

Appropriate Number of Observations For Determining Hand Hygiene Compliance Among Healthcare Workers

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Short report

Keywords: Hand hygiene, Monitor, Healthcare worker, Compliance, Observation

Posted Date: June 30th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-659400/v1>

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Version of Record: A version of this preprint was published at Antimicrobial Resistance and Infection Control on December 1st, 2021. See the published version at <https://doi.org/10.1186/s13756-021-01035-1>.

1 **Appropriate number of observations for determining hand hygiene compliance among**
2 **healthcare workers**

3 **Running title:** Minimum hand hygiene observations needed

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25 **Abstract**

26 We sought to determine the minimum number of observations needed to determine hand
27 hygiene (HH) compliance among healthcare workers. The study was conducted at a referral
28 hospital in South Korea. We retrospectively analyzed the result of HH monitoring from
29 January to December 2018. HH compliance was calculated by dividing the number of
30 observed HH actions by the total number of opportunities. Optimal HH compliance rates
31 were calculated based on adherence to the six-step technique recommended by the World
32 Health Organization. The minimum number of required observations (n) was calculated by
33 the following equation using overall mean value (ρ), absolute precision (d), and confidence
34 interval (CI) ($1-\alpha$) [The equation: $n \geq Z_{\alpha/2}^2 \times \rho \times (1 - \rho)/d^2$]. We considered d s of 5%,
35 10%, 20%, and 30%, with CIs of 99%, 95%, and 90%. During the study period, 8,791 HH
36 opportunities among 1,168 healthcare workers were monitored. Mean HH compliance and
37 optimal HH compliance rates were 80.3% and 59.7%, respectively. The minimum number of
38 observations required to determine HH compliance rates ranged from 2 (d : 30%, CI: 90%) to
39 624 (d : 5%, CI: 99%), and that for optimal HH compliance ranged from 5 (d : 30%, CI: 90%)
40 to 642 (d : 5%, CI: 99%). We found that at least five observations were needed to determine
41 optimal HH compliance with 30% absolute precision and a 90% CI.

42 **Keywords:** Hand hygiene, Monitor, Healthcare worker, Compliance, Observation

43

44 **Background**

45 Hand hygiene (HH) is known to be one of the most basic and effective strategies for
46 preventing healthcare-associated infections [1]. HH can prevent the spread of pathogens
47 between healthcare workers (HCWs) and patients, between HCWs themselves, and between
48 the environment and HCWs. Medical institutions can determine the levels and quality of HH
49 among their HCWs through HH monitoring. The HH compliance rate serves as an indicator
50 of healthcare-associated infection rates and can be used to develop strategies for HH
51 promotion and to determine the most appropriate intervention activities, such as education
52 and training [2].

53 To perform a meaningful before-and-after comparison regarding the improvement effects
54 of HH interventions, the World Health Organization (WHO) manual for HH observation
55 recommends observing a minimum of 200 opportunities for HH in each department or ward
56 during each measurement period [3]. This ensures that the number of observations is
57 sufficient to draw valid conclusions within groups. However, it should be noted that 200 is
58 not an exact or required number for actual observations. It is also difficult to know the
59 appropriate number of HH observations for each individual. This study aimed to determine,
60 based on actual results of HH monitoring, the number of observations needed to estimate HH
61 compliance.

62

63 **Methods and materials**

64 This study was conducted in Soonchunhyang University Seoul Hospital, a 734-bed acute-care
65 referral hospital in South Korea. It was approved by the Institutional Review Board (approval
66 number: 2019-01-008). Since 2010, we have maintained an HH monitoring team at the
67 hospital, comprising 24 members across various departments; the infection control team
68 comprises five members. Every quarter, approximately 3,000 HH opportunities are monitored

69 by the infection control and HH monitoring team members. We follow standard HH
70 monitoring methods by directly observing HH per WHO guidelines [1]. From January to
71 December 2018, we collected data regarding the HH compliance rates of doctors, nurses, and
72 other HCWs (medical technical assistants, dieticians, physiotherapists, and radiological
73 technologists).

