub (ABHR) as part of a multimodal strategy to improve compliance with hand antisepsis among health workers has been associated with a major impact on both healthcare-associated infections (HAIs) and antimicrobial resistance cross-transmission [4, 5, 21-23]. Despite such success, compliance does not achieve desirable sustainable practice in most settings. The 2009 WHO Guideline on Hand Hygiene in Health Care recommended application of ABHR for a duration of 20s to 30s [5]. However, commercially available ABHRs used on artificially contaminated hands can reach the efficacy of the reference alcohol (60% v/v Propan-2-ol) tested for 60 s, within 15 s [24, 25]. This has been confirmed under practical working conditions in a neonatal intensive care unit (NICU) [26]. It has also been shown that, after training of the rub-in technique, gelling of hands for 15 seconds is equal to a 30-second application [26].

To date, the equivalence of the antibacterial efficacy of hand rubbing for 15 vs. 30 s has only been tested in NICU. The aim of this study was to investigate the equivalence of efficacy in a low-risk ward.

While just frequency of ABHR use was determined in the previous study by Kramer and colleagues [25], the current investigation compares the indication-dependent compliance of hand antisepsis. It also investigates whether the type of activity influences the bioburden

on hands during patient care, classified according to the Fulkerson scale [27]. Contact with intact skin, as well as with surfaces and objects from the patient nearby-environment, leads to relevant contamination of the hands [28-30]. Thus, we checked whether different bacterial loads on hands following healthcare activities would influence ABHR use and its effect.

Materials and methods

The Ethic Committee of the University of Greifswald (Reg.-No. BB 109/10) approved the study.

Study design

We conducted a crossover trial including 14 experienced nurses in the Department of Gynaecology of the University Medicine Greifswald, Germany. In order to standardize the procedure as far as possible, tests were carried out in comparable weather conditions within 3 weeks. All volunteers completed the test series without any drop-outs. Inclusion criteria were healthy skin, short and clean fingernails without artificial or gelled fingernails and no nail polish. Exclusion criteria were open wounds and/or skin irritations on hands and lower forearms. All 14 participants underwent specific training on correct use of hand rubbing technique using a pictogram (EN 1500), along with practical exercises using fluorescent dye and UV-Light. Additional on-site training was repeated with each participant before the start of the trial. Pictograms demonstrating the correct hand rubbing technique were placed next to each ABHR dispenser.

Analysis of bacterial loads on fingertips

Before the beginning of each (8 hours) shift and before the first ABHR application, the initial bacterial colony counts on fingertips, including thumbs, of both hands were determined according to EN 1500 [31] . This was repeated each hour until the end of the shift. Before each analysis, the last nursing activities were classified according to the Fulkerson contamination risk assessment scale [27].

Frequency, compliance and consumption of ABHR

Hand antisepsis was monitored during a complete 8-hour shift, starting at the beginning of a shift. Registered nurses were computer generated randomly allocated to a 15 s (trial A) or 30 s (trial B) ABHR application time cohort. Indications for hand antisepsis were documented by an independent observer during the nurses‘ shift. Compliance was monitored according to the WHO “My 5 moments for hand hygiene” model [32]. The same 14 volunteers participated in both interventions (15 vs 30 s) in a crossover study design.

The overall consumption of ABHR was used to determine the average use of ABHR for each hand antisepsis action.

Comparison of ABHR efficacy for 15 s vs 30 s of use

Shortly before lunch break, all participants were asked to perform hand antisepsis according to a randomly determined exposure time. Antimicrobial efficacy was evaluated according to EN 1500, comparing 15 s and 30 s exposure times.

