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## Original Article

# Interventions to improve healthcare workers' hand hygiene compliance: A systematic review of systematic reviews

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**Abstract**

Objective: To synthesize the existing evidence base of systematic reviews of interventions to improve healthcare worker (HCW) hand hygiene compliance (HHC).

Methods: PRISMA guidelines were followed, and 10 information sources were searched in September 2017, with no limits to language or date of publication, and papers were screened against inclusion criteria for relevance. Data were extracted and risk of bias was assessed.

Results: Overall, 19 systematic reviews (n = 20 articles) were included. Only 1 article had a low risk of bias. Moreover, 15 systematic reviews showed positive effects of interventions on HCW HHC, whereas 3 reviews evaluating monitoring technology did not. Findings regarding whether multimodal rather than single interventions are preferable were inconclusive. Targeting social influence, attitude, self-efficacy, and intention were associated with greater effectiveness. No clear link emerged between how educational interventions were delivered and effectiveness.

Conclusions: This is the first systematic review of systematic reviews of interventions to improve HCW HHC. The evidence is sufficient to recommend the implementation of interventions to improve HCW HHC (except for monitoring technology), but it is insufficient to make specific recommendations regarding the content or how the content should be delivered. Future research should rigorously apply behavior change theory, and recommendations should be clearly described with respect to intervention content and how it is delivered. Such recommendations should be tested for longer terms using stronger study designs with clearly defined outcomes.

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Healthcare-associated infections (HAIs) have serious consequences for patients and healthcare systems, leading to longer hospital stays, increased mortality and morbidity, and financial burden.[1,2] In Europe, ~80,000 hospital patients suffer at least 1 HAI on any given day, yielding an overall prevalence of 5.7%.[3] HAIs also affect millions of patients worldwide annually.[3–7]

Organisms that cause HAIs can be transmitted to patients through healthcare worker (HCW) hands contaminated by patient contact or touching the patient environment.[2] Effective hand hygiene (HH) is thus critical to preventing HAIs,[8] which is reflected by the emphasis on HCW compliance with HH guidelines. Such HH guidance relates to both opportunity and technique. Opportunity concerns *when* to do HH, and the World Health Organization (WHO) specify Five Moments.[2] Technique relates to *how* to enact HH, with 2 main procedures internationally: the Six Step[2] and Three Step[9] techniques. However, HCW compliance with this guidance is suboptimal.[2,10–17]

A major challenge within healthcare systems is how to improve hand hygiene compliance (HHC) among HCWs. An early systematic review identified 21 primary studies evaluating HH interventions for HCWs.[18] A plethora of primary studies and a growing number of systematic reviews have since assessed the effectiveness of interventions to improve HCW HHC. To assist practitioners in optimizing HHC among HCWs, this review aims to synthesize the evidence base of systematic reviews of interventions to improve HCW HHC.

## Methods

### Protocol and registration

This systematic review followed a published protocol[19] and is reported according to the PRISMA guidelines.[20]

### Inclusion criteria

Systematic reviews were included if they evaluated any intervention to improve HHC among HCWs. Interventions could

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PREVIOUS PRESENTATION: Results based on a search of the literature up to June 2016 were presented on September 19, 2017, at the Annual Conference of the Infection Prevention Society, held in the Manchester Central Convention Complex, England, United Kingdom. This presentation resulted in the following abstract: Price L, MacDonald J, Gozdzielewska L, et al. An overview of systematic reviews of interventions designed to improve healthcare workers' hand hygiene compliance. *J Infect Prev* 2017;18: S56–S57.

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have no comparator or be compared to usual care, another intervention, or historical control. Systematic reviews were required to report HHC as the primary outcome. Other outcomes of interest included bacterial load on HCW hands, HAI rates, organizational culture, and psychological variables. No restrictions were placed on the design of primary studies within systematic reviews.

### Information sources and search

In September 2017, we searched 4 databases (CINAHL, EMBASE, MEDLINE, and PsycINFO) and 6 specialist registers (Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effectiveness, Epistemonikos, Joanna Briggs Institute Database of Systematic Reviews and Implementation Reports, Health Technology Assessment Database, and PROSPERO). No language or date of publication restrictions were applied. The search included index terms and text words relating to HH[21] and systematic review methods.[22] Database searches were broadly similar; modifications were made to account for minor differences in functionality (see Supplemental Table 1 for MEDLINE search). Due to limited functionality of specialist registers (except the Cochrane Database of Systematic Reviews), these searches were restricted to HH text words. We also manually searched the reference lists of included systematic reviews.

