ORIGINAL ARTICLE

Systematic Review of Studies on Compliance with Hand Hygiene Guidelines in Hospital Care

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OBJECTIVES. To assess the prevalence and correlates of compliance and noncompliance with hand hygiene guidelines in hospital care.

DESIGN. A systematic review of studies published before January 1, 2009, on observed or self-reported compliance rates.

METHODS. Articles on empirical studies written in English and conducted on general patient populations in industrialized countries were included. The results were grouped by type of healthcare worker before and after patient contact. Correlates contributing to compliance were grouped and listed.

RESULTS. We included 96 empirical studies, the majority ($n = 65$) in intensive care units. In general, the study methods were not very robust and often ill reported. We found an overall median compliance rate of 40%. Unadjusted compliance rates were lower in intensive care units (30%–40%) than in other settings (50%–60%), lower among physicians (32%) than among nurses (48%), and before (21%) rather than after (47%) patient contact. The majority of the time, the situations that were associated with a lower compliance rate were those with a high activity level and/or those in which a physician was involved. The majority of the time, the situations that were associated with a higher compliance rate were those having to do with dirty tasks, the introduction of alcohol-based hand rub or gel, performance feedback, and accessibility of materials. A minority of studies ($n = 12$) have investigated the behavioral determinants of hand hygiene, of which only 7 report the use of a theoretical framework with inconclusive results.

CONCLUSIONS. Noncompliance with hand hygiene guidelines is a universal problem, which calls for standardized measures for research and monitoring. Theoretical models from the behavioral sciences should be used internationally and should be adapted to better explain the complexities of hand hygiene.

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Hospital-acquired, or nosocomial, infections are a major threat to patients. At any time, over 1.4 million people worldwide develop infectious complications associated with health care.[1] Universally across the globe, 5%–10% of patients acquire nosocomial infections, with prevalence rates of 20%–30% for patients admitted to an intensive care unit (ICU). This leads to a considerable burden of disease and mortality. It has been estimated that hospital-acquired infections are responsible for 80,000 deaths in the United States and 5,000 deaths in the United Kingdom.[2]

Over the past 2 decades, improving patient safety has received growing attention, and one of the first goals of the World Health Organization's World Alliance for Patient Safety is the substantial reduction of hospital-acquired infections. To reach this goal, improvement in compliance with hand hygiene guidelines is needed. Observed compliance rates among healthcare workers (HCWs) have been regarded by public health authorities as unacceptably poor.[3] Hand hygiene (ie, washing hands with soap and water, or disinfection using alcohol-based hand rub) is considered the most important measure to prevent nosocomial infections and the spread of antimicrobial-resistant pathogens and subsequent nosocomial infections.[4] Over the past several decades, various campaigns promoting hand hygiene have been launched, but substantial and lasting effects on compliance rates have hardly been reported.[5]

To be able to effectively improve compliance rates, it is important to follow a planned and stepwise approach to the development of interventions, using insights from the behavioral sciences.[6] Compliance with hand hygiene guidelines in health care is considered preventive behavior and should be approached as such.[7] A first step toward the development of interventions should be to identify the prevalence of the risk behavior (ie, noncompliance), the differences in risk be-

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havior between target populations (ie, physicians, nurses, as well as other HCWs who have contact with patients), as well as the determinants of the risk behavior.[6] General overviews of hand hygiene compliance rates have been reported in previous reviews,[8-12] but compliance across studies has not yet been quantified for specific settings (eg, ICU vs non-ICU ward) or for specific parts of the guidelines (eg, before and after patient contact). Moreover, the relative importance of factors influencing compliance and noncompliance has not yet been documented in a systematic review.

We conducted a systematic literature review of observed and self-reported compliance with hand hygiene guidelines in health care. We focused our review on hospitals, because the risk for acquiring and spreading infection is most substantial in this setting. We addressed the following research questions: (1) Which settings have been studied and which methods have been used to measure hand hygiene compliance rates in hospital care? (2) What hand hygiene compliance rates have been reported in general and for different HCWs, settings, and situations? (3) Which correlates of compliance and noncompliance with hand hygiene guidelines have been identified?

METHODS

Data Sources and Search Strategy

Searches for eligible studies were conducted using the Medline (PubMed), PsycINFO, and Web of Science databases. All articles published prior to January 1, 2009 were included in the searches. The search terms used were "hand hygiene," "hand washing," "guideline adherence," "compliance," "standard precaution," "general precaution," "nosocomial infection," "hospital acquired," and "infection control." Keywords were matched to database-specific indexing terms. The search strategy was verified by hand searches, by checking whether 3 key articles[13-15] from our personal database (which should be selected by use of the search strategy) were actually retrieved during the search. In Medline (PubMed), the "related articles" of these key papers were retrieved and added to the search database.