Briefly, fingertips, including thumbs, were sampled in soy broth with the addition of Tween 80 3% (weight/weight [w/w]), saponins 3% (w/w), histidine 1% (w/w), and cysteine 1% (w/w) to eliminate any residual effect of a potential bacteriostatic agent. The fingertips of each hand were tested separately. The initial number of colonies (pre-value) was determined, followed by the standardized hand rubbing at the respective exposure time (15 s or 30 s) and post-value was recorded afterwards. Fingertips were tested immediately after the exposure time, possibly still wet. Fluid (0.1ml) sampled from hands was plated within 30 min following serial dilutions on Columbia blood agar plates. These were incubated for 48 h at 36°C ± 1°C under aerobic conditions and the number of CFU determined thereafter. The log reduction factor (log RF) was calculated by subtracting the log post-values from the log pre-values. Log RFs were calculated separately for each participant along with the arithmetic mean of all samples. The selected ABHR containing the active ingredients 45% (w/w) propan-2-ol + 30% (w/w) propan-1-ol + 0.2% mecetroniumetile sulphate, as this product showed non-inferiority tested

at 15s compared with the reference alcohol 60% (v/v) propan-2-ol [23]. This ABHR was available as routine in the gynaecological unit under observation.

Statistical analysis

The frequency of hand antisepsis action during shift was calculated as the mean of all separate counts ± standard deviation (SD) and tested for statistical difference using the Wilcoxon Rank Sum Test. Compliance between the two arms of the trial was compared using the Wilcoxon Rank Sum Test. We used the Spearman rank correlation coefficient to examine possible associations between hand contamination and the Fulkerson risk class,

Bacterial counts were logarithmically transformed and expressed as means ± SD before statistical analysis. The log reduction factor was calculated for each subject from the difference between the logarithmic initial value and the post-value. From these log reduction factors arithmetic mean and SD were calculated for trial A (15 s) and trial B (30 s). The extent to which pre- and post-values were normally distributed in both trials was examined using the Kolmogorov-Smirnov adaptation test with significance correction according to Lilliefors. Both pre-values and reduction factors were tested for significant differences using the Wilcoxon rank sum test. In order to compare the reduction factor of both series, contamination levels according to Fulkerson were compared statistically.

Results

Frequency of application and compliance

The frequency of ABHR use per working hour was significantly higher for trial A (15s) than for trial B (30s) (Wilcoxon rank sum test, $p<0.05$, Table 1).

The actual and the target values for hand antisepsis were compared for both trial arms. The target values (Table 2) showed no significant difference between the two arms (Wilcoxon rank sum test, asymptotic significance $p=0.747$). In both arms, the actual values differed

significantly from the target values; asymptotic significance was p= 0.016 in the 15s arm, and p=0.01 in the 30s arm. Compliance significantly increased by 14.8% in the 15s arm compared with the 30s arm (Wilcoxon rank sum test, asymptotic significance p <0.05).

Table 1: Frequency of alcohol-based hand rub application per hour of patient care in the two study arms (15s and 30s) and resulting compliance for hand antisepsis

	ABHR application time			
	15s		30s	
	Actual	Target	Actual	Target
ABHR use (number/h)	5.96	8.57	4.77	8.72
SD	2.799	1.425	2.91	1.26
Confidence interval (95 %)	5.748 - 6.172	5.864 – 6.056	4.542 - 5.016	4.691 – 4.849
Hand antisepsis action (n)/shift	667	960	534	977
Compliance (%)	69.5		54.7	

Footnote: ABHR; alcohol-based hand rub

Hourly determined bioburden load during a work shift

The hourly determined bioburden load on fingertips averaged 1.79±0.76 for participants following a hand antisepsis application time of 15s and was 1.86±0.71 for an application time of 30s (n=112). The difference was not statistically significant. Considering that the frequency distribution of the risk of hand contamination according to the Fulkerson scale did not differ significantly in the two study arms (Figures 1 A and B), it may be concluded that a shorter hand antisepsis time of 15s did not result in higher accumulation of bioburden during a work shift compared with an application time of 30s.

