

Hand hygiene among healthcare workers – theoretical knowledge and microbiological effectiveness of hand disinfection in practice

Higiena rąk wśród pracowników ochrony zdrowia – wiedza teoretyczna a skuteczność mikrobiologiczna dezynfekcji rąk w praktyce

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Słowa kluczowe: wiedza, pracownicy ochrony zdrowia, higiena rąk, personel medyczny, dezynfekcja rąk.

Abstract

Introduction: Hand hygiene is very often omitted or improperly performed by healthcare workers. Knowledge of hygienic procedures and guidelines may play a pivotal role in the effectiveness of healthcare workers hand disinfection.

Aim of the research: The assessment of potential correlation between theoretical knowledge of guidelines to hand hygiene and the frequency of theoretical and practical training in hand hygiene on the microbiological effectiveness of hand disinfection.

Material and methods: The study was conducted among 200 healthcare workers. For the assessment of the healthcare workers' knowledge of hand hygiene a self-designed questionnaire was used. The microbiological effectiveness of hand hygiene was performed by collecting pre- and post-disinfected handprints. We assumed that a decrease in bacteria levels on the hands after disinfection indicates the effectiveness of hand hygiene.

Results: The analysis of microbiological tests demonstrated that the levels of bacteria on healthcare workers' hands differ according to theoretical knowledge of guidelines for hand hygiene. The group with better results in the knowledge test had a lower number of microorganisms on their hands after hand disinfection. Participants had many problems with identification of situations in which hand disinfection is obligatory. Among wrong answers the most common were: belief that gloves can replace hand disinfection (31%), and lack of knowledge that hand rub must be performed before contact with the patient (30%). More than one theoretical training per year was associated with better hand disinfection efficiency.

Conclusions: Theoretical knowledge of hand hygiene affects compliance with hand hygiene recommendations and results in better microbiological effectiveness of performed procedures. The fact that HCWs are not aware in which moments they should disinfect their hands highlight the need for designing and implementation of adequate multi-modal strategies for improvement of hand hygiene.

Streszczenie

Wprowadzenie: Higiena rąk jest bardzo często pomijana lub niewłaściwie wykonywana przez pracowników ochrony zdrowia. Znajomość procedur higienicznych i zaleceń może odgrywać znaczącą rolę w skuteczności dezynfekcji rąk wykonywanej przez personel medyczny.

Cel pracy: Ocena potencjalnego związku między teoretyczną znajomością zaleceń dotyczących higieny rąk oraz częstością szkoleń z tego zakresu a skutecznością mikrobiologiczną dezynfekcji rąk.

Materiał i metody: Badanie zostało przeprowadzone wśród 200 pracowników ochrony zdrowia. Do oceny wiedzy teoretycznej personelu użyto autorskiego kwestionariusza. Mikrobiologiczna skuteczność higieny rąk została oceniona poprzez zebranie od uczestników odcisków rąk przed dezynfekcją i po dezynfekcji. Za wskaźnik skuteczności higieny rąk przyjęto zmniejszenie liczby bakterii na rękach po dezynfekcji.

Wyniki: Analiza testów mikrobiologicznych wykazała, że liczba bakterii na rękach personelu medycznego różni się w zależności od posiadanej wiedzy teoretycznej z zakresu higieny rąk. W grupie, która osiągnęła wyższy wynik z testu, liczba bakterii na rękach po dezynfekcji była mniejsza niż w grupie z niższym wynikiem. Uczestnicy mieli problemy ze wskazaniem sytuacji, w których dezynfekcja rąk jest niezbędna. Najczęstszymi spośród błędnych odpowiedzi były: przekonanie, że jednorazowe rękawice mogą zastąpić dezynfekcję rąk (31%), brak wiedzy o konieczności dezynfekcji rąk przed kontaktem z pacjentem (30%). Więcej niż jedno szkolenie teoretyczne w ciągu roku wiązało się z lepszą skutecznością dezynfekcji rąk.

Wnioski: Wiedza teoretyczna dotycząca higieny rąk wpływa na przestrzeganie zaleceń z tego zakresu oraz na większą skuteczność mikrobiologiczną wykonywanych procedur. Fakt, że personel medyczny nie jest świadomy momentów, w których powinien dezynfekować ręce, powoduje, że konieczne jest zaprojektowanie i wdrożenie odpowiednich wielokierunkowych działań zwiększających przestrzeganie higieny rąk.