Selection Criteria

Studies included in the review met the following criteria: the subjects of a study were HCWs caring for patients from the general hospital population; compliance with hand hygiene guidelines was measured, either by self-reporting or observation; empirical studies were included; the samples were taken from countries with established market economies, as defined by the World Bank; and the articles were published in English.

Selection Procedure

Relevant papers were selected by screening the titles (first step), abstracts (second step), and entire articles (third step) retrieved during the database searches. During each respective step, the title, abstract, or entire article was screened to ensure that it met the selection criteria listed above. This screening was conducted independently by 2 researchers (V.E. and E.F.v.B.). Disagreement between the reviewers about eligibility was resolved through discussion.

Data Extraction and Management

Data were extracted from the studies included by the 2 researchers (V.E. and E.F.v.B) and entered into a Microsoft Access database. The findings (ie, the compliance rates and their underlying factors) and methodological details of each study (eg, design, setting, sample size, type of HCWs included in the sample, type of compliance measurement [ie, observed or self-reported], characteristics of the measurement instrument, data analysis, and country) are listed in Tables 1–4. All the characteristics of the studies that were reviewed are shown in Table 1.

Summarizing Study Findings

The compliance rates measured were grouped into intervals and listed in Tables 2 and 3. Furthermore, information on the setting (ie, ICU or general ward) and sample (ie, type of HCWs studied) is given. Specific distinctions were made between compliance rates measured by means of observation and compliance rates measured by means of self-reporting, between 3 groups of HCWs (ie, physicians, nurses, and other HCWs), and between before and after patient-contact situations. These results are also presented in graphic form in Figure 1. The underlying factors for hand hygiene performance that were found in the studies were grouped and listed separately (Table 4).

RESULTS

Selected Papers

The database search identified 3,264 titles (Medline [PubMed], 2,543 titles; PsycINFO, 13 titles; and Web of Science, 708 titles). Searching in PubMed for articles related to 3 key papers[13-15] added an additional 5,48 titles. This resulted in 2,727 unique titles of articles of potential relevance to the review. Screening of the titles and abstracts resulted in a selection of 215 articles that appeared to meet all the selection criteria. One hundred and fifteen of these articles did not meet the inclusion criteria after they had been fully read, resulting in final inclusion of 96 articles.

Included studies. Studies were included if they met the 5 selection criteria mentioned in Methods. Each step of the selection process resulted in the following: 2,727 titles screened, 667 titles included; 667 abstracts screened, 215 abstracts included; and 215 papers screened, 96 papers included.

Study Characteristics

Hospital settings and HCWs studied. In the majority of studies ($n = 65$), hand hygiene compliance was studied in the

ICU setting (Table 1). Compliance rates and their determinants have been studied less frequently in both general ($n = 32$) and surgical wards ($n = 22$). Information on compliance rates for 3 types of HCWs has been collected in the available studies (ie, for physicians, registered nurses, and other HCWs), although a number of studies do not specifically mention which HCWs were studied. The majority of studies ($n = 46$) have taken combined samples of the 3 types of HCWs.

Sample sizes and study designs. With respect to the sizes of the samples studied, a very large variation was present in both the number of HCWs included in the study (7–1,050 HCWs) and the number of observations included in the study (19–20,082 observations). The majority of studies ($n = 56$) refrained from mentioning the number of HCWs included. Most studies ($n = 76$) reported the number of observations, showing a tendency toward samples with 500–1,500 observations. Cross-sectional studies ($n = 45$) and before-after intervention studies ($n = 41$) were roughly equally represented. All compliance rates derived from before-after studies in the present review are based on data collected prior to the intervention.

Measurement of compliance rates. Compliance was measured using direct observation by a trained observer and/or self-reporting by an HCW. In all studies, compliance was defined as the percentage of opportunities for which HCWs adhered to hand hygiene guidelines; in other words, a compliance rate of 50% means that hand hygiene was performed in one-half of the opportunities for hand hygiene according to guidelines. All observational studies used some type of self-developed scoring form to directly observe hand hygiene compliance. A few studies ($n = 9$) also assessed compliance by means of self-reporting, using self-developed questionnaires. Only a minority of studies ($n = 17$) mention any form of reliability testing; all studies reporting reliability testing showed good results (Cronbach α, >0.7). Compliance was reported in different ways (ie, before patient contact, after patient contact, as an overall average of possible events, or a combination of these).

