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HAND HYGIENE COMPLIANCE IN THE INTENSIVE CARE UNIT: A SYSTEMATIC REVIEW

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ABSTRACT

Objectives: To synthesize the literature describing compliance with WHO hand hygiene (HH) guidelines in Intensive Care Units (ICUs), to evaluate the quality of extant research, and to examine differences in compliance rates across geographical regions, ICU types, and healthcare worker groups, observation methods, and Moments (indications) of HH.

Data sources: Electronic searches were conducted in August 2018 using Medline, CINAHL, PsycInfo, Embase, and Web of Science. Reference lists of included studies and related review articles were also screened.

Study selection: English-language, peer-reviewed studies measuring HH compliance by healthcare workers in an ICU setting using direct observation guided by the WHO's 'Five Moments of Hand Hygiene', published since 2009, were included.

Data extraction: Information was extracted on study location, research design, type of ICU, healthcare workers, measurement procedures, and compliance rates.

Data synthesis: Sixty-one studies were included. Most were conducted in high-income countries (60.7%) and in adult ICUs (85.2%). Mean HH compliance was 59.6%. Compliance rates appeared to differ by geographic region (high-income countries 64.5%, low-income countries 9.1%), type of ICU (neonatal 67.0%, pediatric 41.2%, adult 58.2%), and type of healthcare worker (nursing staff 43.4%, physicians 32.6%, other staff 53.8%).

Conclusions: Mean HH compliance appears notably lower than international targets. The data collated may offer useful benchmarks for those evaluating, and seeking to improve, hand hygiene compliance in ICUs internationally.

Key words: critical care; hand disinfection; hand hygiene; intensive care; systematic review

INTRODUCTION

Healthcare-associated infections (HAIs) affect 4% of patients worldwide and account for almost 100,000 deaths annually in the USA(1, 2). Improvement in hand hygiene (HH) practices has been highlighted as the most effective safeguard against HAIs(3), and the World Health Organization's (WHO) Five Moments of Hand Hygiene have been widely adopted(4, 5). However, poor HH compliance remains a concern and research priority internationally(6).

HH is of particular concern in the Intensive Care Unit (ICU), where immuno-compromised patients are particularly vulnerable to infection. HAI prevalence rates of between 20% and 30% have been reported in ICU settings(7). A variety of interventions have been trialed to improve HH in ICU settings(6); however, the level of baseline HH compliance in ICUs internationally is unknown. This is important information for local assessors of HH compliance at hospital and national level, in order to contextualize local compliance and determine appropriate benchmarks and targets.

A review of the literature (prior to 2009) on HH compliance rates found median compliance rates of 40-50% in ICUs and 50-60% in non-ICU settings(8). However, the reviewed studies predate the WHO guidelines and do not reflect current practice and conditions.

Therefore, the primary aim of this systematic review was to identify studies that have measured HH compliance rates in ICU settings in accordance with the WHO guidelines, and to derive an estimate of HH compliance from these studies. The secondary aim of the review was to investigate whether HH compliance rates differ by region, ICU type, healthcare worker group, method of observation (i.e., covert, not covert), and individual moment (indication) of HH.

METHOD

This review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Guidelines(9). The review protocol was registered with PROSPERO (ref. CRD42018095336).

Study identification

Five databases were searched in August 2018: Medline, CINAHL, PsycInfo, Embase, and Web of Science. The search strategy included MEDical Subject Headings (MESH) search terms and keywords. Search terms were selected for three domains: hand hygiene (e.g., “hand cleansing”), hospital settings (e.g., “critical care”), and compliance (e.g., “rates”). The Medline search strategy is shown in the Supplemental Digital Content 1. This search was modified as necessary for other databases. These electronic searches were also supplemented by screening the reference lists of all studies identified for inclusion and those of 11 related review articles (10-19).

Study selection

Inclusion criteria required that a study: 1) be published in a peer-reviewed journal, in English, and after 2009; 2) reported HH compliance among HCWs in an ICU, either in the absence of any intervention or before the implementation of an intervention (i.e., at baseline); and 3) measured HH compliance by means of direct observation of at least one of the five WHO HH Moments.