74 The HH compliance rate was calculated by dividing the number of observed HH actions by
75 the total number of opportunities. Opportunities were defined based on the WHO's "5
76 moments for HH" (before touching a patient, after touching a patient, before clean/aseptic
77 procedures, after body fluid exposure/risk, and after touching patients' surroundings).
78 Meanwhile, rates of compliance with optimal HH techniques were calculated based on
79 adherence to the six-step technique recommended by the WHO on each opportunity (rub
80 hands palm to palm, right palm over left dorsum with interlaced fingers, and vice versa; palm
81 to palm with fingers interlaced; backs of fingers to opposing palms with fingers interlocked;
82 rotational rubbing of left thumb clasped in the right palm, and vice versa; and rotational
83 rubbing, backward and forwards, with clasped fingers of the right hand in left palm, and vice
84 versa) [1,4].

85 The HH compliance/optimal HH compliance values were calculated for each observed
86 person and the data were expressed as mean, median, and interquartile range (IQR)
87 measurements. We used the generalized estimating equation model for logistic regression
88 using an unstructured working correlation matrix to compare HH compliance or optimal HH
89 compliance rates in different job categories (doctors, nurses, and other HCWs) and year
90 quarters.

91 To calculate the sample size for estimating the population's HH compliance and optimal
92 HH compliance, the following conditions were considered: (1) the variability in the target
93 population; (2) the desired precision in the estimate; and (3) the desired confidence in the

94 estimate. In this study, the following equation was applied: $n \geq Z_{\alpha/2}^2 \times \rho \times (1 - \rho) / d^2$,
95 where ρ represents the overall mean value, d the absolute precision, and $1-\alpha$ the confidence
96 interval (CI).^{5,6} This sample size can be interpreted as the minimum sample size required to
97 get the sample proportion to fall within $100d\%$ of the true proportion with $100(1-\alpha)\%$
98 probability. We considered d s of 5%, 10%, 20%, and 30%, with CIs of 99%, 95%, and 90%,
99 respectively. Among the various cases, we focused on 10% for d and 95% for CI.

100

101 **Results**

102 During the study period, 8,791 HH opportunities among 1,137 HCWs (574 nurses, 321
103 doctors, and 242 others) were monitored. Mean rates of compliance for HH and optimal HH
104 were 80.3% and 59.7%, respectively (Table 1). Throughout the study period (one year), the
105 median number of observations per HCW was five (IQR: 2–10, range: 1–74 observations).

106 The minimum number of observations required to determine HH compliance rates ranged
107 from two (d : 30%, CI: 90%) to 624 (d : 5%, CI: 99%), and that for optimal HH compliance
108 ranged from five (d : 30%, CI: 90%) to 642 (d : 5%, CI: 99%). At 10% absolute precision with
109 95% confidence, the minimum number of observations to determine HH and optimal HH
110 compliance were 61 and 92, respectively.

111 In terms of job category, sample means of (optimal) HH compliance for nurses and doctors
112 were 90.9% (78.6%) and 62.2% (27.6%), respectively. If we used those values, using a d of
113 10% and applying 99%, 95%, and 90% CIs, respectively, the minimum number of
114 observations required to determine HH compliance was 55, 32, and 22 for nurses, 156, 90,
115 and 64 for doctors, and 103, 60, and 42 for other HCWs. Meanwhile, regarding optimal HH,
116 the minimum number of observations was 112, 65, and 46 for nurses, 133, 77, and 54 for
117 doctors, and 159, 92, and 65 for other HCWs, respectively (Figure 1, Supplemental Table 1).

