American Journal of Infection Control 50 (2022) 1263–1265

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief Report

Implementation of an electronic, secure, web-based application to support routine hand hygiene observation with immediate direct feedback and anonymized benchmarking

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Key Words:
Hand hygiene adherence
Hospital acquired infection
Infection control
Surveillance
Infection prevention
Intervention

A B S T R A C T

A secure web-based electronic tool was developed and implemented to record adherence to hand hygiene during routine care and to provide direct feedback including anonymized benchmarking. It was found suitable for documenting hand hygiene improvements in a local campaign and following rollout to other institutions in 2013, the tool is currently used in >100 hospitals in Switzerland and will play a major part in upcoming national hand hygiene campaigns.

INTRODUCTION

An ongoing challenge in modern medicine is the prevention of health care-associated infections.[1] Hygienic hand disinfection (or hand hygiene, HH) is considered the simplest and single most effective measure to prevent the transmission of multidrug-resistant microorganisms.[2]

Improving HH adherence by means of continuous education, monitoring using direct observation as gold standard [3] and direct feedback[4] is therefore a key task of any infection control team. In clinical practice, 2/5 of the required hand disinfection are actually omitted.[5]

In 2005/06, as part of a national campaign in Switzerland, measurements of HH adherence were conducted through direct observations with data collection on paper forms.

The main disadvantage of that method was the time-consuming and costly manual processing of the data with a long delay before the results were reported back to the institutions.

Our aim was to develop a standardized electronic tool that eliminates these disadvantages and allows easy digital recording of adherence to HH. The tool should be easy to introduce in everyday clinical routine and then be evaluated for its suitability in the context of a local campaign. In addition to data collection with a uniform methodology for epidemiological studies, immediate analysis should be feasible to allow for direct feedback with anonymized benchmarking. We hypothesized that this facilitates both the use in training and for disease outbreak interventions.

METHODS

"CleanHands" was developed as a platform-independent web application that allows data entry during direct observation of HH adherence via a touch-enabled device and by using a pictogram-based input mask. After data collection via an internet-enabled

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Funding: This study was not funded.
Conflicts of Interest: There are no conflicts of interest to declare.
Author contributions: Conceptualization and Methodology: SS, MS and CRK; Software: SS; SS, JM, RK, MS and CRK contributed to acquisition, analysis and interpretation of data. SS: wrote the first draft of the manuscript. JM, RK, MS, and CRK critically revised the manuscript. All authors read and approved the final manuscript.

https://doi.org/10.1016/j.ajic.2022.04.006

mobile device, the user interface immediately displays automated graphical results with anonymized benchmarking and allows extensive grouping and filtering to further specify the analysis and make stratifications. A technical description can be found in the supplement.[6]

The following independent predictors were considered in the analysis: profession group (nurses, physicians, others), indication (all 5 moments of HH according to WHO [7] as well as "between patients" until 2014 as employed during the national campaign), departments and the temporal relation to an intervention.

Initially, "CleanHands" was tested at a 700-bed tertiary care hospital when conducting a direct observational study without intervention on the state of HH adherence, and to evaluate "CleanHands" for everyday clinical routine and as part of a local HH campaign. The multi-modal HH campaign was conducted from January to July 2011. In addition to adherence measurement with instant analysis and direct feedback, the campaign consisted of training and educational sessions and the placement of campaign reminders on the doors of patients' rooms.

HH measures were assessed independently of the wearing of gloves and since hand washing is comparatively rarely done, no distinction between hand disinfection with an alcohol-based preparation and hand washing with soap and water was made in the data collection.

RESULTS

From January 2009 to December 2016, 15,487 indications were recorded by 19 different observers across 46 inpatient wards. The average adherence was 79% (Table 1).

Small but significant differences in HH adherence between the professional groups were detected. The mean HH adherence of nurses was 79%, higher than that of physicians (76%) and paramedical hospital staff (70%).

Mean HH adherence to WHO indications after patient contact (touching the patient 86%, contact with body fluids 86%, patient environment 80% and additionally "between patients" 86%) were significantly higher than before patient contact (touching the patient 67%, aseptic activity 75%).

In addition, 1,380 (9%) non-coded actions (hand disinfection without any indication) were recorded during the study period.

In comparison, a significantly lower mean HH adherence of 71% was observed on the intensive care units compared to normal wards, with values around 80%.

HH adherence increased from 78% before the multi-modal HH campaign to 85% during the campaign and dropped back to 78% later during campaign. Among physicians, there was a significant increase in HH adherence from 69.5% to 87.8% during the campaign, while HH adherence among nurses increased only slightly from 80.5% to 83.4% (Table 2).

DISCUSSION

In this study, we demonstrate the successful implementation of a newly developed secure web-based electronic tool to assess HH adherence with instant analysis for direct feedback in clinical routine. As the tool has been adopted and implemented by the Swiss National Centre for Infection Prevention (Swissnoso) in >100 hospitals in Switzerland since August 2014[8], it does not only support routine HH surveillance and training but also mono- or multicenter HH campaigns and research.

