

Hand hygiene technique quality evaluation in nursing and medicine students of two academic courses¹

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Objective: because they are health professionals, nursing and medical students' hands during internships can function as a transmission vehicle for hospital-acquired infections. Method: a descriptive study with nursing and medical degree students on the quality of the hand hygiene technique, which was assessed via a visual test using a hydroalcoholic solution marked with fluorescence and an ultraviolet lamp. Results: 546 students were assessed, 73.8% from medicine and 26.2% from nursing. The area of the hand with a proper antiseptic distribution was the palm (92.9%); areas not properly scrubbed were the thumbs (55.1%). 24.7% was very good in both hands, 29.8% was good, 25.1% was fair, and 20.3% was poor. The worst assessed were the male, nursing and first year students. There were no significant differences in the age groups. Conclusions: hand hygiene technique is not applied efficiently. Education plays a key role in setting a good practice base in hand hygiene, theoretical knowledge, and in skill development, as well as good practice reinforcement.

Descriptors: Students; Medicine; Nursing; Hand Disinfection; Evaluation.

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Introduction

Hospital-acquired infections (HAIs) are one of the main causes for morbidity and mortality in the health field, which constitute one of the main issues in global public health⁽¹⁾.

Health professionals' hands are one of the main transmission mechanisms for HAIs. Hand washing with water and antiseptic soap before and after patient contact is the most efficient technique proven to prevent hospital-acquired infection⁽²⁾.

However, in everyday clinical practice, hand hygiene (HH) is happening less often than desired⁽³⁾.

The World Health Organizations' (WHO) recommendations about enhancement strategies and better HH practice are considered as reference criteria, setting up several educational interventions targeting health professionals⁽⁴⁾.

Both in Spain⁽⁵⁾ and in the Autonomous Community of Extremadura⁽⁶⁾, promotion and knowledge development as well as a culture of patient safety are being stressed among professionals and patients in all health service levels. While performing its working lines on a local stage, the Complejo Hospitalario Universitario Infanta Cristina de Badajoz, the Sociedad Española de Medicina Preventiva, Salud Pública e Higiene (SEMPSPH) planned educational seminars and workshops about hand hygiene and its assessment.

Because they are health professionals, nursing and medical students' hands during internships can function as a transmission vehicle for hospital-acquired infections, and can cause patient, object and surface contamination⁽⁷⁾.

In this study we plan to assess the current state of HH in nursing and medicine students, enrolled to the Facultad de Medicina del Campus de Badajoz of the Universidad de Extremadura (UEX), who were doing an internship at the Complejo Hospitalario Universitario Infanta Cristina de Badajoz (CHUICB).

Method

Our study was a descriptive, cross-sectional study that occurred in two periods of time, and a sample was limited by the UEX, namely the Medicine Campus where medicine (six courses) and nursing (four courses) undergraduate studies are available. Three hundred seventeen students were enrolled in the nursing degree 2012/13 class, and 294 students in the 2013/14 class. For the medicine degree, there

were 877 students for the 2012/13 class and 878 for the 2013/14 class.

The CHUICB is integrated with the Hospital Infanta Cristina, Hospital Perpetuo Socorro, Hospital Materno-Infantil and the Specialty Center. This complex belongs to the Health Department of Badajoz, which served a populace of 276, 154 people; it owned 831 beds, had a total of 40, 434 hospital admissions, 31, 533 surgical procedures, 2,430 deliveries and the mean stay was 6.84 days⁽⁸⁾.

No selection of the student' sample was conducted. All students attending preventive medicine and public health classes of the biomedical sciences department and community nursing I and II classes of the nursing department were included. Student participation was voluntary.

Nursing and medical students from the Medicine Campus of Badajoz who participated in our study were: nursing degree students in the second and third years, medicine degree students in second and fifth year, and medicine baccalaureate students in sixth year (last class of the old program).

The study occurred in two periods of time: Academic year 2012/213 and 2013/2014

The study was conducted by the same professionals in the preventive medicine and public health service, on several days and different schedules in order to study the whole sample of students. A one-hour theory lesson about the foundations of hand, object, and surface contamination, epidemiology on the chain of bacteria transmission, and the different kinds of HH (instructions, material and technique) were taught during the school year of 2012/13 and 2013/14. The lesson focused on hygienic hand washing, antiseptic hand washing and hand rubbing with hydroalcoholic solutions. Likewise, instructions on applying HH, following the methodology of the "five moments of hand hygiene" proposed by the WHO were stressed.