118

119 **Discussion**

120 Through observing HH at a large medical institution over year, this research determined the
121 minimum number of HH observations required to appropriately monitor HH compliance.
122 Although, the required number of observations changed depending on the settings for d and
123 CI. For a d of 10% and a CI of 95%, the minimum number of observations to estimate the
124 overall mean of HH compliance and optimal HH compliance were 61 and 92, respectively. To
125 our knowledge, this study is the first to provide data verifying the appropriate number of
126 observations for determining HH compliance.

127 HH compliance rates reported in previous literature have been based on analysis of
128 compliance rates in terms of job category without any lower limit on the number of
129 observations per person [2,4,7]. Typically, the observation numbers in these studies were only
130 two to four per medical personnel approximately [4,7]. Similarly, in the present study, the
131 number of observations among each medical personnel ranged from one to hundreds.
132 However, our study shows that optimal HH compliance requires at least five observations per
133 person, and up to 624 are required for elaborate calculations. In the case of medical staff for
134 which there are few opportunities to observe HH, a higher number of observations may be
135 necessary to ensure accurate evaluation; alternatively, a method other than direct observation
136 could be used for monitoring [8]. Moreover, we suggest that each medical institution should
137 determine the minimum number of observations to be applied using statistics, and the criteria
138 may be individualized for each job category and compliance rate. According to the study, at
139 least five observations were needed to determine optimal HH compliance.

140 There was a limitation to this study. This research was conducted in a single acute-care
141 hospital using direct observation methods. The appropriate number of observations for
142 determining HH compliance rate could differ depending on the characteristics of the setting
143 (i.e., the institution) and the methodology applied (i.e., the observation method), among other

144 factors.

145 Minimum number of observations to determine HH compliance varies widely according to
146 setting. We found that at least five observations were needed to determine optimal HH
147 compliance. The findings are expected to be useful for HH observers and future HH-related
148 studies, as they provide criteria for estimating the number of observations in general and in
149 relation to specific job categories.

150

151 **Abbreviations**

152 HH: hand hygiene; HCWs: healthcare workers; WHO: World Health Organization; IQR:
153 interquartile range; CI: confidence interval.

154

155 **Acknowledgments**

156 We thank the hand hygiene team “Hand Love, Patient Love” at Soonchunhyang University
157 Seoul Hospital. The study was presented at the SHEA Spring 2021 conference (No. 83).

158

159 **Authors’ contributions**

160 Conceptualization: SY Park, S Park, S Won; Data collection: SY Park, S Park; Formal
161 analysis: S Park, S Won; Writing original draft: SY Park; Writing review & editing: S Park, E
162 Lee, TH Kim, S Won. All authors critically assessed the manuscript through the writing
163 process and also read and approved the final version.

164

165 **Financial support**

166 This work was supported by the National Research Foundation of Korea (NRF) grant funded
167 by the Korean government (MSIT)(grant No. 2019R1G1A1099867) and the Soonchunhyang
168 University Research Fund.

169

170 **Competing interests**

171 The authors have no potential conflicts of interest to declare.

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216 tough sensor and wireless internet. *Am J Infect Control.* 2021;49(1):50-4.

217 **Table 1.** Mean hand hygiene and optimal hand hygiene compliance in terms of job category and year quarter.

	Number of observations	Healthcare workers	Mean, median (IQR) HH compliance	<i>p</i> -value ^a	Mean, median (IQR) optimal HH compliance	<i>p</i> -value [†]
Total	8791	1137	80.3, 100 (66.7–100)		59.7, 75 (0–100)	
Job category				< 0.001		< 0.001
Nurse	4090	574	90.9, 100 (100–100)		78.6, 100 (62.5–100)	
Doctor	2843	321	62.2, 71.4 (33.3–100)		27.6, 0 (0–50)	
Other	1858	242	80.8, 100 (66.7–100)		60.2, 75 (0–100)	
Quarter				0.011		< 0.001
First	2586	615	80.0, 100 (66.7–100)		59.6, 72.7 (0–100)	
Second	1805	598	78.9, 100 (60–100)		59.8, 80 (0–100)	
Third	2352	673	78.8, 100 (66.7–100)		59.1, 75 (0–100)	
Fourth	2048	621	83.7, 100 (80–100)		60.6, 80 (0–100)	

218 *IQR, interquartile range; HH: hand hygiene.*

219 ^a *p*-value determined through generalized estimating equation.