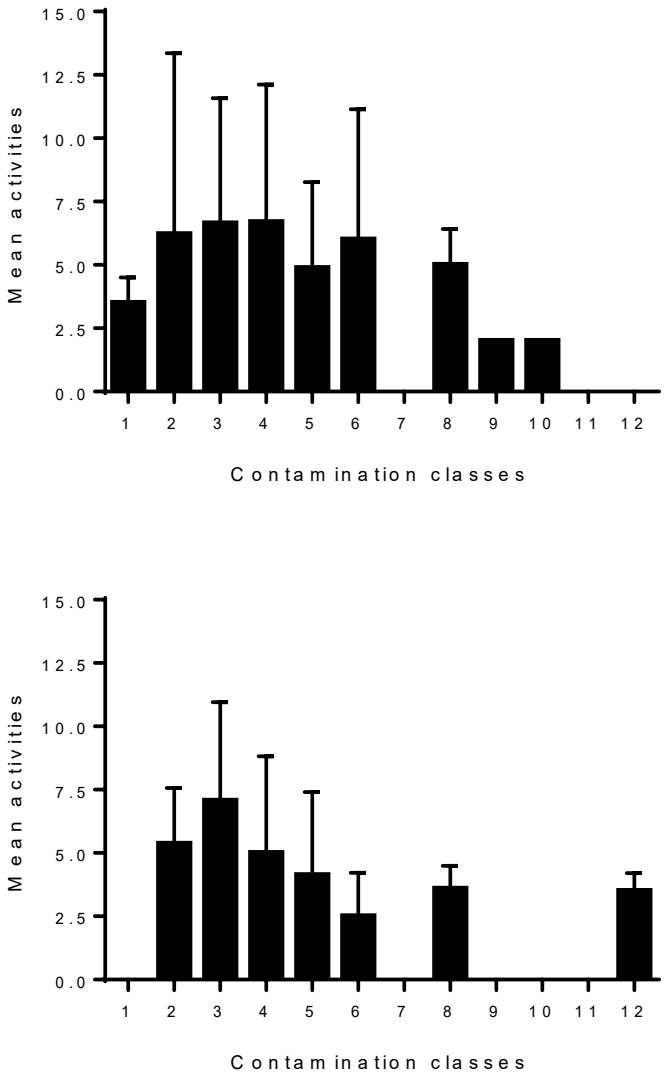


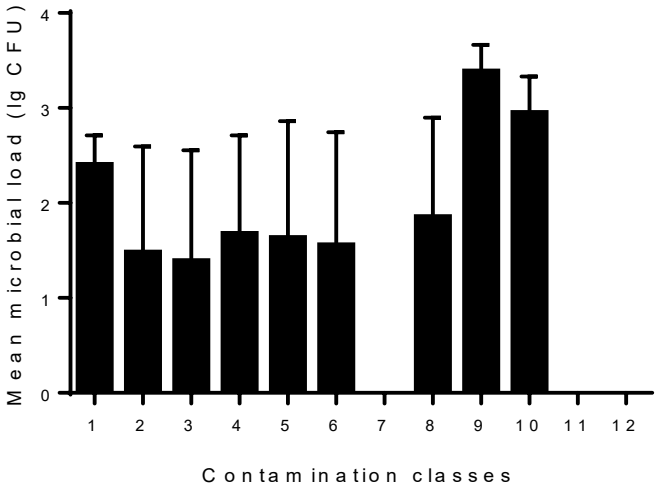
Fig.1 A and B. Distribution of nursing care activities associated with hand antisepsis classified according to the Fulkerson scale for both study arms (15s application time, Fig 1A, and 30s application time, Fig 1B, respectively; mean, SD)

The analysis of the relationship between the common logarithm and contamination risk classes showed a statistically significant correlation between the pre-values in both arms (chi-square, $p < 0.05$). The presumed correlation between increasing colony count on the hands and increased contamination classes could also be proven (Spearman correlation coefficient 0.282).