Introduction

Although the history of hand hygiene is very long, and Semmelweis observations date back to 1847, the problem of accurate hand disinfection is still up to date. Modern medicine faces the problem of health-care-associated infections with all its consequences, such as increasing mortality rate or spreading antimicrobial resistance [1–3]. Hand hygiene with the use of alcohol-based hand disinfectant is a simple and short procedure; however, this basic means of prevention is very often omitted or improperly performed by healthcare workers (HCWs), with mean baseline rates ranging from 5% to 89% and an overall average of 38.7% [1, 3, 4], higher among nurses (75–39%) than doctors (47–15%) [5, 6], and dependent on the observed situation, e.g. 40–85% of doctors and nursing staff perform hand hygiene before touching a patient and 51–89% after touching a patient, with disinfection rates up to 100% after body fluid risk [7]. Potential reasons of poor compliance to hand hygiene include: lack of knowledge of guidelines, failure to identify which situations require hand hygiene, lack of role models from colleagues and superiors, work overload, lack of time, lack of appropriate infrastructure, and scepticism about the value of hand hygiene [1–4, 7, 8]. Therefore, knowledge of hygienic procedures and guidelines among HCWs may play a pivotal role in the effectiveness of hand disinfection; in particular, an insufficient theoretical base can contribute to improper hand hygiene. The World Health Organisation (WHO) underlines the need for comprehensive and constant training and education on the importance of hand hygiene among HCWs [1, 2].

Aim of the research

The assessment of potential correlation between theoretical knowledge of guidelines on hand hygiene among HCWs and its microbiological effectiveness in practice. The assessment of awareness of the constant need for education in hand hygiene among HCWs. Description of the impact of theoretical and practical training in hand hygiene and their frequency on hand disinfection effectiveness.

Material and methods

The study was approved by the Bioethics Committee at Wrocław Medical University (consent no. KB – 475/2013) and was conducted from October 2013 to November 2013. According to conditions required by the Scientific Committee and due to financial limitations, the study group consisted of 200 healthcare

workers from seven hospitals located in the south-west region of Poland. The volunteer participants were practicing doctors and nurses who agreed to participate in the study.

We assumed that a decrease in the number of colony-forming units (CFUs) after hand disinfection is an indicator of the microbiological effectiveness of the performed procedure. In order to quantify the bacterial level on HCW's hands the palm imprint method was used before and after hand disinfection for each participant. Microbial contamination of the hands was evaluated with the use of TSA with LECITHIN & TWEEN 80 COUNT – TACT according to the manufacturer's instructions; the surface of all plates was 25 cm². The subjects placed the palm of their right hand on the surface of individual plates for 10 s. All the samples were transported to the laboratory within 2 h and incubated at 35°C for 48 h. After incubation the colonies were counted and the results were expressed as colony-forming units per 100 cm² (CFU/100 cm²).

The assessment of HCWs' knowledge in the field of hand hygiene recommendations was performed with the use of a self-designed questionnaire. There were 12 questions, including multiple-choice questions, which assessed the knowledge WHO Guidelines on Hand Hygiene in Health Care. Subjects were asked about procedures of hand washing and hand disinfection, in which situations they should be performed, and technical aspects of the procedure (i.e. duration of hand disinfection and volume of hand-disinfectant). For each correct answer one to two points in single-choice and one point in multiple-choice questions was added, with a maximum of 29 points if all the correct answers were chosen. For the statistical analysis participants were divided into two groups according to the results: good or very good knowledge with more than 75% of correct answers, or insufficient knowledge if 75% or fewer of the answers were correct.

Statistical analysis

Data were analysed using MS Excel and Statistica 12 software. ANOVA test was used for testing the equality of mean CFU on HCW's hands between groups divided due to the results of knowledge assessment and declared frequency of theoretical training in hand hygiene. Statistical significance was set at $p < 0.05$.

Results

Among participants there were 168 (84%) women and 32 (16%) men, and according to the type of medical profession: 141 (69%) nurses and 62 (31%) medical