Compliance Rates

Overall compliance rates (ie, the sum of all events in which hand hygiene was performed divided by the sum of all possible hand hygiene events) measured in the studies included ranged from 4% to 100%; whenever possible, this rate was calculated per type of HCW, otherwise the results are designated as "Type of HCW unknown." Table 2 provides an overview of overall compliance rates by type of HCW. This table shows that compliance rates higher than 50% were found among 41% of samples of nurses, 20% of physicians, 47% of other HCWs, and 25% of HCWs of unreported profession.

Across all professions, 25% of studies reported overall compliance rates higher than 50%. The majority of studies used direct observation (Figure 1), providing a median overall baseline compliance rate across all settings, situations, and HCWs of 40%. With respect to the study design, 45 studies were cross-sectional, and 41 had a before-after intervention design (Table 1). The median compliance rate reported in cross-sectional studies was somewhere in the range of 30%–40%. For before-after intervention studies, the median baseline compliance rate was somewhere in the range of 40%–50%.

Sixty-five studies measured and reported observed compliance rates for the ICU, with a median compliance rate somewhere in the range of 40%–50%. Of these studies, 28% reported compliance rates higher than 50%. In comparison, the median compliance rate measured in the non-ICU wards was somewhere in the range of 50%–60%.

The studies reviewed showed lower compliance among physicians than among nurses and other HCWs; 9 studies reported compliance rates of greater than 50% (median, 32%) among physicians. In comparison, 17 studies reported compliance rates of greater than 50% (median, 48%) among nurses. The group designated "other HCWs" had an overall compliance rate of 40%–50% (Table 2).

In 35 studies, compliance rates were measured both before and after patient contact. There were large differences, with hand hygiene compliance by all HCWs before patient contact showing a median compliance rate of 21%, whereas compliance after patient contact was higher, with a median compliance rate of 47%. Fifteen studies reported compliance rates before or after patient contact by profession.[14,16-22,55-58,71,90,91] Table 3 shows that compliance rates lower than 20% before patient contact were found in 29%, 67%, 40%, and 67% of studies among nurses, physicians, other HCWs, and HCWs of unknown profession, respectively. Compliance rates lower than 20% after patient contact were not found for nurses but were found in 18%, 13%, and 14% of studies on physicians, other HCWs, and HCWs of unknown profession, respectively. Nurses showed quite similar median compliance rates before (46%) and after (53%) patient contact. Among physicians, large differences in compliance were present before and after patient contact, with a tendency toward low compliance rates before contact (median, 13%) and higher compliance after contact (median, 43%) (Figure 1).

Correlates of Noncompliance with Hand Hygiene Guidelines

Table 4 shows the studies that investigated to a greater or lesser extent which factors might be underlying compliance behavior, with the associations found. The factors studied most frequently were profession, workload, attitude, time of day, patient's risk of infection, feedback, knowledge, and the effects of different materials (eg, alcohol-based hand rub) on compliance.

The effect of profession (ie, physician or nurse) was studied most frequently ($n = 44$). Physicians are generally associated