### Systematic review selection

Systematic review selection was conducted in 2 stages, with all papers assessed by 2 independent reviewers. First, titles and abstracts of included papers were screened against the inclusion criteria. Second, papers that appeared to meet the inclusion criteria or lacked sufficient information to allow an informed judgement on relevance underwent full-text review. Disagreements were resolved via discussion or referral to a third reviewer.

### Data collection and risk of bias within systematic reviews

A standardized tool was devised for data extraction (Supplemental Table 2). Risk of bias within systematic reviews was assessed using the ROBIS tool (Supplemental Table 3).[23] Data were extracted and risk of bias was assessed by 2 independent reviewers for 25% (n = 5) of systematic reviews. The remaining systematic reviews were data extracted and assessed for risk of bias by 1 reviewer and checked by another. Disagreements were resolved through discussion or referral to a third reviewer.

### Synthesis

Findings were synthesized following the Economic and Social Research Council's guidance for narrative synthesis.[24]

## Results

### Systematic review selection

The search yielded 993 papers (Fig. 1). Following the removal of duplicates, 566 unique papers remained; all were screened against the inclusion criteria. Most papers (n = 481) were discarded at the title or abstract stage, and 65 were excluded by full-text review (Fig. 1). Overall, 19 systematic reviews (n = 20 articles) were included.[18,25–43] Reference list checks did not identify any further papers.

### Systematic review characteristics

The characteristics of the 19 systematic reviews are summarized in Supplemental Table 4. Overall, 15 narrative syntheses,[18,25–29,31,32,35,36/37,39–43] 3 meta-analyses,[33,34,38] and 1 network meta-analysis[30] were published between 2001 and 2017, with 15 published after 2010.[25–33,38–43] Primary studies in included systematic reviews were published from 1986 to 2016 and ranged in number from 3[41] to 73.[32] Collectively,[1] 236 unique primary studies were cited. However, some primary studies were included in >1 systematic review. The degree of overlap has been quantified and presented in a transparent manner[44,45]: 139 (58.9%) primary studies were cited once; 46 (19.5%) were cited twice; 25 (10.6%) were cited 3 times; 17 (7.2%) were cited 4 times; 7 (3.0%) were cited 5 times; and 2 (<1%) were cited 6 times.

#### Countries and healthcare settings

In all but 2 systematic reviews where inclusion was limited to primary studies conducted in developed[32] or low- or middle-income countries,[42] systematic reviews were open to primary studies from all countries. Regarding healthcare settings, 13 systematic reviews included primary studies conducted in hospitals.[25,26,28,30,31,33–35,39–43] In addition, 6 systematic reviews included primary studies conducted in hospitals in addition to elder care homes;[29] nursing homes;[32] long-term care facilities;[27,32,36/37,38] care homes for people with disabilities;[18] and/or primary care facilities.[27,29]

#### Population

All systematic reviews were open to primary studies of any type of HCW, with the exception of Doronina et al,[26] which specified a particular professional group (nurses). Most systematic reviews included data from a range of HCWs (eg, nurses, doctors, healthcare assistants, and students), and 6 systematic reviews included at least 1 primary study (n = 1;[28,30,33,43] n = 3;[40] and n = 6[32]) with data from patients or visitors or relatives, but the proportions of the overall samples that were not HCWs were not reported.

#### Interventions

With regard to types of interventions, 11 systematic reviews took an inclusive approach. Others focused on the introduction of alcohol-based hand rub (ABHR),[34] ABHR accessibility,[41] educational interventions,[25] interventions using psychological theory,[39] monitoring technology,[31,40,43] or quality improvement strategies.[35] Supplemental Table 5 illustrates how the content of interventions evaluated in primary studies of each systematic review mapped onto the WHO multimodal strategy for HH.[2] The most frequent component was 'observation and feedback,' which was mapped in all but 1 systematic review,[41] followed by 'training and education' (n = 16)[18,25–39,42] and 'reminders' (n = 15).[18,25–33,35,38,40,43] The least common component was 'safety climate,' which was mapped in 10 systematic reviews.[25–30,32,35,38,43]

[1]Excluding primary studies in Ward et al[43] because it is unclear exactly how many reported HHC and/or HAI outcomes and only including 8 primary studies in Kingston et al[29] with baseline and post-intervention HHC data, upon which conclusions about effectiveness were based.