During practical teaching, nursing and medical students attended a simulated specialty medical practice session. Small groups were established with five students. The reason for visit was explained (nausea) and students were asked to care for the patient (taking vital signs); asking them to perform a correct HH following WHO commendations. There was no sink or water and soap for performance of the HH, only hydroalcoholic solution was available which students had to use, applying knowledge acquired in the theoretical class.

Identifying variables included: date, center, academic course, nursing or medicine, sex and age.

An alcohol-based mix marked with fluorescence and an ultraviolet (UV) lamp (Dermalux®, Derma LiteCheck by Dermalux – Training) were used to assess HH.

A visual assessment of the correct fluorescence-marked hydroalcoholic solution (HAS) distribution (categories yes/no) was performed. Five main sections were considered: palms, back of the hand, between the fingers, finger tips/nails separately for each hand (right and left) and for both hands.

For the final quality assessment of the HH technique, some categories were established: “very good” if HAS was spread throughout all sections, “good”, if four sections were exposed, “fair” if two sections were not exposed, and “poor” if three or more regions were left without HAS exposure (Likert-type scale with four categories). Subsequently, they were divided in two categories: “proper HH” when the right hand, left hand and both hands obtained a “very good” or “good” notation; “inadequate HH” when the right hand, left hand or both hands obtained a “fair” or “poor” notation.

Limitations to the study included: lack of a randomized sample, as well as the concomitant differences in year of education, which could bias the study.

A separate descriptive analysis of the variables was conducted, presenting the mean corresponding to the qualitative variables, and centralizing measures as well as dispersion of the quantitative variables.

A chi-square (χ^2) was used for the bivariate analyses of the qualitative variables and a Student t-test for the quantitative variables, considering as significant the values $p > 0.05$.

Excel of Microsoft Office 2007 was used for the coding of the obtained data, and SPSS version 15.0 for the statistical analysis.

Ethical factors: Participation of all subjects in the study was voluntary. Confidentiality of data (Organic Law 15/1999, of December 13, of the Protection of Personal Character Data) and statistics (group coding, analysis and results) were kept secret at all times; likewise, the compliance was maintained with the Hospital Infanta Cristina de Badajoz's (Spain) Ethics Committee's research protocols.

Results

A total of 546 students participated in the study, 403 (73.8%) of them were medical students and 143 (26.2%) were nursing students; 216 (39.6%) students were from the 2012/2013 class and 330 (60.4%) students were from the 2013/2014 class. Males accounted for 30.45%

(144), and 69.6% (380) were female. The mean age of the sample was 21.4 ± 3.73 years of age.

In general, HAS distribution on the right hand was correct in 96.5% of cases on the palm, 86.1% between the fingers, 72.7% on the back of the hand, 70.3% on the finger tips, and 56.9% on the thumbs. For the left hand: 95.2% on the palm, 82.6% between the fingers, 80.4% on the back of the hand, 68.7% on the finger tips, and 63% on the thumbs. Considering both hands, the eHAS covered: 92.9% on the palms, 78.02% between the fingers, 65.2% on the finger tips, 64.2% on the back of the hand, and 55.1% on the thumbs.

Through direct observation, right hand, left hand and both hand HH technique quality was obtained. It was noted that 34.1% performed HH on the right hand by spreading HAS on five sections properly, 29.5% performed good HH, 21.7% achieved a fair score, and 14.6% achieved a poor score. For the left hand, 38.5% obtained a very good HH score, 30.9% had one mistake a 19.9% had two mistakes, 20.4% had three or more mistakes. Thus, 24.7% in both hands was very good, 29.8% was good, 25.1% was fair, and 20.3% was poor.

Category results were as follows: right hand HH was appropriate in 63.5%, 69.4% on left hand and HH for both hands was accurate in 50.2% of the students.

In terms of bivariate analysis by sex, men spread HAS worse than women in between the fingers and the back of the hand, on both the right and left hand (table 1). Observation for both hands showed that men did not spread HAS to the thumbs and in between the fingers as often as women did. Likewise, it was the men who obtained a “fair” notation on the right hand and “poor” on both hands, with significant differences versus women. These differences kept grouping the evaluation into two HH categories, which were: inappropriate HH on the right hand, and both hands, for men (table 1). There were no difference in the men and women groups based on year, course or age.