TABLE 1. Characteristics of Studies Included in the Review

Characteristic	References	No. of samples
Setting		
Intensive care unit	[2, 15–54]	65
General ward	[15, 18, 24, 28, 43, 44, 50, 52, 55–69]	23
Surgical ward	[15, 18, 25, 28, 44, 47, 50, 52, 55, 56, 58–67, 69, 70]	22
Other	[15, 21, 28, 35, 42, 50, 52, 55, 58–61, 63–67, 69, 71–89]	37
Unknown	[14, 90–98]	10
Sample type (HCWs)		
Nursing staff only	[14, 21, 33, 38, 44, 57, 58]	7
Physicians only	[15, 60, 69, 71, 80, 87]	4
Other HCWs only	[73, 76, 92, 93]	4
Nursing staff and physicians	[20, 27, 32, 34, 68, 78, 82, 88, 98–102]	10
Nursing staff, physicians, and other HCWs	[16–19, 22–26, 2831, 36, 37, 39, 40, 42, 43, 45, 46, 48, 50–56, 59, 61–64, 66, 67, 70, 79, 81, 83, 85, 86, 89, 91, 94–97, 103–106]	46
Physicians and other HCWs	…	…
Nursing staff and other HCWs	[49, 72, 74, 75]	4
Unknown	[35, 41, 47, 65, 77, 84, 90, 107–109]	7
Sample size (HCWs)		
<20	[57, 88, 90]	3
20–40	[31, 49, 60, 74, 76, 82]	6
41–60	[19, 38, 53, 107]	4
>60	[14, 15, 17, 18, 21, 32, 42–44, 50, 52, 56, 59, 64, 67, 72, 73, 78, 80, 83, 85, 92–95, 100, 105]	27
Unknown	[16, 20, 22–30, 33–37, 39–41, 45–48, 51, 54, 55, 58, 61–63, 65, 66, 68–71, 75, 77, 79, 81, 84, 86, 87, 89, 91, 96–99, 101–104, 106, 108, 109]	56
Sample size (observations)		
<100	[38, 76, 88, 90, 99]	5
100–500	[16, 19, 30, 31, 49, 50, 54, 57, 69, 70, 71, 73, 79–82, 86, 87, 91, 93, 94, 96]	22
501–1,500	[15, 21, 22, 29, 37, 40, 42, 43, 45, 48, 51, 56, 61, 62, 68, 74, 89, 92, 95, 97, 100, 102, 104, 106, 107]	25
1,501–2,500	[17, 23, 24, 27, 39, 66, 98, 105]	8
2,501–5,000	[26, 33, 41, 46, 52, 55, 67, 75, 83, 103]	10
>5,000	[25, 28, 35, 63, 77, 101]	6
Unknown	[20, 34, 36, 44, 47, 53, 58, 60, 64, 65, 84, 85, 108, 109]	14
Not applicable (self-report)	[14, 18, 32, 59, 72, 78]	6
Study design		
Cross-sectional	[14, 15, 18–21, 29, 32, 37, 41, 43, 44, 48, 50–52, 56, 57, 59–62, 67, 69, 71, 72, 74–76, 78, 80–83, 86, 88, 90, 91, 93, 94, 96, 98, 105–107]	45
Before-after	[16, 22–24, 26–28, 30, 31, 33, 34, 36, 40, 42, 45, 47, 49, 53–55, 58, 63–66, 70, 73, 77, 79, 84, 85, 87, 89, 95, 97, 99, 100, 101, 104, 108, 109]	41
Other	[17, 25, 35, 38, 39, 46, 68, 92, 102, 103]	10
Assessment of compliance		
Observed	[15–17, 19–23, 25–30, 34–49, 51–53, 55, 57, 70, 71, 73–76, 79, 81–83, 92, 94–97]	82
Self-reported	[14, 18, 32, 59, 72, 78, 80]	7
Observed and self-reported	[21, 31, 33, 50, 54, 91, 93]	7
Reliability of instrument used		
Unknown or not reported	[14–20, 22–24, 26, 27, 29, 30, 32, 34, 36, 38, 41–45, 47, 48, 50, 51, 53, 54, 57, 70–76, 78–83, 91–97]	79
Cronbach $\alpha > 0.7$	[21, 25, 28, 31, 33, 35, 37, 39, 40, 46, 49, 52, 55, 56, 63, 101, 109]	17
Data analysis		
Univariate	[18–20, 23, 28, 31, 35–38, 40–42, 44, 45, 47–51, 53, 56–58, 67–69, 72, 74, 77, 79, 80, 82, 85, 86, 91, 93, 95, 96, 98, 100, 109]	42
Multivariate	[14, 15, 17, 21, 25, 26, 29, 32, 33, 39, 43, 46, 52, 55, 59, 60, 63, 66, 75, 78, 81, 83, 89, 92, 101, 103, 104, 106]	28
Frequencies	[16, 22, 24, 27, 30, 34, 54, 61, 62, 64, 65, 70, 71, 73, 76, 84, 87, 88, 90, 94, 97, 99, 102, 105, 107, 108]	26

TABLE 1. (*Continued*)

Characteristic	References	No. of samples
Country		
Europe	[15, 20, 24, 26–28, 31, 32, 34, 41–44, 50, 52, 56, 59, 67, 68, 70, 73–76, 80, 83, 88, 91, 95, 97, 98, 101, 104, 105, 107]	35
USA and Canada	[14, 16–19, 21–23, 25, 29, 30, 33, 35–40, 46, 48, 49, 53–55, 57, 61–64, 66, 71, 72, 77–79, 81, 82, 84, 87, 89, 90, 92–94, 96, 99, 100, 103, 106, 109]	50
Australia	[45, 47, 58, 60, 65, 85, 86, 102, 108]	9
Asia	[51, 69]	2