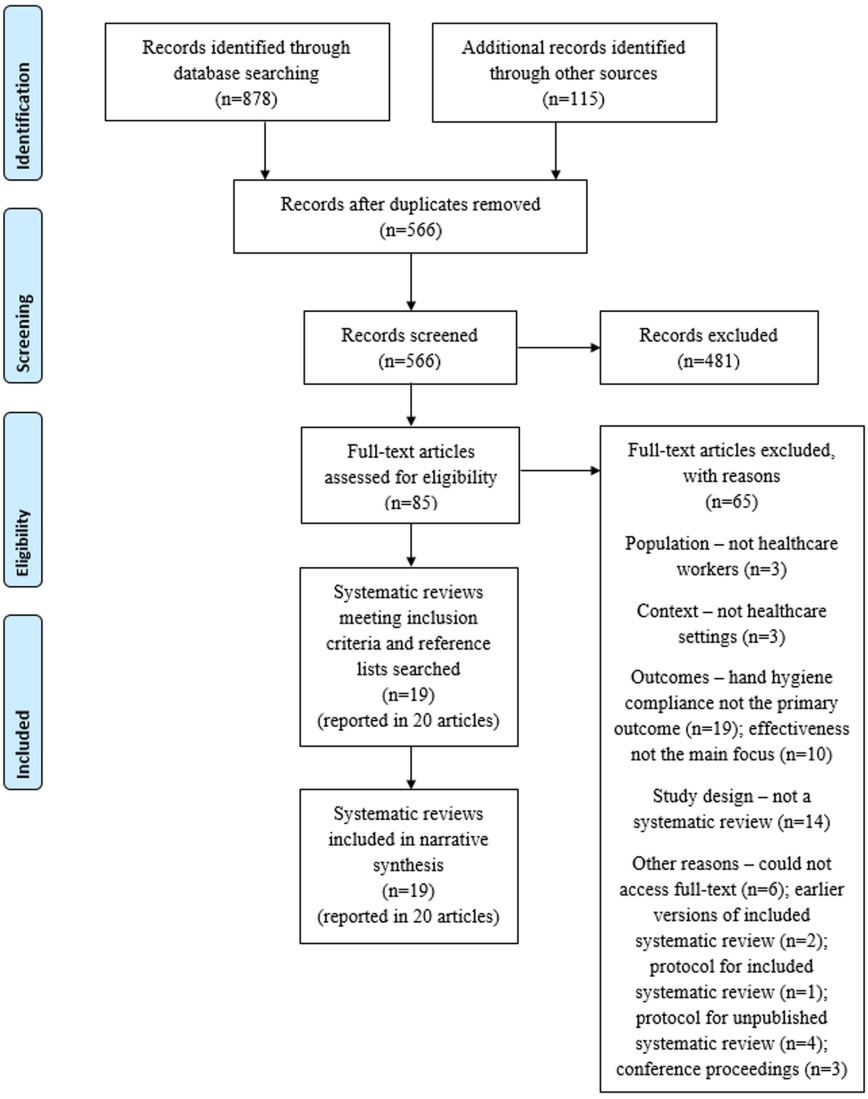


**Fig. 1.** PRISMA flow diagram outlining the systematic review selection process.

### *Outcomes*

Hand hygiene compliance was measured by direct observation (n = 13),[18,26–30,32,33,36/37,38,39,41,42] unobtrusive observation (n = 2),[26,28] video camera (n = 4),[27,30,38,43] mobile handheld devices (n = 1),[43] electronic monitoring (n = 9),[32,36/37,42] or self-report (n = 3).[32,36/37,42] Proxy measures, such as rate or number of HH events (n = 4),[27,28,30,40] ABHR consumption or soap use (n = 11),[18,26,31,36/37,38,40,41] and procurement of ABHR or soap (n = 2),[27,39] were also employed. A lack of longer-term evaluation of HHC was observed in 11 systematic reviews.[18,25–30,32,33,36/37,42] HAI rates were reported in 11 systematic reviews.[25,27,30,31,33,35,36/37,39,40,42,43] Bacterial load on HCW hands, organizational culture, and psychological variables were not reported in any systematic reviews.