Table 2 shows that nursing students performed inappropriate HH on the right hand 2.2 times and on the left hand 1.7 times ($p < 0.05$) more often than medical students. Future nurses obtained a “fair” and “poor” notation on the right hand and “poor” on the left hand, with significant differences compared to the medical students. Hand sections most often left without HAS by nursing students versus medical students were the palm, thumb and in between fingers of right hand; back of the hand and between the fingers on left hand, leaving back of hands, thumbs and in between fingers poorly washed on both hands (Table 2, $p < 0.05$).

Hand hygiene technique quality was significantly better for the 2013/14 class versus the previous class and in women; there were no differences per year of

study or age (Table 3). Table 3 shows how a lack of rubbing HAS in between the fingers and thumbs stood out as a factor most involved in inappropriate HH.

Table 1 - HAS spreading on students' hands as per sex, marked section and degree of sanitation. Facultad de Medicina de Badajoz. Badajoz. Spain. 2012/2014

Sections	Value	Male		Female		OR	CI 95%	
		N	%	N	%			
Palm	Right	No	7	4.2	12	3.2	1.35	0.52-3.49
		Yes	159	95.8	368	96.8		
	Left	No	12	7.2	14	3.7	2.04	0.92-4.51
		Yes	154	92.8	366	96.3		
Thumb	Right	No	78	47	157	41.3	1.26	0.87-1.82
		Yes	88	53	223	58.7		
	Left	No	67	40.4	135	35.5	1.23	0.85-1.79
		Yes	99	59.6	245	64.5		
Interdigital	Right	No	34	20.5	42	11.1	2.07	1.26-3.40
		Yes	132	79.5	338	88.9		
	Left	No	42	25.3	53	13.9	2.09	1.33-3.29
		Yes	124	74.7	327	86.1		
Heel of the hand	Right	No	49	29.5	113	29.7	0.99	0.66-1.48
		Yes	117	70.5	267	70.3		
	Left	No	54	32.5	117	30.8	1.08	0.73-1.60
		Yes	112	67.5	263	69.2		
Back of the hand	Right	No	57	34.3	92	24.2	1.64	1.10-2.44
		Yes	109	65.7	288	75.8		
	Left	No	42	25.3	65	17.1	1.64	1.06-2.55
		Yes	124	74.7	315	82.9		
Both hands		Value	Male		Female		OR	CI 95%
Palm	No	17	10.2	21	5.5	1.95	0.99-3.79	
	Yes	149	89.8	358	94.5			
Thumb	No	104	62.7	197	51.8	1.56	1.08-2.26	
	Yes	62	37.3	183	48.2			
Interdigital	No	51	30.7	69	18.2	1.99	1.31-3.04	
	Yes	115	69.3	311	81.8			
Heel of the hand	No	63	38	127	33.4	1.22	0.83-1.78	
	Yes	103	62	253	66.6			
Back of the hand	No	67	40.4	128	33.7	1.33	0.92-1.94	
	Yes	99	59.6	252	66.3			
Assessment - 4 categories			Male		Female		OR	CI 95%
Hand		N	%	N	%			
Right	Very good	50	30.1	136	35.8	1	-	
	Good	37	22.3	124	32.6	0.85	0.59-1.23	
	Regular	49	29.5	70	18.4	1.53	1.11-2.11	
	Bad	30	18.1	50	13.2	1.39	0.96-2.01	
Left	Very good	55	33.1	155	40.8	1	-	
	Good	53	31.9	116	30.5	1.19	0.87-1.64	
	Regular	38	22.9	71	18.7	1.33	0.94-1.18	
	Bad	20	12	38	10	1.31	0.86-2.00	
Both hands	Very good	35	21.1	100	26.3	1	-	
	Good	40	24.1	123	32.4	0.94	0.63-1.40	
	Regular	49	29.5	88	23.2	1.37	0.96-1.98	
	Bad	42	25.3	69	18.2	1.45	1.01-2.11	

(continue...)