Our results confirm findings from traditional assessments by paper questionnaires.[9] Numerous studies investigated the difference between occupational groups in terms of HH adherence.[5] We found that disparities have decreased overall as a result of the campaign, primarily due to better adherence among physicians.

Significantly lower adherence was observed for pre-patient versus post—patient contact indications. In previous studies, a greater concern regarding self-protection over potential contamination was

Table 1
Hand hygiene adherence as a function of the different study variables

Variable	Number of indications		Adherence	Univariate analysis		Multivariate analysis	
	n	(%)	%	Odds ratio[†] (95% CI)	*P* values	Odds ratio[†] (95% CI)	*P* values
Occupation							
Nursing[‡]	12460	(80.5)	79.4	1.00	–	1.00	–
Physicians	2833	(18.3)	76.5	0.84 (0.77-0.93)	<.001	0.81 (0.73- 0.90)	<.001
Other	194	(1.2)	69.6	0.59 (0.44-0.81)	<.001	0.73 (0.53- 1.01)	.059
Indication							
Before patient[‡]	3985	(25.7)	66.8	1.00	–	1.00	–
Between patients[*]	1049	(6.8)	85.9	3.03 (2.52-3.65)	<.001	3.05 (2.52-3.68)	<.001
After patient	5076	(32.8)	85.9	3.02 (2.72-3.35)	<.001	3.00 (2.70-3.32)	<.001
After body fluid	1300	(8.4)	86.0	3.06 (2.58-3.62)	<.001	3.09 (2.60-3.68)	<.001
Before invasive procedure	2106	(13.6)	75.0	1.49 (1.33-1.68)	<.001	1.43 (1.27-1.62)	<.001
After environment	1971	(12.7)	80.0	1.99 (1.75-2.26)	<.001	2.07 (1.82-2.37)	<.001
Unit							
Medicine[‡]	4848	(31.3)	83.0	1.00	–	1.00	–
Surgery	4847	(31.3)	79.1	0.77 (0.70-0.86)	<.001	0.80 (0.72-0.89)	<.001
Gynaecology/Obstetric	166	(1.1)	80.7	0.85 (0.58-1.27)	.434	0.84 (0.57-1.26)	.411
Intensive care/monitoring	3675	(23.7)	71.5	0.51 (0.46-0.57)	<.001	0.53 (0.47-0.59)	<.001
Mixed	1686	(10.9)	80.7	0.86 (0.74-0.99)	.031	0.91 (0.79-1.06)	.235
Neonatology	265	(1.7)	80.0	0.82 (0.60-1.11)	.201	0.94 (0.69-1.29)	.715
HH campaign (01-06/2011)							
Before[‡]	3224	(20.8)	78.5	1.00	–	1.00	–
During	1459	(9.4)	85.1	1.56 (1.32-1.84)	<.001	1.64 (1.38-1.95)	<.001
After	10804	(69.8)	78.0	0.97 (0.88-1.07)	.513	1.11 (1.00-1.23)	.041
Total	15487		78.7				

A $P < .05$ was considered significant. Multivariate analysis using logistic regression models.
HH, hand hygiene.
*Recorded until 08/2014.
[†]Odds ratio and 95% confidence interval given for adherence to hygiene rules.
[‡]Reference category for odds ratio.

Table 2
Hand hygiene adherence among occupational groups before, during (01-06/2011) and after local HH campaign

Variable	Number of indications		Adherence	Univariate analysis	
	n	(%)	%	Odds ratio* (95% CI)	*P* values
Nursing*	12460				-
Before	2602	(20.9)	80.5	1.00	
During	872	(7.0)	83.4	1.21 (0.99-1.49)	.062
After	8986	(72.1)	78.7	0.89 (0.80-1.00)	.044
Physicians	2833				
Before	560	(19.8)	69.5	1.00	
During	583	(20.6)	87.8	3.17 (2.33-4.31)	<.001
After	1690	(59.6)	74.9	1.31 (1.06-1.62)	.011

A $P < .05$ was considered significant.
HH, hand hygiene.
*Reference category for odds ratio.

mentioned as a possible explanation.[5] Targeted training concerning this indication led to an improvement in adherence "before patient contact" from 59% in 2009 to 71% in 2016.

The intervention as part of a multi-modal campaign showed that further improvement in adherence is possible even where HH adherence is already quite high.[10] However, without regularly raising awareness of the topic and repeated training, the achievements do not seem sustainable.

The study has some limitations. Although the observations were made as inconspicuously as possible, it is likely that the people being observed changed their behavior during the ongoing data collection. Therefore, adherence tends to be somewhat overestimated (ie, Hawthorne effect). On the other hand, observations were optimized through structured training of observers and supervision of observations by experienced trainers with the goal of reducing inter-observer variability. Another limitation is that no observations were made during night shifts and weekends when staffing is reduced, which could also lead to a slight overestimation of adherence.

In conclusion, "CleanHands" has replaced the tedious traditional hygiene adherence assessment using paper questionnaires at our center. It has also proven to be a suitable tool in a local HH campaign and beyond that, on a national level for easy benchmarking of this important performance indicator.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

ACKNOWLEDGMENTS

The authors wish to thank the health care workers participating in this study.

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