### *Study designs*

In 3 systematic reviews,[26,27,30] primary studies were required to meet the Cochrane Effective Practice and Organization of Care methodological criteria for randomized controlled trials (RCTs), non-randomized trials, controlled before-and-after studies, or interrupted time series (ITS).[46] Across the other systematic reviews, before-and-after studies were common,[18,28,31–33,35,36/37,38–40] although 5 reviewers did not specify the design of the included primary studies.[25,34,41–43] Although Kingston et al[29] described all primary studies as 'clinical trials,' this term was not defined, and ITS and before-and-after studies were included.[47]

## *Risk of bias within systematic reviews*

Overall, 13 systematic reviews had a high risk of bias,[18,25,26,29,31–34,36/37,38,41–43] 5 systematic reviews had an unclear risk of bias,[28,30,35,39,40] and 1 systematic review had a low risk of bias (Table 1).[27] The most common methodological weaknesses within systematic reviews related to synthesis and findings, for example, not reporting individual study results, not including all primary studies in the synthesis, or not addressing biases in the synthesis. Other common methodological weaknesses within systematic reviews were not reporting a risk of bias assessment or the process for data extraction and risk of bias assessment.

## *Effectiveness of HH interventions*

*Hand hygiene compliance.* In total, 18 systematic reviews reported the overall effectiveness of interventions in improving HCW

**Table 1.** Risk of Bias Within Systematic Reviews

| First Author (Year) | Level of Concern | | | | All concerns identified in domains 1 to 4 addressed in interpretation of findings? | Relevance of identified studies to the review's research question appropriately considered? | Emphasizing results based on statistical significance avoided? | Overall Judgment of Risk of Bias |
|---|---|---|---|---|---|---|---|---|
| | Domain 1: Eligibility Criteria | Domain 2: Identification and Selection of Studies | Domain 3: Data Collection and Study Appraisal | Domain 4: Synthesis and Findings | | | | |
| Cherry et al (2012)[25] | Unclear | Unclear | Low | High | No | Probably yes | Probably no | High |
| Doronina et al (2017)[26] | High | Unclear | Unclear | High | No | Yes | Probably yes | High |
| Gould et al (2017)[27] | Low | Low | Low | Low | Yes | Yes | Yes | Low |
| Huis et al (2012)[28] | Unclear | Unclear | Low | Low | Probably no | Yes | Yes | Unclear |
| Kingston et al (2016)[29] | High | High | High | High | No | Probably yes | Yes | High |
| Luangasanatip et al (2015)[30] | High | Low | Unclear | Low | Probably no | Probably yes | Yes | Unclear |
| Mitchell et al (2014)[31] | Unclear | High | High | High | No | Probably no | Yes | High |
| Naikoba & Hayward (2001)[18] | Unclear | High | High | High | No | Probably yes | Yes | High |
| Neo et al (2016)[32] | Unclear | High | High | High | No | Probably yes | Probably yes | High |
| Ofek Shlomai et al (2015)[33] | Unclear | High | Low | Unclear | No | Probably yes | No | High |
| Picheansathian et al (2004)[34] | High | High | High | Unclear | No | No | Probably no | High |
| Ranji et al (2007)[35] | Unclear | Low | Unclear | Low | Probably no | Probably yes | Yes | Unclear |
| Ritchie et al (2005)[36] and Stout et al (2007)[37] | Unclear | Unclear | High | High | No | Yes | Yes | High |
| Schweizer et al (2014)[38] | Unclear | Unclear | High | High | Probably no | Probably yes | Yes | High |
| Srigley et al (2015)[39] | High | Low | Low | Low | Probably no | Yes | Yes | Unclear |
| Srigley et al (2015)[40] | High | Unclear | Low | Low | Probably no | Yes | Yes | Unclear |
| Stiller et al (2016)[41] | High | Low | Unclear | High | No | Probably yes | Probably yes | High |
| Vindigni et al (2011)[42] | Unclear | High | High | High | No | Probably yes | No | High |
| Ward et al (2014)[43] | High | High | High | High | No | No | Yes | High |