Table 1 - (continuation)

Assessment - 2 categories		Male		Female		OR	CI 95%
Hand		N	%	N	%		
Right	Inappropriate	79	47.6	120	31.6	1.97	1.35-2.86
	Proper	87	52.4	260	68.4		
Left	Inappropriate	58	34.9	109	28.7	1.33	0.90-1.97
	Proper	108	65.1	271	71.3		
Both hands	Inappropriate	91	54.8	157	41.3	1.72	1.19-2.49
	Proper	75	45.2	223	58.7		
Observations	Some	37	22.3	108	28.4	1.38	0.90-2.12
	None	129	77.7	272	71.6		

Table 2 - HAS spreading on students' hands as per nursing and medicine studies, year, sex, age and section. Facultad de Medicina de Badajoz. Badajoz. Spain. 2012/2014

	Value	Nursing		Medicine		OR	CI 95%
		N	%	N	%		
Year	2012/2013	71	49.7	145	36.0	1.76	1.19-2.58
	2013/2014	72	50.3	258	64.0		
Gender	Male	45	31.5	121	30.0	1.07	0.71-1.62
	Female	98	68.5	282	70.0		
Age	Mean (years)	21.2	± 4.77	21.43	± 3.2	NS	

Right Hand	Value	Nursing		Medicine		OR	CI 95%
		N	%	N	%		
Finger Tips	No	43	30.1	119	29.5	1.03	0.68-1.56
	Yes	100	69.9	284	70.5		
Back of the hand	No	48	33.6	101	25.1	1.51	0.99-2.28
	Yes	95	66.4	302	74.9		
Palm	No	11	7.7	8	2.0	4.12	1.62-10.45
	Yes	132	92.3	395	98.0		
Thumb	No	77	53.8	158	39.2	1.81	1.23-2.66
	Yes	66	46.2	245	60.8		
Between the fingers	No	47	32.9	29	7.2	6.31	3.78-10.56
	Yes	96	67.1	374	92.8		

Left Hand	Value	Nursing		Medicine		OR	CI 95%
		N	%	N	%		
Finger Tips	No	46	32.2	125	31.0	1.06	0.70-1.59
	Yes	97	67.8	278	69.0		
Back of the hand	No	39	27.3	68	16.9	1.85	1.18-2.90
	Yes	104	72.7	335	81.1		
Palm	No	9	6.3	17	4.2	1.53	0.66-3.50
	Yes	134	93.7	386	95.8		
Thumb	No	62	43.4	140	34.7	1.44	0.97-2.12
	Yes	81	56.6	263	65.3		
Between the fingers	No	40	28.0	55	13.6	2.46	1.58-3.90
	Yes	103	72.0	348	86.4		

Both hands	Value	Nursing		Medicine		OR	CI 95%
		N	%	N	%		
Finger Tips	No	54	37.8	136	33.7	1.19	0.80-.77
	Yes	89	62.2	267	66.3		
Back of the hand	No	62	43.4	133	33.0	1.55	1.05-2.29
	Yes	81	56.6	270	67.0		
Palms	No	14	9.8	24	6.0	1.71	0.86-3.40
	Yes	129	90.2	378	94.0		

(continue...)

Table 2 - (continuation)

Thumbs	No	97	66.8	204	50.6	2.06	1.38-3.07
	Yes	46	32.2	199	49.4		
Between the fingers	No	48	33.6	72	17.9	2.32	1.51-3.57
	Yes	95	66.4	331	82.1		
Assessment - 4 categories		Nursing		Medicine		OR	CI 95%
Hand	Value	N	%	N	%		
Right	Very good	33	23.1	153	38.8	1	-
	Good	38	26.6	123	30.5	1.34	0.88-2.03
	Regular	34	23.8	85	21.1	1.62	1.07-2.47
	Bad	38	26.6	42	10.4	2.7	1.84-3.98
Left Hand	Very good	45	31.5	165	40.9	1	-
	Good	42	29.4	127	31.5	1.16	0.80-1.67
	Regular	32	22.4	77	19.1	1.37	0.92-2.02
	Bad	24	16.8	34	8.4	1.93	1.29-2.88
Both hands	Very good	20	14.0	115	28.5	1	-
	Good	55	38.5	108	26.8	2.27	1.44-3.60
	Regular	13	9.1	124	30.8	0.64	0.33-1.13
	Bad	55	38.5	56	13.9	3.34	2.14-5.22
Assessment - 2 categories		Nursing		Medicine		OR	CI 95%
Hand	Value	N	%	N	%		
Right	Inappropriate	72	50.3	127	31.5	2.2	1.49-3.25
	Proper	71	49.7	276	68.5		
Left Hand	Inappropriate	56	39.2	111	27.5	1.69	1.13-2.52
	Proper	87	60.8	292	72.5		
Both hands	Inappropriate	68	47.6	180	44.7	1.12	0.77-1.65
	Proper	75	52.4	223	55.3		