220 **Figure legends**

221 **Figure 1.** Minimum number of observations for determining hand hygiene compliance for
222 absolute precisions of 5, 10, 20, and 30%, at confidence intervals of (A) 99%, (B) 95%, and
223 (C) 90%.

224

Figures

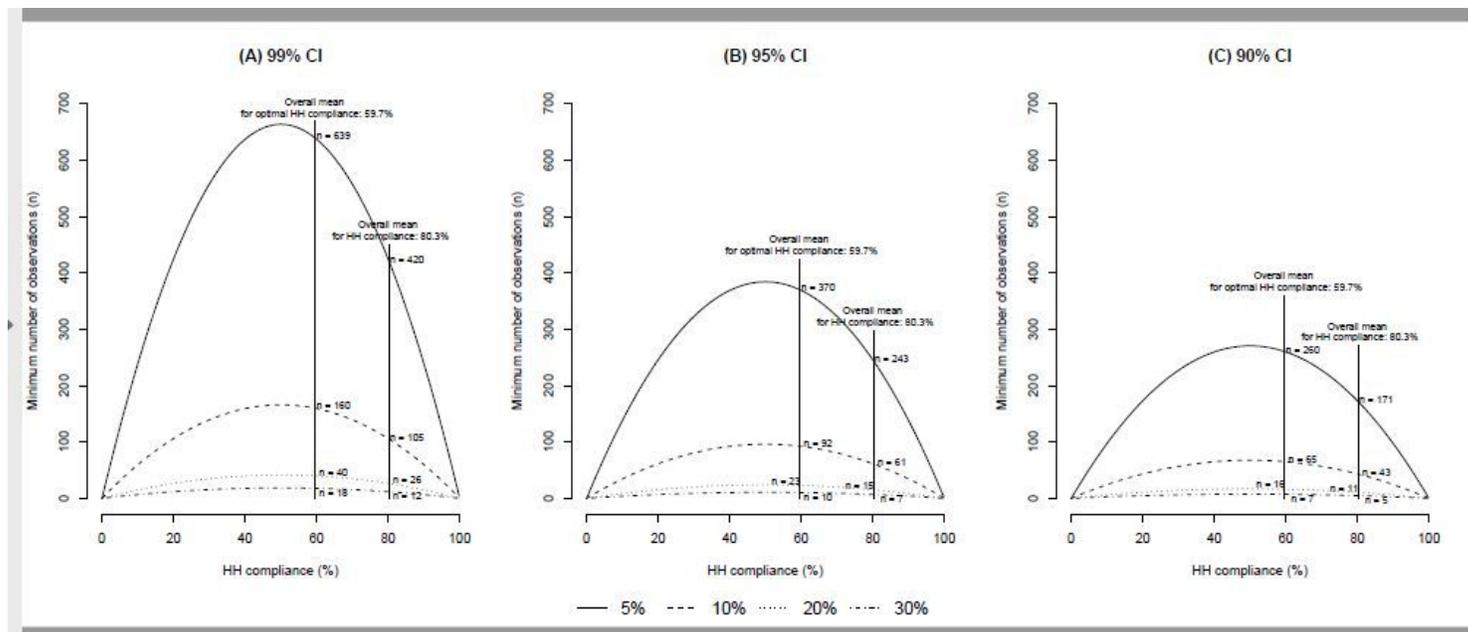


Figure 1

Minimum number of observations for determining hand hygiene compliance for absolute precisions of 5, 10, 20, and 30%, at confidence intervals of (A) 99%, (B) 95%, and (C) 90%.

Supplementary Files

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- [SupplementalTable.docx](#)