Efficiency of standardized hand antisepsis comparing 15s and 30s application time

The pre-values for both 15s and 30s test arms showed normal distribution (Kolmogorov-Smirnov-test). To allow comparisons, they were tested for normal distribution using the

Kolmogorow-Smirnow-Test with significance correction by Lilliefors and the Shapiro-Wilk test. For 15s application time for participants 3, 4, 9 and 12, and for 30 s application time for participants 3, 5 and 8, no normal distribution was identified. Although not all contamination classes were present in the test arms, there were only minor differences for total frequencies of occurrence (Figs. 2A and 2B). The result of the Wilcoxon-tests showed no significant difference between test arms regarding contamination classes (asymptotic significance p=0.087). Although there were single outliers among participants, there is statistical evidence that both test arms were comparable regarding contamination classes.



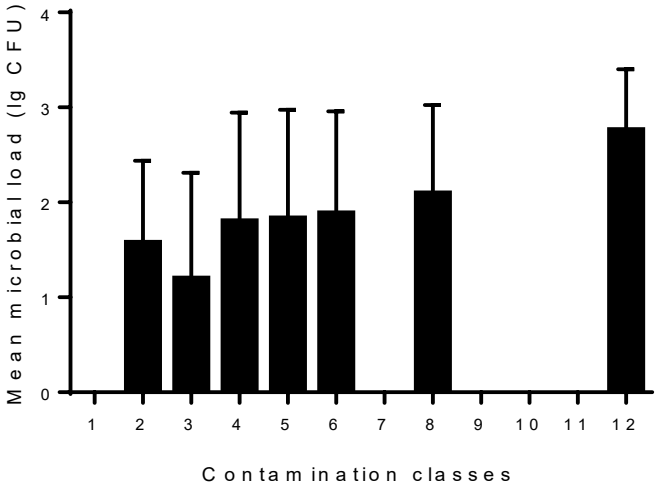


Fig. 2. A and B. Average bacterial contamination (pre-test values (mean, SD) according to the Fulkerson scale for participants in the 15s (2A) and the 30s (2B) study arm

Statistical analysis of reduction factors in the Kolmogorov-Smirnov test showed that both series were normally distributed. Determined values and reduction factors did not differ significantly (Wilcoxon-test, asymptotic significance 2-sided p=0.701 and p=0.427; Table 2). Thus, the efficiency of ABHR application, independent of contamination risk, is comparable for application times of 15s and 30s under controlled circumstances.

Table 2. Means and standard deviation (each n=14) of the common logarithm of pre- and post- values as well as reduction factor

Application time (s)	Log_{10}					
	Pre-value		Post-value		Reduction factor	
	Mean	SD	Mean	SD	Mean	SD
15	1.78	0.76	0.87	0.684	0.92	0.466
30	1.86	0.707	0.98	0.688	0.89	0.447

On average, 3 ml of ABHR was used for each episode of hand antisepsis, with no difference in consumption between test arms (3.3 ml + 0.55, 15s vs. 3.2 ml +0.05, 30s; p> 0.05), because one hub of the dispensers release 3ml.

Discussion

The overall objective of the study was not to modify compliance and participants were not instructed to improve compliance with WHO 5 moments for hand antisepsis. This explains why compliance in the study arm (baseline) was only 54.7% at 30 s. The observed remarkable improvement in compliance from an average of 54.7 to 69.5% resulted from the shorter ABHR application time. Even if a Hawthorne effect cannot be ruled out completely, it would have a similar effect on both study arms. It was instructive that compliance increased by about 15% just from shortening the application time from 30s to 15s without any additional

training, intervention or motivation. If it can be assumed that the frequency of hand antisepsis during an exposure time of 30s reflects the usual nursing routine on a general ward, then an increase in compliance by about 15% occurs with a shortened ABHR exposure application time of 15s. A shorter exposure time may unconsciously motivate nurses to perform hand antisepsis more often. Alternatively, a longer exposure time may unconsciously demotivate nurses to perform hand antisepsis. Further studies will examine the influence of a shortened application time in a multimodal intervention program in order to improve compliance.