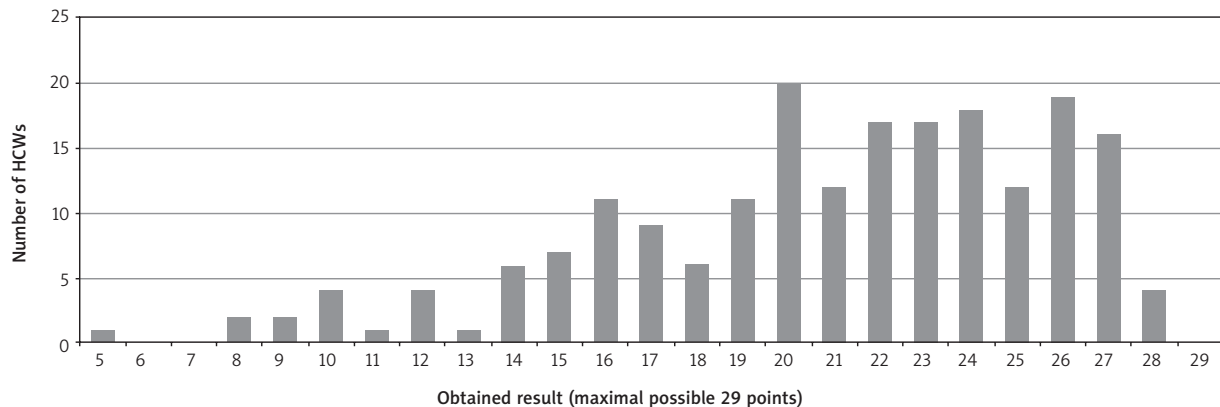


Figure 1. Results of knowledge questionnaire. Maximal possible score to obtain was 29. Number of healthcare workers (HCWs) – 200

doctors. The age of the respondents varied from 23 to 66 years.

The knowledge of hand hygiene recommendations and declared need of training

The maximum score in the knowledge test, i.e. 29 points, was achieved only by four healthcare workers. The mean score from the questionnaire was higher among nurses, and was 21.21 points, while among doctors it was 19.92 points. The most common among the wrong answers were: conviction about the necessity of hand wash before each contact with the patient (118; 59%), belief that gloves can replace hand disinfection (62; 31%), or that hand disinfection is not required if glove changing is performed (164; 82%). In addition, participants had many problems with identification of situations in which hand disinfection is obligatory. For instance, participants did not know that hand disinfection must be performed before contact with the patient (60; 30%), before putting on gloves (82; 41%), or after procedures in the patients' surrounding (74; 37%). The results from the questionnaire and answers for each question are presented in Figure 1, Tables 1 and 2.

Theoretical knowledge and microbiological effectiveness of hand disinfection

The analysis of microbiological tests demonstrated that bacterial colonisation of HCWs' hands differed significantly between groups depending on their theoretical knowledge of guidelines for hand hygiene. The group that obtained better results in the knowledge test had fewer microorganisms on their hands after hand disinfection, which reflects that knowledge was associated with better microbiological effectiveness of performed procedures ($p = 0.004$, Table 3).

Training in hand hygiene – declared participation and its effectiveness

An education program for improvement of hand hygiene is one of the essential components of the WHO multi-modal Hand Hygiene Improvement Strategy. Most of the respondents stated that they took part in a hand hygiene training at least once during the previous year, either theoretical (52%) or practical training (55.5%) (Table 4). In our study about 93% of HCWs declared the need for training in hand hygiene. We observed that those who declared that they required training in hand hygiene had slightly lower average scores in our questionnaire (20.78 points) than those who did not expect more training in hand hygiene (22.17 points). This observation might reflect the accuracy of self-assessment among HCWs in the scope of the knowledge of hand hygiene recommendations in clinical care. We also aimed to ascertain whether those HCWs who were convinced that they had sufficient knowledge of hand hygiene were aware of the constant need for training. Seventy-five percent of the HCWs who subjectively assessed their knowledge of hand hygiene as sufficient also declared that they still needed training in that field.

The correlation between the declared frequency of participation in educational training and its impact on microbiological effectiveness of performed hand hygiene was examined. More than one theoretical training per year was associated with fewer microorganisms on the hands after hand disinfection ($p = 0.02$, Table 5). We also observed that the number of CFUs on hands after hand disinfection was lower if HCWs took part in practical training twice or more per year, although this was statistically insignificant (Table 6).

Discussion

Several studies have focused on the problem of improper hand hygiene among healthcare workers

Table 1. Results of knowledge assessment questionnaire for each short question (1–9)