Table 3 – Degree of HH performance in nursing and medical students' hands as per class, year, gender, age and section. Facultad de Medicina de Badajoz. Badajoz. Spain. 2012/2014

	Value	HH Inappropriate		HH Proper		OR	CI 95%
		N	%	N	%		
Year	2012/2013	128	51.6	88	29.5	2.55	1.79-3.62
	2013/2014	120	48.4	210	70.5		
Course	Nursing	68	27.4	75	25.2	1.12	0.77-1.65
	Medicine	180	72.6	223	74.89		
Gender	Male	91	36.7	75	25.2	1.72	1.19-2.49
	Female	157	63.3	223	74.8		
Age	Mean (years)	21.18	±3.54	21.54	± 3.88	NS	
Right Hand		HH Inappropriate		HH Proper		OR	CI 95%
		N	%	N	%		
Finger Tips	No	116	46.8	46	15.4	4.81	3.22-7.19
	Yes	132	53.2	252	84.6		
Back of the hand	No	115	46.4	34	11.4	6.71	4.34-10.38
	Yes	133	53.6	264	88.6		
Palm	No	15	6	4	1.3	4.73	1.55-14.45
	Yes	233	94	294	98.7		
Thumb	No	179	72.2	56	18.8	11.21	7.50-16.56
	Yes	69	27.8	242	81.2		
Between the fingers	No	73	29.4	3	1	41.02	12.74-132.12
	Yes	175	70.6	295	99		

(continue...)

Table 3 - (continuation)

Left Hand		HH Inappropriate		HH Proper		OR	CI 95%
		N	%	N	%		
		Finger Tips	No	120	48.4		
Yes	128	51.6	247	82.9			
Back of the hand	No	80	32.3	27	9.1	4.78	2.97-7.69
	Yes	168	67.7	271	90.9		
Palm	No	24	9.7	2	0.7	15.86	3.71-67.80
	Yes	224	90.3	296	99.3		
Thumb	No	161	64.9	41	13.8	11.6	7.62-17.66
	Yes	87	35.1	257	86.2		
Between the fingers	No	89	35.9	6	2	27.24	11.66-63.67
	Yes	159	64.1	292	98		

Both hands		HH Inappropriate		HH Proper		OR	CI 95%
		N	%	N	%		
		Finger Tips	No	152	61.3		
Yes	96	38.7	260	87.2			
Back of the hand	No	155	62.5	40	13.4	10.75	7.06-16.37
	Yes	93	37.5	258	86.6		
Palms	No	34	13.7	4	1.3	11.64	4.07-33.29
	Yes	214	86.3	293	98.7		
Thumbs	No	219	88.3	82	27.5	19.89	12.51-31.62
	Yes	29	11.7	216	72.5		
Between the fingers	No	110	44.4	10	3.4	22.96	11.65-45.24
	Yes	138	55.6	288	96.6		

Discussion

HH is recognized globally as a key factor in the reduction of hospital-acquired infection occurrence. The WHO recommends that research and publications focus on the establishment of hydroalcoholic solution and assessment of its use via diverse strategies. Educational and awareness programs, workshops, reminder posters, direct observation to assess completion and adherence stand out among them^(7, 9), as well as indirect assessment via proxy variables such as HAS use and hospital-acquired infection rates.

However, routine checking⁽¹⁰⁾ of methodology quality to improve HH adherence in order to reduce hospital-acquired infection is still inadequate to prove the efficiency of this approach; in addition to maintaining the biases in this type of study⁽¹¹⁾.

Currently, the use of a motivational tool named positive deviation is suggested. This tool identifies groups of individuals that solve problems better than others without additional resources, which in a study conducted by Mara AR et al. ⁽¹²⁾ obtained an improvement, although no conclusive results were obtained in another routine revision⁽¹³⁾.