Studies were excluded for a number of reasons. First, studies that examined compliance in both ICUs and other areas of the hospital were only considered for inclusion where data on compliance in ICUs could be extracted. Next, studies that examined compliance among both HCWs and other populations (e.g., patients, visitors) were only considered for inclusion where data on compliance among HCWs could be extracted. Further, studies using self-report measures, proxy measures (e.g., hand rub consumption), or observation using other indicators for HH (e.g., entry-exit, indicators from the Centre for Disease Control (CDC) guidelines) were excluded. Finally, data were extracted only where it was possible to determine the corresponding total number of observed HH opportunities. Therefore, studies that reported percentage compliance only were not included.

Titles and abstracts of articles returned during the search were screened using the inclusion criteria. The full texts of articles appearing to meet the inclusion criteria, or for which information in the title and abstract was insufficient to determine whether the study met inclusion criteria, were obtained for review. Ambiguities regarding inclusion or exclusion of these studies were resolved through discussion between authors until consensus was achieved.

Data extraction

Two authors extracted data independently and resolved any discrepancies through discussion. Information was extracted on the following variables using a structured form: location (country; region and income group per World Bank classification (20), research design (intervention, observational), ICU type, participant group, sample size, observation method (covert, not covert; i.e., whether HCWs were aware of the observation), assessment of inter-rater reliability, training of observers, Moments observed (Moment 1, before patient

contact; Moment 2, before aseptic procedures; Moment 3, after body fluid exposure/risk; Moment 4, after patient contact; Moment 5, after contact with patient's surroundings), number of opportunities observed for each Moment and for all observed Moments pooled, and percentage compliance for each Moment and for all observed Moments pooled.

Quality assessment

Risk of bias was assessed by two authors, using the Quality Assessment Tool for Studies of Diverse Designs (QATSDD) (21). Disagreements were resolved through discussion until consensus was achieved. The tool comprises 16 indicators assessing the quality of reporting and the appropriateness of data collection methods and analysis. Each indicator is scored on a 4-point scale, with higher scores indicative of better methodological quality. Two items relating only to qualitative studies were removed. Total scores could therefore range from 0 to 42. The tool has been shown to be reliable and valid(21) and has been used in other reviews relating to health services research and patient safety(22-25).

RESULTS

More than 5,480 articles were screened, of which 61 studies met the inclusion criteria (Figure 1). Table 1 presents a summary of the included studies (for more detail, see Supplemental Digital Content 2).

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses diagram.