NOTE. The no. of samples does not always add up to 96 in those categories in which $\geqslant 1$ option is possible; for example, a study that takes place in both an intensive care unit and a surgical ward appears in both rows. HCWs, healthcare workers.

with lower compliance rates than are registered nurses (25 of 44 samples). In 17 samples, no effect of profession was found; in 2 samples, the reverse association was found. Activity level (an indicator for workload) was studied in 13 samples and was frequently associated with a lower compliance (9 of 13 studies). The effect of the time of day (daytime shifts vs evening, night, or weekend shifts) was studied in 10 articles, with 6 studies showing no effect for time of day. Patient's risk of infection, which was studied in 10 articles, was frequently associated with lower compliance (5 of 10 studies) . Feedback was often associated with higher compliance (6 of 9 studies), as was glove use (8 of 8 studies) and accessibility of materials (4 of 7 studies). However, the only factor consistently associated with higher compliance was type of task (dirty vs clean), with 5 of 5 studies showing higher compliance with dirty tasks.

Eight studies examined the effects of the introduction of alcohol-based hand rub or gel on hand hygiene compliance by HCWs, and all found a positive association with hand hygiene compliance irrespective of whether a promotional campaign was launched or not (8 of 8 studies). An alcohol-based liquid or gel solution was made available in either wall-mounted dispensers[23,103] or wall-mounted dispensers in combination with carrying individual bottles.[24-28,104] Furthermore, a number of studies also launched some form of promotional campaign together with the introduction of alcohol-based disinfectant.[23,25,26,28,103] Only 1 study looked at the effect of carrying an individual bottle[104] and found a positive significant effect on hand hygiene compliance.

Behavioral factors in relation to compliance were studied in 13 articles.[15,18,21,29,30-32,56,59,72,91-93] Ten studies analyzed some form of attitude in relation to compliance, but the results remain inconclusive, with 4 studies showing a positive effect and 6 studies showing no effect.[15,18,21,31,32,56,59,91-93] The same applies to the effects of positive role models, which were analyzed in 3 studies.[29,30,92] With respect to the theoretical framework used in these studies, 7 studies reported applying a theory from the behavioral sciences. The Theory of Planned Behavior was used in 4 studies,[14,21,56,59] the PRECEDE (Predisposing, Reinforcing, Enabling Constructs in Educational Diagnosis and Evaluation) model in 2 studies,[31,33] and 1 study applied a theory of thinking styles to their hand hygiene research.[60]

DISCUSSION

We assessed the methodological characteristics of 96 empirical studies on compliance with hand hygiene guidelines in industrialized countries. Most studies included the ICU. In general, the study methods were not very robust and often ill reported. We produced a quantitative summary of compliance rates, showing a large variation (4%–100%) with an overall median compliance rate across all settings, situations, and HCWs of 40%. Compliance rates were lower in the ICUs (with a median rate somewhere in the range of 30%–40%) than in other settings (with a median rate somewhere in the range of 50%–60%), were lower among physicians (32%) than among nurses (48%), and were lower before patient contact (21%) than after patient contact (47%). To date, we have found that type of HCW and workload have been studied most extensively as potential determinants of noncompliance. The majority of the time, the situations that were associated with a lower compliance rate were those with a high activity level and/or those in which a physician was involved. The majority of the time, the situations that were associated with a higher compliance rate were those having to do with dirty tasks, the introduction of alcohol-based hand rub or gel, performance feedback, and accessibility of materials. Of the studies investigating the behavioral determinants of hand hygiene, only 7 reported the use of a theoretical framework. Results from this field of research are still scarce and inconclusive.

On the basis of this systematic review, it can be concluded that direct observation is considered the norm when it comes to measuring compliance, because this method is applied in approximately 90% of the studies reviewed. However, it still remains unclear how valid this method is as an indicator of the extent to which the international hand hygiene guidelines are adhered to. First, there are the problems arising from the Hawthorne effect, a form of reactivity whereby people will improve an aspect of their behavior if they are aware of being observed.[34] Solutions for this phenomenon are not always

TABLE 2. Overall Baseline Compliance Rates Observed in the Studies Reviewed, by Profession