In another HH compliance study⁽¹⁴⁾ with interns in a Brazilian hospital, 50% lower adherence was

obtained, but this is no guarantee of performed hand-washing efficiency via verification/assessment of proper HH technique. Likewise, nursing students had their internship in different hospitals, which prevented a follow-up; the introduction of this assessment in an undergraduate program becomes justified along with the five-step HH proposed by the WHO, complete with adherence studies during the clinical internship and career.

There are few studies that assess the HH technique via marked HAS spreading. This is probably due to the HH guide provided by the WHO and other institutions that describe the solutions, their efficiency, and application sequence, but which do not provide statements about quality assessment.

Macdonald⁽¹⁵⁾ assessed marked-HAS distribution in three sections (fingers, palms and thumbs) in trained staff, but the study does not detail the percentage of the sample who rubbed each individual section properly. In another study by the same author, the surface of a practice workshop was assessed before and after in the traumatology service, providing an estimate of the palm and back of the hand sections.

Widmer⁽¹⁶⁾ found a great improvement and correlation between HAS covered areas scores and hand

colony-forming units (CFUs), before and after specific training, which was compulsory for the staff.

Hautmaniere⁽¹⁷⁾ and Sutter⁽¹⁸⁾ performed a before-after assessment of specific HH training programs for medical students, improving sections covered with HAS and CFU spreading; they concluded that this tool is easy and trustworthy for gauging the HH technique.

Kampf⁽¹⁹⁾ found that 53% of subjects studied left out at least one section during HH, using the reference technique in the EN1500 norm; although the sample was small (55 people) and had many comparisons (16 variables).

Via a compulsory educational course, Szilágy⁽²⁰⁾ obtained an assessment of 67-72% from 4642 participants with a "good" notation; in that study, the sections forgotten most frequently were the top section of the fingers close to the nails, the thenar eminence, and the wrist. These results are similar to the present study, although this last one was performed on students and was voluntarily.

In Spain, only the study conducted by Ramon-Canton⁽²¹⁾ assessed HH technique in healthcare professionals at their work post, with no previous compulsory workshop. The results showed that 95.2% of people assessed left at least one section unclean, and the sections with the worst scores were the thumbs and fingers. In our study, the same assumption gives a result of 75.27% with at least one section of the hand left unclean, and the sections with worst scoring were the thumbs and in between the fingers.

Other studies^(17, 22) involving medical and nursing students obtained a rating of inadequate HAS HH of 78.5% and 81.5%, much higher than our study (49.82%).

Furthermore, 26.6% of the students were observed to have attended the practicum with long nails, with nail polish or artificial nails, watches or bracelets; these circumstances complicate correct HH performance, and were not taken into account in other studies.

It is important to point out that the right hand on its own was better cleaned with HAS than the left one, except the thumb; considering that most of the human population is right-handed, this entails that the dominant hand is washed less properly. Therefore, emphasis should be placed on raising awareness and training the non-dominant hand on HH.

Likewise, comments and questions of the students attending were heeded, this helped identify the fact that they had difficulty in recognizing the opportunities for HH according to the different procedures that form their

usual clinical practice. All these elements must be taken into account and incorporated into cross-disciplinary education during undergraduate studies.

Knowledge that health care students must have about hand, object and surface contamination and HH issues in hospital-acquired infection prevention and control is key to improve HH quality and adherence⁽²³⁻²⁴⁾ to provide safe health services.

Conclusions

All staff in a health institution, and specially health care professionals, including students during their internship, must deliver safe health services that prevent hospital-acquired infection in their everyday practice.

Therefore, proper education and training in proper HH technique performance and regular creation of campaigns and workshops remains a priority.

Moreover, effectiveness of HH also depends on quality technique, and we believe that regular practicum and assessment using this immediate feedback method could provide a simple, quick tool with large effect in students and professionals; it can ascertain HH technique quality at an individual level, after a course/workshop or at their place of work, giving them the necessary skills and knowledge as well as awareness and better adherence, which need improvement.

Hand hygiene improvement must be a priority for healthcare authorities in all levels, be it undergraduate, graduate studies or ongoing training, where there is an individual responsibility for each healthcare professional. All HH programs must include different actions, such as alcoholic solution introduction, staff education and motivation, as well as assessment and counselling in HH technique quality.

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