HHC (Supplemental Table 6). Also, 2 meta-analyses showed similar increases (odds ratio [OR], 2.04; 95% confidence interval [CI], 1.40–2.97[33]; and Peto OR, 1.96; CI, 1.56–2.46[34]). Luangasanatip et al[30] found that 18 of 22 pairwise comparisons (82%) showed both stepwise increases in HHC during intervention implementation and a trend for increasing HHC postintervention. In 8 narrative syntheses, most or all primary studies reported significant improvements in HHC.[25,26,32,35,36/37–39,41] Overall effectiveness was further

supported by 4 narrative syntheses, which described positive findings, largely without reference to statistical significance.[27–29,42] Furthermore, 3 narrative syntheses on monitoring technology found scarce evidence for effectiveness in improving HHC in general.[31,40,43]

*Healthcare-associate infection rates.* In 4 systematic reviews, most or all primary studies that measured HAI rates showed a reduction in HAI rates, although significance levels were not always stated.[25,30,33,36/37] Results were more mixed in 4 other systematic reviews reporting HAI data,[27,31,35,43] and there were no significant decreases in HAI rates in relevant primary studies included within 2 systematic reviews.[39,40] The final systematic review did not report HAI results.[42]

### Intervention content and effectiveness

Supplemental Table 7 summarizes findings of 10 systematic reviews that considered the relationship between intervention content and effectiveness. One meta-analysis[38] indicated that interventions with more components, as conceptualized by WHO in their multimodal strategy for HH,[2] did not see larger increases in HHC.[2] Conversely, within the same systematic review, 2 further meta-analyses of primary studies assessing the same combination of components showed that using all components of the WHO multimodal strategy for HH (OR, 1.82; 95% CI, 1.69–1.97) seems more effective in improving HHC than including only feedback, education, and reminders (OR, 1.47; 95% CI, 1.12–1.94).[38] Additionally, in a network meta-analysis,[30] interventions that supplemented the WHO multimodal strategy for HH with incentives, goal setting, or accountability produced further improvements in HHC than 'training and education' or 'system change' (OR not reported) and the WHO multimodal strategy for HH alone (OR, 1.82; 95% CI, 0.2–12.2). Doronina et al[26] reached a similar conclusion in their narrative synthesis.

Naikoba and Hayward[18] emphasized that combining education with written material, reminders, and continued performance feedback can have a marked effect on HHC compared to single interventions comprising reminders or regular performance feedback, which in turn are more effective than one-off education and ABHR provision. Neo et al[32] also proposed that effectiveness may be enhanced by multimodal interventions, as well as facilities design and planning and financial rewards. In another narrative synthesis, multimodal interventions supplying ABHR were as conducive to improving HHC as those without.[36/37] Meta-analytic findings suggest that providing (OR, 2.81; 95% CI, 1.32–5.96) in contrast to not providing (OR, 1.55; 95% CI, 1.13–2.11) performance feedback in a multimodal intervention is more likely to improve HHC.[33] However, the Cochrane authors concluded that it is unclear whether multimodal over single interventions are preferable, or which components add the most value.[27]

With regard to monitoring technology, Mitchell et al[31] reported that devices delivering a real-time reminder that HH was indicated but not actioned were consistently linked to increased HHC, while systems with periodic feedback by managers produced variable findings. However, in assessing devices that give reminders without feedback, aggregate feedback without reminders, or individual feedback and reminders, Srigley et al[40] found limited evidence to recommend any specific technology.

[2]Increase in HHC for interventions with 1–2 components (OR, 3.44; 95% CI, 1.11–10.68), 3–4 components (OR, 2.16; 95% CI, 1.82–2.55), and ≥5 components (OR, 2.49; 95% CI, 1.74–3.56).