	Nurses (n = 41)		Physicians (n = 45)		Other HCWs (n = 45)		Type of HCW unknown (n = 36)	
Observed compliance rate	References	No. (%) of samples	References	No. (%) of samples	References	No. (%) of samples	References	No. (%) of samples
<20%	[83]	1 (2)	[28, 60, 67, 81, 83, 87, 102, 110]	8 (18)	[28, 48, 62, 67, 85, 96, 104]	7 (16)	[24, 67, 90, 95]	4 (11)
20%–30%	[25, 38, 44–46, 48, 67]	7 (17)	[29, 40, 48, 85, 97, 103–105]	8 (18)	[63, 85, 103]	3 (7)	[22, 24, 37, 41, 47, 54, 65, 84, 99]	9 (25)
31%–40%	[61, 62, 68, 96, 102–104]	7 (17)	[25, 27, 31, 46, 52, 53, 61, 63, 68, 79, 80, 85, 96, 103]	14 (31)	[68, 83, 85, 86, 102, 103, 106]	7 (16)	[24, 26, 35, 36, 41, 77, 81, 94]	8 (22)
41%–50%	[27, 40, 43, 53, 63, 97, 103, 105, 106]	9 (22)	[34, 45, 62, 85, 100, 106]	6 (13)	[45, 52, 85, 86, 92, 97, 105]	7 (16)	[24, 36, 39, 41, 89, 101]	6 (17)
51%–60%	[29, 31, 33, 34, 52, 79, 81, 100, 110]	9 (22)	[15, 69, 86]	3 (7)	[30, 40, 43, 46, 53, 85, 86]	8 (18)	[98, 107–109]	5 (14)
61%–70%	[30, 42]	2 (5)	[64, 86]	2 (4)	[25, 31, 42, 79, 85, 86]	6 (13)	[22, 49]	2 (6)
71%–80%	[21, 28, 85]	3 (7)	[66, 86]	2 (4)	[64, 66, 85, 86, 88]	5 (11)	[50, 51]	2 (6)
>80%	[64, 66, 86]	3 (7)	[30, 86]	2 (4)	[85, 86]	2 (4)	None	No data

NOTE. Calculated by dividing the sum of all events in which hand hygiene was performed by the sum of all possible hand hygiene events. Whenever possible, this was calculated per type of healthcare worker (HCW), otherwise the results can be found in the column labeled "Type of HCW unknown." For intervention studies, only baseline data were used.

TABLE 3. Baseline Compliance Rates before and after Patient Contact, Observed in the Studies Reviewed, by Profession

	Nurses		Physicians		Other HCWs		Type of HCW unknown	
Observed compliance rate	References	Proportion (%) of samples	References	Proportion (%) of samples	References	Proportion (%) of samples	References	Proportion (%) of samples
Before patient contact								
<20%	[16, 17]	2/7 (29)	[16, 17, 56, 91]	4/6 (67)	[16, 17]	2/5 (40)	[23, 29, 74, 75]	4/6 (67)
20%–30%	[56]	1/7 (14)	[55]	1/6 (17)	[55, 56]	2/5 (40)	[91]	1/6 (17)
31%–40%	None	No data	[22]	1/6 (17)	None	No data	[70]	1/6 (17)
41%–50%	[55, 58]	2/7 (29)	None	No data	[22]	1/5 (20)	None	No data
51%–60%	[22]	1/7 (14)	None	No data	None	No data	None	No data
61%–70%	[21]	1/7 (14)	None	No data	None	No data	None	No data
71%–80%	None	No data	None	No data	None	No data	None	No data
>80%	None	No data	None	No data	None	No data	None	No data
After patient contact								
<20%	None	No data	[19, 20]	2/12 (17)	[73]	1/8 (13)	[23]	1/7 (14)
20%–30%	[20]	1/11 (9)	[20, 91]	2/12 (17)	[16, 17, 19]	3/8 (38)	None	No data
31%–40%	[16, 17, 20]	3/11 (27)	[17, 20]	2/12 (17)	None	No data	[29, 74, 75, 91]	4/7 (57)
41%–50%	[20, 57]	2/11 (18)	[18, 20]	2/12 (17)	None	No data	[90]	1/7 (14)
51%–60%	[58]	1/11 (9)	[16, 56]	2/12 (17)	[38]	1/8 (13)	None	No data
61%–70%	[19, 56]	2/11 (18)	[55]	1/12 (8)	[55, 56]	2/8 (25)	None	No data
71%–80%	[55]	1/11 (9)	[71]	1/12 (8)	None	No data	None	No data
>80%	[21]	1/11 (9)	None	No data	[76]	1/8 (13)	[70]	1/7 (14)

NOTE. Calculated by dividing the sum of all events in which hand hygiene was performed by the sum of all possible hand hygiene events. Whenever possible, this was calculated per type of healthcare worker (HCW), otherwise the results can be found in the column labeled "Type of HCW unknown." For intervention studies, only baseline data were used.