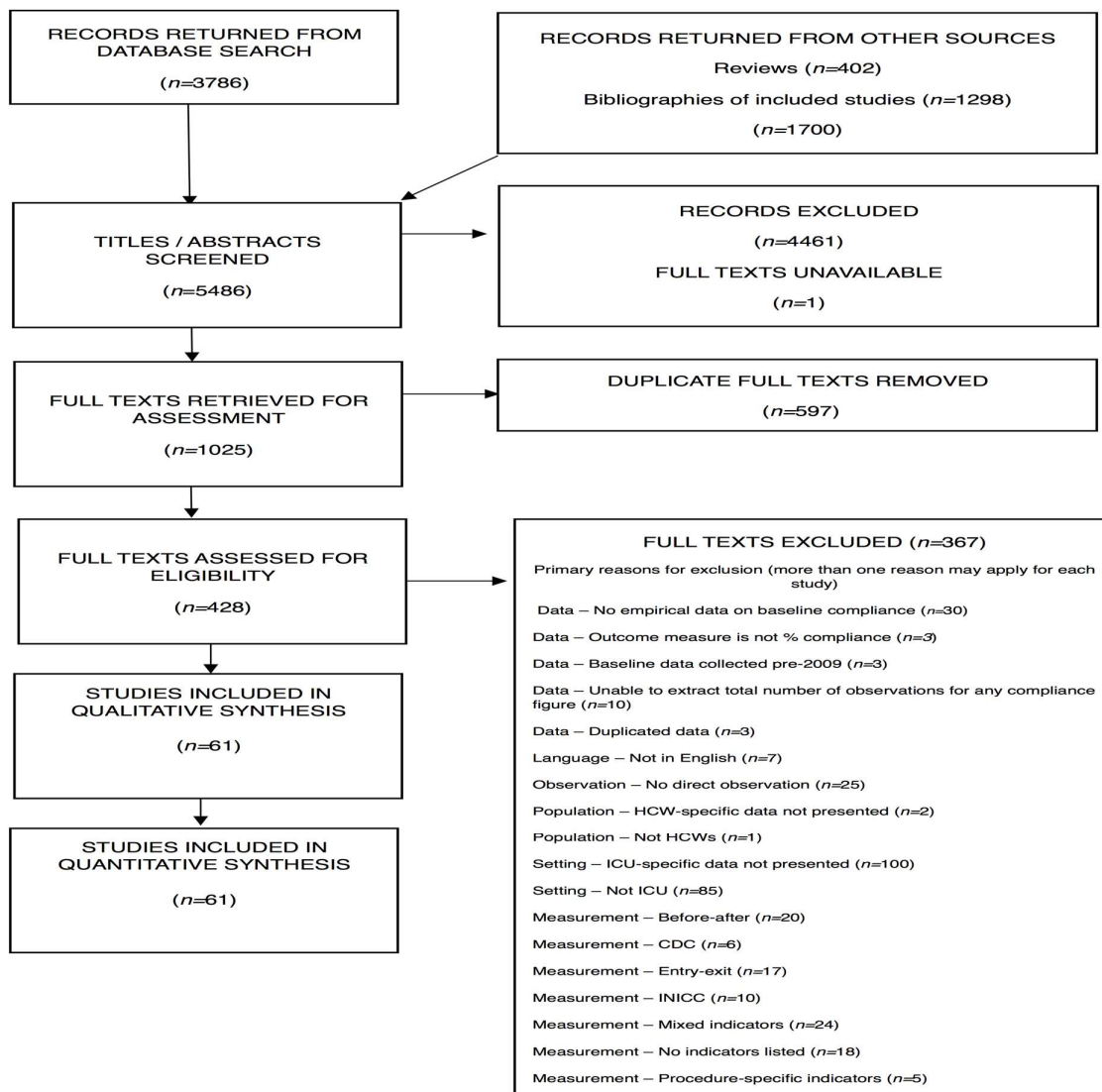


Table 1. Characteristics of 61 included studies assessing HH compliance in ICU

Study location*	Europe & Central Asia	Middle East & North Africa	East Asia & Pacific	Latin America & Caribbean	North America	South Asia	Sub-Saharan Africa
No. studies (%)	22 (36.1%)	11 (18.0%)	11 (18.0%)	7 (11.5%)	5 (8.2%)	5 (8.2%)	3 (4.9%)
Study location income*	High income	Upper middle income	Lower middle income	Low income	Missing (continent only specified)		
No. studies (%)	38 (62.3%)	12 (19.7%)	9 (14.8%)	3 (4.9%)	1 (1.6%)		
Participants	All HCWs or multiple HCW groups	Doctors and nurses only	Nurses only	Nursing staff only	Unspecified HCW group		
No. studies (%)	25 (41.0%)	10 (16.4%)	4 (6.6%)	2 (3.3%)	20 (32.8%)		
ICU Type (Adult)	<i>All Adult</i>	General / unspecified ICU	Medical ICU	Surgical ICU	Medical-surgical ICU	Cardiac-related ICU	Other ICU**
No. studies (%)	52 (85.2%)	30 (49.2%)	7 (11.5%)	10 (16.4%)	6 (9.8%)	4 (6.6%)	10 (16.4%)
ICU Type (Non-adult)	<i>All Pediatric</i>	Pediatric ICU	Pediatric surgical ICU	<i>All Neonatal</i>	Neonatal ICU	Neonatal surgical ICU	
No. studies (%)	10 (16.4%)	10 (16.4%)	1 (1.6%)	12 (19.7%)	12 (19.7%)	1 (1.6%)	
Study design	Intervention	Observation	Observation method	Covert	Not covert	Not reported	
No. studies (%)	25 (41.0%)	36 (59.0%)	No. studies (%)	12 (19.7%)	36 (59.0%)	16 (26.2%)	
WHO Moments Observed	All Moments	All Moments with Moments 4 and 5 combined	Moments 1, 4, and 5	Moment 1 only (before patient contact)	Moment 2 only (before aseptic task)	Moments 1 and 5	
No. studies (%)	52 (85.2%)	3 (4.9%)	2 (3.3%)	2 (3.3%)	1 (1.6%)	1 (1.6%)	

*Note: Figures do not total to 61 because some studies fit within more than one of the categories (e.g., were conducted in both adult and pediatric settings).

