Figure 1. 'Clean Hands Count' campaign logo designed by the US Centers for Disease Control and Prevention (CDC), available for no cost on the CDC's 'Hand hygiene in healthcare settings', 'Promotional materials' page. Stickers and posters in the campaign featured this image.

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Why volume matters — implications of applied volume of alcohol-based disinfectants for infection prevention

Sir,

The recently published study by Pidot *et al.* investigated the hypothesis as to whether increased use of alcohol-based disinfectants for hand disinfection purposes can induce tolerance of *Enterococcus faecium* to alcohols [1].

Enterococci are known for their intrinsic resistance to antimicrobial substances, and Wassilew *et al.* reported a large outbreak of vancomycin-resistant enterococci in Switzerland, which demonstrated that effective hygiene measures to prevent outbreaks and spread of nosocomial pathogens are of great relevance [2,3].

The study by Pidot *et al.* is an important contribution toward demonstrating that decontamination of surfaces (animate or inanimate) with a volatile active substance such as 70% (v/v) propan-2-ol can be substantially impaired if the quantities used for disinfection are too small [1]. In their animal model, Pidot *et al.* demonstrated that impaired disinfection of inanimate surfaces poses a great risk of transmission of pathogens. For disinfection of an area measuring 15 × 30 cm, a 4 × 4 cm piece of filter paper soaked with 0.85 mL of 70% (v/v) propan-2-ol was used [1]. Due to the minute amount of disinfectant applied, proper disinfection was substantially impaired, and evidence is provided that residual contamination of the animal housing resulted in a statistically significant increase in ingestion of the *E. faecium* strains by the mice that were kept in these cages afterwards. The hypothesis that the tested *E. faecium* isolates developed alcohol tolerance is, however, difficult to verify with the published experimental design.

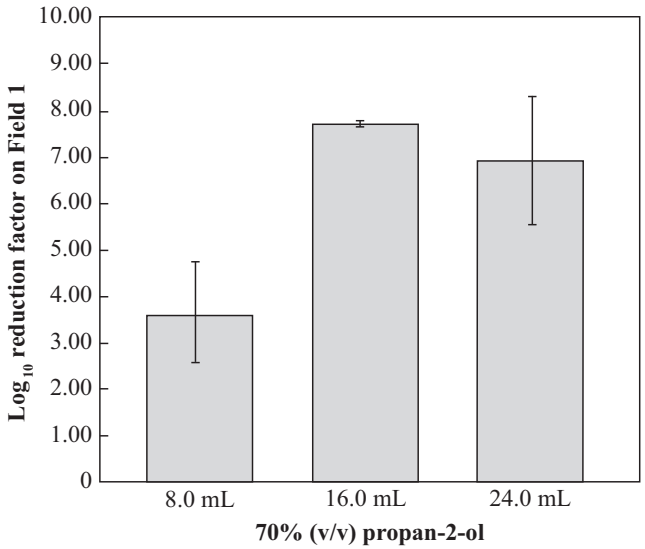

Figure 1. Antimicrobial efficacy of different volumes of 70% (v/v) propan-2-ol in a standardized surface disinfection test according to EN 16615. Test organism: *Enterococcus hirae* ATCC 10541.

This correlation between the volume of alcohol-based formulations applied and efficacy is well in line with investigations by Goroncy-Bermes *et al.*, who demonstrated that efficacy is influenced by the volume of alcohol-based disinfectant hand rubs applied and that the use of larger volumes promotes efficacy [4]. Thus, the findings of Pidot *et al.* also indicate that a potential reduction of volume in order to shorten application times is not to be recommended [1,5].

As the study by Pidot *et al.* underlines, there is a need for adequate test methods for the evaluation of disinfectants under practical conditions; the work of the European standardization group CEN/TC 216 summarized in EN 14885 is to be mentioned [1,6]. Within the framework of CEN/TC 216 methods EN 16615 is a test method for the evaluation of surface disinfectants by wiping a test surface under practical conditions including the measurement of the product volume released from the tissue on to the surface [7].