practical, but the implications for the data collected cannot be ignored. Second, although there are international guidelines describing specific situations in which hand hygiene is required, the application of these guidelines for measuring compliance remains limited. Some studies only observed hand hygiene behavior before contact with the patient,[22,72] and some only after contact.[19,20,57,71,73,90,93] Some studies only observed hand hygiene after a specific task (ie, after disconnection or connection from a hemodialysis machine)[74,75] or only laboratory workers at the end of a shift.[76] Furthermore, many studies merely report "observing compliance," and in these cases, it is completely unclear which hand hygiene events were observed or what the reported compliance rates actually determined.

Almost all studies used a self-developed tool to measure the compliance rate, causing further problems in the comparability of studies and their results. So far, only a few studies have used previously developed and tested instruments, such as the Hand Hygiene Observation Tool (either the original tool or an adapted form of it).[21]

Apart from observation and self-reporting, there are a number of other methods that may be employed as indicators of hand hygiene compliance, such as the amount of alcohol or soap used (ie, 2 L/day),[111,112] electronic monitoring (ie, counter in alcohol dispenser),[35] or the number of hospital-acquired infections.[10] Each of these indirect measures has some advantages over direct observation by a trained observer—because some are much cheaper and easier to use—but they do not provide valid information on compliance.[113] One study made a new step in this direction, however, by monitoring the entrance and exit of people from a patient's room and linking this to electronic monitoring of the alcohol-based hand rub dispenser.[77] When someone enters without using the dispenser, this is registered as noncompliance. However, this method also has limitations, because only hand hygiene behavior when entering and exiting can be monitored, and it can only be applied to single-patient rooms.

Our systematic review has confirmed that compliance rates are universally low and that they vary quantifiably depending on situational factors. We found that median compliance rates were 16% lower among physicians than among nurses and that they were lower in ICUs than in other settings. In addition, we were the first to make a distinction in our quantifications between compliance before and compliance after patient contact. Compliance before patient contact appeared to be lower (with a median rate of <20%) than compliance after patient contact (with a median rate somewhere in the range of 30%–40%). This could indicate that factors related to the HCWs' benefit are understudied as potential determinants of compliance with hand hygiene in hospitals, as has been found in qualitative research,[7,114] and is consistent with the positive association found between dirty tasks and hand hygiene performance.

What Influences Hand Hygiene?

Many factors underlying compliance have been studied, and although the results remain far from conclusive, a number

TABLE 4. Correlates of Compliance with Hand Hygiene Guidelines in Health Care in the Studies Included in the Review

Correlate	References	Total no. of samples	No. of samples with		
			Positive association	Negative association	No association
Profession (MD vs RN)	[18, 19, 22, 25, 26, 28–30, 37, 40, 42, 43, 45, 46, 48, 52, 55, 56, 61, 62, 64, 66, 67, 71, 72, 79, 81, 83, 85, 86, 88, 89, 91, 94–96, 98, 100, 102–106, 110]	44	2	25	17
Activity level	[15, 21, 26, 28, 44, 46, 52, 75, 81, 83, 94, 103, 104]	13	1	9	3
Attitude	[15, 18, 21, 31, 32, 56, 59, 91–93]	10	4	0	6
Time of day (day vs night)	[40, 52, 62, 66, 70, 77, 81, 94, 96, 104]	10	3	1	6
Patient's risk	[15, 26, 28, 37, 42, 56, 57, 59, 81, 96]	10	4	5	1
Feedback	[23, 33, 36, 49, 64, 70, 85, 97, 101]	9	6	0	3
Alcohol	[24–28, 39, 103, 104]	8	8	0	0
Glove use	[29, 43, 48, 58, 92, 96]	6	4	1	1
Knowledge	[31, 32, 44, 75, 93]	5	2	1	2
Accessibility of materials	[15, 45, 58, 68, 89, 100, 104]	7	4	1	2
Sex of HCWs (male vs female)	[32, 59, 71, 86, 92]	5	0	4	1
Experience of HCWs	[59, 80, 92, 95, 110]	5	0	2	3
Type of task (dirty vs clean)	[29, 46, 57, 102, 110]	5	5	0	0
No. of sinks	[19, 29, 61]	3	1	0	2
Positive role model	[29, 30, 92]	3	2	0	1

NOTE. HCWs, healthcare workers; MD, physician; RN, registered nurse.