**Note: Cardiac-related: Coronary / cardiac care ICU; Cardiovascular and thoracic ICU; Cardio-surgical ICU. Other: Gastroenterology ICU; Liver ICU; Neurosurgery ICU; Neurologic ICU; Respiratory care ICU; Trauma ICU; Intensive therapy unit; Anesthesiological-surgical ICU; Burn unit; Kidney center; Internal ICU; Critical care unit; Anesthesiological and reanimation ICU.

Location

Studies were most frequently conducted in Europe and Central Asia, followed by the Middle East and North Africa (see Table 1). The majority of studies were conducted in high-income countries.

Settings and participants

A majority of studies took place in adult ICU settings. A total of 80% of studies did not report sample size. Across the remaining studies, the mean number of participants was 149 (SD=202.0). Over 70% of studies included multiple HCW groups or all ICU HCWs (see Table 1).

Design and observation method

The majority of included studies were observational. Observation of HH compliance was generally not covert. More than 90% of studies measured all five WHO Moments (see Table 1).

Compliance rates

Table 2 presents rates of HH compliance in ICU, stratified by study location income classification, ICU type, HCW group, study design, and observation method. The median number of opportunities observed per study was 903 (mean = 3,026). Overall compliance rates ranged from 1.4% to 100% and weighted mean compliance rate was 59.6% ($n=184,597$ opportunities). Thirteen studies provided data on compliance for individual Moments. Of

these, compliance was most frequently reported for Moment 1 and was highest for Moment 4 (see Table 2)

As can be seen in Table 2, there were notable differences in compliance between high- and low-income countries. Further, compliance was highest for non-nursing and non-physician HCWs and highest in neonatal ICU settings. Compliance appeared similar when measured using covert and non-covert means.

Table 2. Rates of compliance with HH

Variables	No. studies	No. opportunities	Weighted mean % compliance	Weighted SD	Range
WHO Moments					
All observed Moments	61	184597	59.6	15.88	1.4-100.0
Moment 1 (before patient contact)	14	6521	33.5	15.81	16.0-82.0
Moment 2 (before clean/aseptic task)	13	2633	29.4	13.08	1.4-67.0
Moment 3 (after fluid exposure/risk)	12	2447	42.5	19.13	8.4-82.0
Moment 4 (after patient contact)	11	4478	52.7	18.59	29.2-86.4
Moment 5 (after contact with patient's surroundings)	9	4175	45.2	17.7	2.3-80.2
Observation method					
Covert	12	14378	57.9	14.63	23.8-78.0
Not covert	36	115266	58.3	17.2	1.4-100.0
Study location income					
High income	37	124016	64.7	14.13	1.4-100.0
Upper middle income	12	14062	43.0	18.01	6.7-70.7
Lower middle income	8	11005	42.5	19.97	11.7-78.0
Low income	2	285	9.1	11.08	2.4-27.3
Participants					
Nurses and nursing staff	21	20786	43.4	13.64	1.4-74.6
Physicians	16	5760	32.6	10.84	0.0-56.0
Other staff	5	1178	53.8	23.47	35.4-86.9
ICU type					
Adult	49	145912	58.2	16.04	1.4-100.0
Pediatric	6	2843	41.2	19.53	11.7-64.0
Neonatal	10	5461	67.0	16.67	27.3-88.0

Note: Figures may differ from those presented in Table 1 because not all studies present data for each subgroup (e.g., a study may be conducted in multiple named ICU types but present only a pooled compliance rate).