While the precursor study in neonatal intensive care only analyzed the influence of a shortened application time on hand antisepsis frequency [26], the present study can confirm an effect on compliance. Whether this effect would persist or last for some time only because would staff endorse the shorter application time, creating a new reference behaviour, is as yet unclear.

In order to counteract any individual factors from participants and other interference both test arms were carried using a crossover design. The bioburden on hands and related reduction factors were determined on the fingertips, including thumbs, using a rinsing technique, because fingertips carry the highest bioburden and can be viewed as representative for the whole hand.

Hourly determination of microbial load on the fingertips showed that a shorter application time does not result in higher or retained bioburden on skin. This supports the results from the daily controlled hand antisepsis of the participants, which also showed no difference in hand antisepsis efficiency between 15s and 30s. For practical use, it is important to note that the efficiency of the shortened hand antisepsis action using ABHR is independent of the Fulkerson contamination class. Furthermore, reducing the hand rubbing time to 15s without compromising efficiency can be clearly demonstrated in the clinical working environment and not just among volunteers under laboratory conditions.

Bingham et al. [33] found no difference in hand contamination beforehand antisepsis indications according to WHO moments 2 and 3. In contrast, this study showed an increase in microbial load with increasing contamination classes according to the Fulkerson scale. However, this had no effect on the efficiency of hand antisepsis.

It is to recognize that, in this study, although participants were instructed to perform hand antisepsis for 15 or 30s according to the study design and scheduled participation, they did not change the amount of ABHR they used for each application time, irrespective of the application times: on average participants applied 3.3 ml vs. 3.2 ml of ABHR while rubbing their hands for 15s vs. 30s, respectively. This element is critical considering that the volume of ABHR applied on hands is among the most important parameters for hand antisepsis efficacy. Studies have highlighted the importance of using the appropriate volume of hand antisepsis agents, and ideally to adapt such volume to the size of the hands of the health worker [34, 35].

Conclusion

Reducing the application time of ABHRs from 30s to 15s leads to improved compliance for hand antisepsis while maintaining antibacterial efficiency. This provides an additional support to the thesis that time is a major limiting factor for hand hygiene in healthcare systems [4, 36], even for trained, experimented staff. Therefore, less time required for hand antisepsis, while respecting the optimal volume of ABHR used, might constitute a key further step to improve compliance in clinical practice.

Acknowledgments

Contributors

AK, OA, and JCH formulated the study hypothesis. SFK realized the observation study.

MZ, and TK supervised quality of data collection procedures. AK, SFK, TK, RB, and RP designed and performed the statistical analysis and interpreted statistical results. All authors were involved in literature search, drafting the manuscript, and processing the study results

together with data interpretation. SJD and PD were responsible for review and editing of the final draft. All authors approved the final draft.

Financial support

This study was funded from the routine departmental research budgets of the Institute of Hygiene and Environmental Medicine, University Medicine Greifswald, Germany. No external funds from sources outside the institution were received.

Potential conflicts of interest

Prof. Ojan Assadian was member of the medical advisory boards of Hutchinson santé, Beckton Dickenson, and Mölnlycke Health Care until end of 2016, and declares having received consulting and lecture fees, travel compensation, and speaker's honoraria from Altrazeal Europe Ltd., Antiseptica chem. GmbH, Bode GmbH Germany, B. Braun Melsungen AG, Ethicon Ltd., Kinetic Concepts Inc., Lohmann & Rauscher, Smith & Nephew Ltd., Quantum Management & Service GmbH, and Schülke & Mayr GmbH in the past. AK, DP, RK, SK, TK, SD and CF report no potential conflicts of interest relevant to this article.

This work is partly supported by the World Health Organization (WHO), Geneva, Switzerland, and the Infection Control Programme and WHO Collaborating Centre on Patient Safety (SPCI/WCC), University of Geneva Hospitals and Faculty of Medicine, Geneva, Switzerland; hand hygiene research activities at the SPCI/WCC are also supported by the Swiss National Science Foundation (grant no. 32003B_163262).

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