of factors appear to play a role in affecting compliance. Studied most often by far are the differences in compliance rates between physicians and nurses. Physicians are associated with lower compliance rates, both in general and in the specific situations before patient contact. Furthermore, a higher activity level correlates with lower compliance, which could at least partly explain the lower compliance rate measured in ICUs, compared with other settings. The only factors consistently associated with higher compliance is type of task (dirty vs clean) and the introduction of an alcohol-based hand rub or gel. This last factor always led to higher compliance (in comparison with when only hand washing was possible) in the studies reviewed here. It remains somewhat unclear, however, whether it is the product itself, the often-improved availability of the product and its method of distribution (ie, individual bottles or wall-mounted dispensers), or the promotional aspects involved that trigger better hand hygiene compliance, although it would appear that the use of individual bottles does have an effect on hand hygiene compliance. This is not unexpected, because these bottles could improve self-efficacy, which was previously shown to influence hand hygiene compliance.[21] Other factors associated with higher compliance are the use of performance feedback and improved accessibility of materials. These 2 factors could be used in interventions to improve compliance. It has also been shown that glove use is a predictor of compliance with hand hygiene guidelines.[92]

So far, only a limited number of studies have focused on behavioral factors, and although some have identified some aspects influencing this behavior, the effects remain unclear and understudied. The theoretical models used so far have not been able to predict hand hygiene behavior very successfully, and these models will have to be adapted to better explain the complexities of this behavior. This can be supported by qualitative research, providing some initial insight into the factors influencing this behavior, which can later be investigated quantitatively. Few studies have as yet adopted this approach, but of late qualitative studies are appearing in the literature.[114-116] Qualitative studies have, for example,

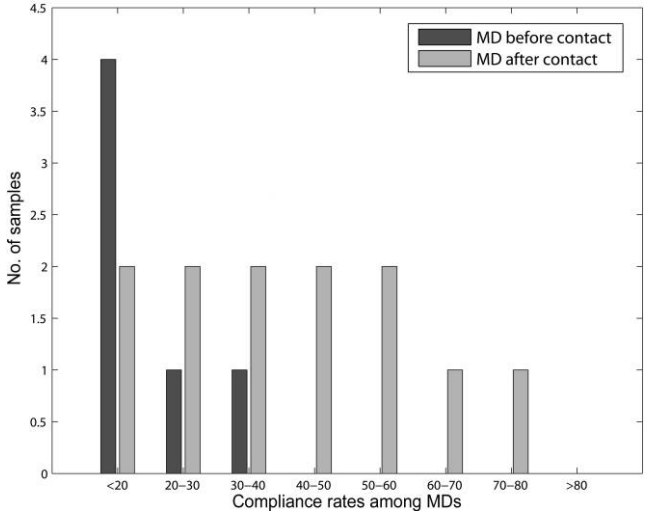

FIGURE 1. Observed baseline compliance rates among physicians (MDs) before and after patient contact.

shown the importance of positive role models, particularly for nursing and medical students,[114,115] a factor only studied by 3 quantitative studies so far.

Our review has some limitations, particularly due to the lack of homogeneity among the studies included. We were not able to perform any type of meta-analysis because of the large methodological differences. The studies included in our review were of varying methodological quality, with some studies reporting neither their sample type, size, or any form of reliability testing. Furthermore, a great deal of the studies failed to report on the type of instrument used for obtaining the data or on how observers were trained. This makes comparison and interpretation of the results difficult, not only in this review but in general for researchers interested in hand hygiene studies.

How to Proceed?

From this review, it has become clear that, although there is a great deal of research available on the topic of hand hygiene compliance, few firm conclusions can yet be drawn. To facilitate comparison and learning in the future, there is a great need for a standardized measuring instrument and standardized reporting. More recently, the World Health Organization has taken steps to enable more standardized guidelines and measurement, and the effects of these efforts will hopefully become visible in future studies. Many more recent studies have adopted stronger designs (ie, larger samples sizes, better controlled conditions, and use of behavioral theories) than did older studies, and it would appear that research in hand hygiene compliance has matured. However, much remains unclear, and that which is clear is not always easy to implement in practice. To develop successful interventions, more research into the behavioral determinants is needed[13,15] (in particular, how these determinants can be applied to improve hand hygiene). Process indicators are of paramount importance here, as in any intervention, and a systematic understanding of why some interventions succeed and others fail is needed. This information could then be applied to those situations identified by this review as being at high risk for noncompliance (eg, before patient contact), leading to improved patient safety.

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