Quality of included studies

The mean QATSDD score was 18.2 ($SD=3.63$). Studies generally performed well on items relating to the fit between the research question and methods of data collection and analysis, and the description of data collection procedures and research settings. Studies performed poorly on items relating to theoretical framework, consideration of sample size, and statistical assessment of the reliability and validity of measurement tools.

DISCUSSION

The primary aim of this review was to derive an estimate of mean HH compliance in ICU settings. Based on the 61 studies included, we estimated mean compliance to be 59.6%. The data collated also reveal that HH compliance rates appear to differ by region, ICU type, HCW group and individual Moment (indication) of HH.

Determining appropriate targets for minimum acceptable HH compliance is an important challenge. Mathematical models have been used to examine the potential impact of improved HH on infection rates. One model (26) indicated that relationship between HH compliance and prevalence of infection is asymptotic, not linear, and is subject to the law of diminishing returns: “The greatest benefits are derived from the first tranche of compliance, with higher levels (>50%) of hand hygiene yielding only marginal benefits”(26). While there is no universally agreed minimum acceptable level of compliance, a number of countries use 80% or 90% as a baseline target, including Australia, Canada, Ireland, and New Zealand(27-30), and the WHO recommends that HH role models have compliance of at least 80%(31). However, the evidence for why a minimum of 80% is desirable would appear to be lacking.

Given that the mean compliance rate in the papers included in this review is considerably less than 80%, it is suggested that there is a need to examine the rationale behind any HH compliance targets, and identify evidence-based interventions to improve HH compliance - something that is also lacking(6). The findings presented here allow assessors of hand hygiene at hospital and national levels to compare local findings to meaningful reference groups (e.g., to other countries in the same income class).

Greater compliance rates were reported in studies from high-income countries, where the majority of the included studies were completed. The two included studies presenting data from low-income countries reported comparatively low compliance rates (2.4%(32) and 27.3%(33)). Poor hand hygiene resourcing and infrastructure in low-income countries was identified as a potential contributor to these low rates (32, 33). While further research focused on these lower-income countries is necessary, this initial synthesis suggests a need for research and initiatives focused on how best to improve HH in these regions, and within the resource constraints in healthcare systems in these countries.

Compliance was highest in neonatal ICU settings, and lowest in pediatric ICU settings. The reasons for the distinctly different compliance rates between pediatric and neonatal ICUs are unclear. It is possible that the infection risk is more salient for staff in neonatal ICUs; newborns in ICU are at increased risk due to underdeveloped immune systems, lack of vaccination, and the close quarters typical in neonatal ICUs(34, 35). However, these risk factors are arguably present for patients in pediatric ICUs. The findings highlight the importance of specific studies of HH practice in non-adult ICU settings and the engagement with staff surrounding barriers and facilitators to HH compliance that may be unique to their setting or context.

Across ICU staff, physicians had the lowest rate of compliance-reflecting the findings of previous research(8). “Other” staff members (non-physician and non-nursing staff) had the

highest rate of compliance. This is an important finding, as it will help those responsible for local and national interventions to more effectively target their efforts and resources.

Interventions to specifically improve compliance among physicians may be of particular value, given their relatively poor performance and the lack of attention this group has received; a previous review of HH interventions(6) found only one study targeting physicians only(36).

Interestingly, similar rates of compliance were reported in studies using covert and non-covert methods of observation. This is surprising, considering the existing literature on the Hawthorne effect(37), whereby research participants behave differently when they know they are being observed; this effect has been observed in some HH studies. In light of this finding that similar results are obtained across the two methods, researchers and auditors may be encouraged to favor non-covert means of observation, which are less difficult and resource-intensive to implement.

Compliance was not uniform for all five WHO Moments; highest compliance was associated with Moment 4 and lowest compliance with Moment 2. Lower compliance rates were associated with Moments 1 and 2 than with Moments 3, 4 and 5. This may reflect a distinction between HH indications intended to protect the patient (i.e., Moments 1 and 2) and those to protect the HCW (i.e., Moments 3, 4, and 5), an issue that has been highlighted in a number of the included studies (39, 40). Previous research has suggested a superior knowledge or awareness of self-protective HH actions among HCWs, or stronger motivation to engage in these actions (41). In order to examine this issue, it is recommended that HH compliance studies evaluate and present data on compliance with each of the five Moments; this should also be a priority for hospital audits at local level.