Short questions	Score	Number of HCWs (%)
1. Which procedure has better microbicidal activity?		
a) Hand wash	0	3 (1.5%)
b) Hand wash + hand disinfection	1	134 (67%)
c) Hand disinfection	2	63 (31.5%)
2. Should hands always be washed before contact with a patient?		
a) Yes	0	118 (59%)
b) No	1	82 (41%)
3. Should hands be disinfected after each contact with a patient?		
a) Yes	1	189 (94.5%)
b) No	0	11 (5.5%)
4. Which volume of alcohol-based hand disinfectant should be used?		
a) 1 ml	0	19 (9.5%)
b) 5 ml	1	12 (6%)
c) A palmful of the product in a cupped hand	2	169 (84.5%)
5. Can hand disinfection be replaced by using gloves?		
a) Yes	0	62 (31%)
b) No	1	138 (69%)
6. How many steps are included in the procedure of hand disinfection?		
a) 5	0	39 (19.5%)
b) 6	1	142 (71%)
c) 7	0	10 (5%)
No answer		9 (4.5%)
7. Can solely hand disinfection be performed before medical procedures with patients?		
a) Yes	1	138 (69%)
b) No	0	62 (31%)
8. How long should hygienic hand disinfection last?		
a) 15 s	0	14 (7%)
b) 20–30 s or until hands are dry	1	186 (93%)
9. Is it correct to change disposable gloves without hand disinfection?		
a) Yes	0	37 (18.5%)
b) No	1	163 (81.5%)

HCWs – healthcare workers.

and healthcare students and have aimed to identify reasons for non-compliance with the guidelines for hand hygiene. However, the number of studies assessing both theoretical knowledge and microbiological effectiveness of hand hygiene is rather limited.

Similarly to our findings, insufficient knowledge of hand hygiene guidelines was underlined as one of the important reasons for improper hand hygiene in hospital settings. According to Nair *et al.*, only 9% of medical and nursing students had good knowledge regarding hand hygiene, with significantly better knowledge, attitude, and practice among nursing students [9]. Also, our study suggests that theoretical knowledge of hand hygiene is better among nurses, which corresponds with results obtained by van de Mortel, who identified the type of medical profession as a risk-factor for non-compliance with hand hygiene guidelines, and revealed better compliance among nursing students in comparison to medical students [10], as well as Azim's study in which hand hygiene compliance rates were better among nurses [11].

Healthcare workers have problems with identification of situations in which hand hygiene is recommended and necessary, such as the moment before touching a patient, which may suggest a tendency toward self-protection rather than protection of patients [11, 12]. Our study also indicates that 30% of HCWs are not aware that they should perform hand disinfection before contact with patients. This corresponds with the rates reported by Kawalec *et al.* or Wałaszek *et al.*, in which, respectively, about 35% and 39% of HCWs did not disinfect their hands in this situation [13, 14], or the study by Lytsy *et al.*, in which 18–60% of medical staff omitted hand disinfection before touching a patient [7]. According to Garus-Pakowska *et al.*, HCWs obeyed the hand washing procedure before patient contact only in 5.2% of situations [15].

Another problem is a misconception among one third of HCWs that the use of non-sterile gloves may replace the need for hand disinfection, which was previously highlighted by Scheithauer and Lemmen [16]. Many studies underlined problems with incorrect use of clinical gloves, i.e. improper use for low-risk procedures, failure to change them between procedures, and failure to remove gloves or to perform hand hygiene after their use [17, 18]. In Poland the overall level of compliance with the guidelines regarding the use of protective gloves is about 50% [19].

To improve compliance with hand hygiene among medical staff, an educational programme focusing on the WHO guidelines and the “Five Moments” for hand hygiene is needed. Our study showed that more than one theoretical training per year is associated with a lower number of microorganisms on hands after disinfection. The need for training has also been highlighted previously, e.g. by Silva *et al.*, who re-

Table 2. Results of knowledge assessment questionnaire for each multiple-choice question (10–12)

Multiple-choice questions	Maximal score	Individual results		Mean score
		Score	Number of HCWs (%)	
10. When should hand washing be performed?	6			3.85
a) When hands are visibly dirty		6/6	66 (33%)	
b) Always before hand disinfection		5/6	29 (14.5%)	
c) Always before eating		4/6	18 (9%)	
d) Before assisting a patient with eating		3/6	35 (17.5%)	
e) After using the toilet		2/6	19 (9.5%)	
f) Before starting work and after longer breaks		1/6	15 (7.5%)	
g) Always after contact with a patient colonised with <i>Clostridium difficile</i>		0/6	18 (9%)	
h) Always after contact with an HIV-positive patient				
11. Should hands be washed before disinfection?	3			1.015
a) Yes, always		3/3	0 (0%)	
b) Yes, after contact with an HIV-positive patient		2/3	68 (34%)	
c) Yes, after contact with patient/surroundings of a patient with diarrhoea caused by <i>Clostridium difficile</i>		1/3	67 (33.5%)	
d) Yes, if hands are visibly dirty		0/3	65 (32.5%)	
e) No				
12. When should hygienic hand disinfection be performed?				6.8
a) Before touching the patient	9	9/9	74 (37%)	
b) After touching the patient	9	8/9	32 (16%)	
c) After contact with body fluids or excretions, mucous membranes	9	7/9	25 (12.5%)	
d) Before performing clean or aseptic tasks	9	6/9	17 (8.5%)	
e) After performing medical procedures	9	5/9	16 (8%)	
f) Before using non-sterile gloves	9	4/9	10 (5%)	
g) After removal of sterile or non-sterile gloves	9	3/9	3 (1.5%)	
h) If moving from a contaminated body site to another body site during care of the same patient	9	2/9	11 (5.5%)	
i) After touching the patient's immediate environment	9	1/9	10 (5%)	
	9	0/9	2 (1%)	