Based on the test design of the four-field test, as described in EN 16615, we tested the impact of different volumes on bactericidal efficacy of 70% (v/v) propan-2-ol (Figure 1) [7]. Throughout the test, the standardized wipe as described in EN 16615 was soaked with either 8 mL, 16 mL or 24 mL 70% (v/v) propan-2-ol, and the impregnated wipe was thereafter applied to disinfect the standardized PVC-floor according to EN 16615 [7]. *Enterococcus hirae* ATCC 10541 was used as the test organism, and the inoculum applied on Field 1 was $0.68—2.25 \times 10^7$ cfu/25 cm^2. The applied volume of 8 mL 70% (v/v) propan-2-ol resulted in a logarithmic reduction factor (log_{10} RF) of 3.58 ± 1.03, whereas 16 mL and 24 mL 70% (v/v) propan-2-ol resulted in log_{10} RF values ≥ 5.

According to EN 16615, efficacy of 8 mL, 16 mL and 24 mL 70% (v/v) propan-2-ol was tested on a standardized PVC floor using *E. hirae* ATCC 10541 as test organism at 5 min contact time. The experiments were repeated at least three times on different days. Mean values are displayed with standard error. Data presented in Figure 1 demonstrate that the applied volume of the 70% (v/v) propan-2-ol affects efficacy in surface disinfection, as has been described before for hand disinfection [4].

Thus, in order to prevent transmission of pathogens from contaminated surfaces, effective hygiene measures need to be taken, and application of sufficient volume of disinfectant on animate or inanimate surfaces is of outmost importance.

Conflict of interest statement

K.S. and K.T. are employees of Schülke & Mayr GmbH, Germany; H.J.R. is an employee of Dr. Hans Rosemann GmbH, Germany; H.M. is an employee of Technical Hygiene, Germany; B.M. is an employee of Ecolab Deutschland GmbH, Germany; C.O. is an employee of Bode GmbH, Germany.

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Hand hygiene and infection control in limited-resource countries: still a big challenge

Sir,

I read with great interest the article by Alshehari *et al*. who investigated effective interventions on hand hygiene (HH) compliance among healthcare workers (HCWs). This mini systematic review indicated that implementation of a multimodal intervention can increase HH compliance [1]. The role of HH is very important in the prevention of healthcare-associated infections (HCAIs) [2], but HH compliance among HCWs is low, and is a particular challenge in low-income countries. An evaluation of HH compliance among nurses in an oncology centre in Iran found the rate to be just 12.8% [3].

In developing countries, there is an extended scope of social and system deficits, and an absence of collection and reporting of incidences of HCAI [4]. The key factors determining HH compliance in developing and developed regions differ. Borg *et al*. identified infrastructural issues such as the numbers of sinks and the quality of HH products as critical factors in eight developing countries [5]. In contrast, heavy workload and skin problems were the main reasons for non-compliance in Western countries. Indeed, in rich countries with well-resourced hospitals and strong infection control, structural and organizational problems are less important factors.

The contrast between countries is demonstrated by a comparison of the situation in Turkey, a country with 'limited' resources, and the Netherlands, a country with 'reasonable' resources. Rates of HH compliance are poor in both countries, despite better availability of hand hygiene facilities in the Netherlands, but rates of HCAI are higher in Turkey. Challenges in Turkish hospitals include an absence of single or isolation rooms, and poor air quality. Thus, poor HH is not the only determinant of HCAI rates [6]. In addition, many countries with limited resources do not have suitable organization chart, hospital manager support, and correct planning for infection prevention and control (IPC) or a trained IPC team [7].

The prevention of HCAIs in limited-resource countries is a critical challenge for global patient safety that needs a strategy, supported by tools, to mobilize an unprecedented global movement. Resource-poor countries require better systems for gathering and reporting HCAI rates. Knowledge of HCAI rates can then be used to measure improvements as national programmes to reduce HCAIs, including improvements in HH compliance, are rolled out following the World Health Organization's multi-modal strategy.

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