Limitations

This review had a number of limitations. First, only articles published in peer-reviewed journals in English were considered; therefore, relevant studies in the grey literature or other languages may have been missed. Second, only studies that used the WHO Five Moments for Hand Hygiene were included. The WHO guidelines are the most widely used and influential guidelines on hand hygiene compliance (5). This inclusion criterion was applied to ensure comparability across studies, but led to the exclusion of studies of compliance in ICU that used other measures (see Figure 1). Third, we assessed the quality of studies using the QATSDD tool (21). The tool has been assessed by its authors for reliability and validity (21) and was used by two authors for each study in this review. However, the evaluation is subjective and concerns have been raised about the tool's structure, particularly around the equal weighting of all items for all studies (42). Fourth, the analysis presented here is descriptive only as this was considered most appropriate; we have described trends in the data but cannot comment on whether these are statistically significant. Figures should therefore be interpreted with caution, particularly in cases where relatively small numbers of observations were reported.

Future research

The quality of studies, as assessed using the QATSDD tool, was mixed. Studies performed well on items relating to the fit between the research question and methods of data collection and analysis; however, this is to be expected, as these studies were specifically selected for their use of the WHO guidelines for direct observation of hand hygiene, regarded as the 'gold standard' method for data collection (15).

Most of the studies presented in this review (77%) failed to establish the reliability and validity of data collection processes and most (70%) did not clarify training procedures for auditors. This is an important issue for future studies to address; in the absence of reliable and valid data, we cannot know the levels of HH compliance, determine the effectiveness of interventions, or make comparisons between settings, HCW groups or regions (43). Relatedly, more detailed data collection and reporting (i.e., compliance rates stratified by HCW group, individual Moment, etc.) in future studies will allow researchers and policymakers to identify particular HCW groups, and particular hand hygiene behaviors, for which targeted intervention is required. Our review has identified compliance rates in the published literature, and collated compliance rates for each of the five Moments of HH. Our data does not examine the reasons for the rates, nor does it allow the identification of clear strategies for improvement. This data allows for international comparisons of HH compliance rates and provides a benchmark in order to evaluate the impact of HH interventions, which will help to identify where resources or further research is required to improve HH compliance.

Conclusions

Despite the adoption of the WHO's HH guidelines worldwide, HH compliance remains suboptimal, particularly in low-income countries and among physicians. The data presented in this review may be used to provide an indication of ICU HH compliance rates reported in the published literature. It is hoped that this data will help contextualize ICU HH compliance rates when ICU are considering their own levels of compliance.

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Supplemental Digital Content 1

Search Strategy for Medline (Ovid)

- 1: exp Hand Hygiene/
- 2: Handwashing.ti,ab.
- 3: (Hand adj2 Cleansing).ti,ab.
- 4: (Hand adj2 Cleaning).ti,ab.
- 5: (Hand adj2 Decontamination).ti,ab.
- 6: (Hand adj2 Gel).ti,ab.
- 7: (Hand adj2 Saniti*).ti,ab.
- 8: (Hand adj2 Rub).ti,ab.
- 9: 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
- 10: exp Personnel, hospital/
- 11: exp Hospitals/
- 12: exp Critical care/
- 13: Health*.ti,ab.
- 14: Medic*.ti,ab.
- 15: 10 or 11 or 12 or 13 or 14
- 16: Compliance.ti,ab.
- 17: Adherence.ti,ab.
- 18: Rates.ti,ab.
- 19: Audit.ti,ab.
- 20: Observ*.ti,ab.
- 21: Opportunit*.ti,ab.
- 22: 16 or 17 or 18 or 19 or 20 or 21
- 23: 9 and 15 and 22
- 24: limit 23 to (english language and humans and yr="2009 -Current" and (adaptive clinical trial or classical article or clinical study or clinical trial, all or comparative study or controlled clinical trial or "corrected and republished article" or duplicate publication or equivalence trial or evaluation studies or historical article or journal article or observational study or randomized controlled trial or validation studies))

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