HCWs – healthcare workers.

Table 3. Number of CFUs on hands before and after hand disinfection according to theoretical knowledge of hand hygiene procedures

Hand disinfection	Theoretical knowledge of hand hygiene		P-value
	≤ 75% correct answers	> 75% correct answers	
Before	447.30 CFU/100 cm ² (±455.71)	327.53 CFU/100 cm ² (±405.78)	0.05
After	274.60 CFU/100 cm ² (±527.41)	106.91 CFU/100 cm ² (±237.46)	0.004

CFU – colony-forming unit.

Table 4. Declared frequency of participation in hand hygiene training

Declared frequency	Theoretical training		Practical training	
	Number of HCWs	%	Number of HCWs	%
Once a year	104	52	111	55.5
Twice a year	55	27.5	50	25
3 or more times a year	23	11.5	20	10
No answer	18	9	19	9.5
Total	200	100	200	100

HCWs – healthcare workers.

Table 5. Number of CFUs on hands after hand disinfection according to frequency of theoretical training in hand hygiene

	Frequency of theoretical training in hand hygiene			P-value
	1 per year	2 per year	3 or more per year	
Mean number of CFUs on hands after hand disinfection	274.62 CFU/100 cm ² (±506.95)	102.47 CFU/100 cm ² (±243.17)	101.22 CFU/100 cm ² (±331.24)	0.02

CFU – colony-forming unit.

Table 6. Number of CFUs on hands after hand disinfection according to frequency of practical training in hand hygiene

	Frequency of practical training in hand hygiene			P-value
	1 per year	2 per year	3 or more per year	
Mean number of CFUs on hands after hand disinfection	242.02 CFU/100 cm ² (±476.89)	108.40 CFU/100 cm ² (±262.78)	126.60 CFU/100 cm ² (±352.13)	0.13

CFU – colony-forming unit.

ported that 34% of HCWs did not attend specific training on hand hygiene [20]. Similarly, a study conducted among Polish medical students by Róžańska *et al.* reported that the professional practice of 22.9% of students was not preceded by any training in the field of hospital hygiene and in 28% of cases training did not cover hand hygiene [21]. According to Jarosik and Garus-Pakowska's findings, HCWs are aware of the need for constant education and obligatory training, and these actions are most frequently indicated as possible factors for improvement of hand hygiene [22]. Sadeghi-Moghaddam *et al.* reported that educational intervention improved hand hygiene compliance from 30% to 70% [23]. Also, Niecwietajewa *et al.* revealed that personalised and group training combined with microbiological hand hygiene control among HCWs resulted in higher consumption of alcohol-based hand disinfectant in hospital wards [24], while Stock *et al.* observed that hands-on training conducted in small groups with a wide array of interactive teaching methods significantly improved hand hygiene compliance among nurses [25]. Nonetheless, more studies are needed to optimise strategies for better compliance with guidelines and monitoring of hand hygiene, to determine which additional

promotional activities can augment improvements in hand hygiene and its quality, and to establish the most effective methods of providing feedback [26]. Recent studies suggest that simplifying the procedure of hand hygiene by reducing the number of recommended six-steps to three, providing the same level of microbiological effectiveness, might be a possible way to improve adherence to hand hygiene actions [27].

To summarise, for better compliance with hand hygiene among HCWs, there is still a need to design a multi-modal and combined strategy, which should focus not only on theoretical knowledge and the need for training but also on many other aspects in clinical settings.

Conclusions

The HCWs are not aware of the situations in which they should perform hand disinfection. Theoretical knowledge of guidelines for hand hygiene is related with fewer microorganisms on the hands after hand disinfection. Educational training is an important element increasing the efficacy of performed hand hygiene procedures. More than one theoretical training per year was associated with better hand disinfection efficiency. There is a need to design and implement

multi-modal educational strategies to improve hand hygiene among HCWs.

Conflict of interest

The authors declare no conflict of interest.

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