### Delivery of educational interventions and effectiveness

Cherry et al[25] considered the relationship between how the educational interventions were delivered and effectiveness. Delivery of education was separated into 6 groups of education with (1) demonstration; (2) no demonstration; (3) self-study; (4) video; (5) demonstration and video, and (6) an online element. However, they were unable to identify a method of delivery that was more effective than another.[25]

### Use of theoretical frameworks

Huis et al[28] found a significant positive correlation between the effectiveness of interventions tested in controlled studies and the number of theoretical determinants of behavior (n = 1–5) addressed (r = .961; $P = .009$).[3] They also noted that less commonly addressed determinants (ie, social influence, attitude, self-efficacy, and intention) were mainly targeted in interventions addressing ≥4 determinants.[28] Gould et al[27] reported interventions lacked convincing theoretical underpinning. Likewise, Srigley et al[39] observed that it was often unclear how theory informed interventions, that typically not all theoretical constructs were represented, and that measures of theoretical constructs were not always consistent with guidelines. No theoretical approach appeared more effective at improving HHC than another.[39]

## Discussion

This systematic review has, for the first time, identified, described, and synthesized the existing evidence base of systematic reviews of interventions to improve HHC among HCWs. In addition, the systematic review was conducted in a transparent and rigorous manner and benefited from a comprehensive literature search, spanning a wide period with no language restrictions. The results of 15 of 18 systematic reviews that reported overall effectiveness showed positive effects of interventions on HCW HHC, across various healthcare settings for different professional groups. However, 6 of 11 systematic reviews that extracted HAI data described mixed or nonsignificant findings. Several reviewers advocated multimodal interventions, incorporating performance feedback and extending the WHO multimodal strategy for HH over single interventions to elicit improvements in HCW HHC. Still, this conclusion was not unanimous. Regarding theory, targeting higher numbers of theoretical determinants of behavior (up to 5) appears to increase effectiveness, with interventions that address social influence, attitude, self-efficacy, and intention especially effective. There was no clear link between how educational interventions were delivered and effectiveness.

### Limits of the evidence and recommendations for practice

Although a substantial number of systematic reviews showed positive effects of interventions to improve HHC among HCW, only 1 systematic review had a low risk of bias.[27] This systematic review concluded that there was sufficient evidence to

[3]One theoretical determinant (n = 3): median relative difference (improvement), 17.6 (range, −8.8 to 61). Two theoretical determinants (n = 1): relative difference (improvement), 25.7. Three theoretical determinants (n = 3): median relative difference (improvement), 42.3 (range, 19.5–82.7). Four theoretical determinants (n = 2): median relative difference (improvement), 43.9 (range, 14.8–73). Five theoretical determinants (n = 3): median relative difference (improvement), 49.5 (range, −8.6 to 429). And 7 theoretical determinants (n = 1): relative difference (improvement), 9.7.

recommend interventions to improve hand hygiene. However, the evidence on the optimum content and how it is should be delivered remain unclear. In addition, evidence for the use of monitoring technology is insufficient to recommend its use.[31,40,43] Theory-informed interventions are recommended by the Cochrane systematic review.[27] The significant findings of Huis et al[28] suggest that targeting social influence, attitude, self-efficacy, and intention may enhance effectiveness, but the evidential basis for this is somewhat lacking.

### *Limits of the evidence and recommendations for future research*

Caution is required when interpreting these findings because only 1 systematic review was at low risk of bias. Reviewers should use quality assessment tools and follow best-practice review guidelines.[48–58] Transparency in reporting of methods should be ensured to minimize bias in future studies. Systematic reviews were restricted in that they largely comprised before-and-after studies; more robust study designs are required moving forward. Also, reviewers rarely conveyed the total sample size, and the type of HCW was often not further defined. These reporting omissions likely reflect the absence of this detail in primary studies. However, this information is necessary to interpret generalizability; what works in one population may differ in another.[59] Primary studies tended to run over short time periods; the longer-term effect[60] of HH interventions has not yet been established. Researchers should consider this when designing studies.

In conclusion, in this systematic review of systematic reviews, we found predominantly low-quality evidence that interventions to improve HCW HHC are effective. The evidence is sufficient to recommend the implementation of interventions to improve HCW HHC (with the exception of monitoring technology), but it is insufficient to make specific recommendations about the content and how the content should be delivered. To fill existing research gaps and to develop a more viable evidence base to enable the generation of recommendations for practice, systematic reviews should follow reporting guidelines, and primary studies need to utilize more robust research designs.

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**Conflicts of interest.** L.P. is the Director of Studies for a PhD student (LG) whose study is being supported by SureWash. L.P. is leading, and L.G. is working on, another study supported by SureWash. L.P. and L.G. have 2 SureWash Elite machines on loan for data collection purposes for these 2 studies. All other authors report no conflicts of interest relevant to this article.

**Supplementary material.** To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2018.262

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