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PIOTR LESZCZYŃSKI^{1, 2} | BEATA SOKÓŁ-LESZCZYŃSKA¹ | PAWEŁ GRZESIOWSKI³ | KATARZYNA DZIERŻANOWSKA-FANGRAT⁴ | ANETTA MAJCHRZAK-JASZCZYK⁵ | GRAŻYNA MŁYNARCZYK¹

HAND HYGIENE KNOWLEDGE OF MEDICAL STUDENTS AT DIFFERENT LEVEL OF UNIVERSITY EDUCATION

WIEDZA NA TEMAT HIGIENY RĄK WŚRÓD STUDENTÓW MEDYCZYNY NA RÓŻNYM ETAPIE KSZTAŁCENIA AKADEMICKIEGO

ORCID*: 0000-0003-3096-5375 | 0000-0001-7446-2222 | 0000-0003-1984-7159 | 0000-0003-4684-0630 | 0000-0002-2116-7614 | 0000-0002-6360-2688

ABSTRACT: Introduction Hand hygiene (HH) is the cornerstone of infection prevention. Knowledge of and compliance with the rules, as well as awareness of the need for such knowledge plays a key role in the daily work of medical personnel within various hospital departments. A clear explanation of HH importance seems to be a significant task in the education process of medical students. **Aim** The aim of the study was to assess the knowledge regarding hand hygiene and its role in hospital infection control among students who underwent hand hygiene training. **Material and methods** One hundred and five students from different years of study in the Faculty of Medicine at the Medical University of Warsaw participated in the survey consisting of 33 questions. **Results** Analysis of our results revealed a correlation between the year of study and the test results. Our research indicates the need for introducing HH at the very beginning of medical university education. The main hand hygiene principles were better understood by younger students ($p > 0.05$). The issue of the frequency of cleaning hands after contact with the patient's skin or area surrounding the patient and saving time by hand scrubbing instead of washing with soap and water and the awareness that alcohol-based handrubs are less drying than ordinary soap and the water was better known to younger students ($p < 0.05$). The main factor influencing the better results was probably the year of study: with lower results related to less time spent in the hospital. Older students more frequently chose the right answers to questions about the indications for HH (95.7% group 2 vs. 79.3% group 1), the correct sequence for hand washing (83% group 2 vs. 65.5% group 1) and knowledge of the most important stages of hand washing (89.4% group 2 vs. 69.0% group 1). Women presented a higher level of knowledge than men in questions about the need for HH after touching the patient or his surroundings (96.08% vs. 85.19%) ($p < 0.05$). **Conclusions** Medical universities should strive to improve HH practices among students from early years of education, so that when students complete their university education and join the healthcare workforce, they will know how to apply HH procedures in their daily practice. HH indications and correct understanding, as well as application should be frequently repeated during university education. A different approach to HH problems by men and women should be considered.

KEY WORDS: hand hygiene, medical university students, teaching

STRESZCZENIE: Wstęp Higiena rąk (ang. hand hygiene – HH) jest jednym z najważniejszych elementów w kontroli zakażeń szpitalnych. Znajomość i przestrzeganie zasad, a także świadomość potrzeby takiej wiedzy odgrywają kluczową rolę w codziennej pracy personelu medycznego na różnych oddziałach szpitalnych. Odpowiednie wyjaśnienie znaczenia higieny rąk wydaje się być ważnym zadaniem w edukacji studentów medycyny. **Cel** Celem pracy była ocena wiedzy na temat HH i jej roli w kontroli zakażeń szpitalnych wśród studentów po szkoleniu z higieny rąk. **Materiał i metody** W ankiecie (składającej się z 33 pytań) wzięło udział 105 studentów na różnym etapie kształcenia akademickiego z Wydziału Lekarskiego Warszawskiego Uniwersytetu Medycznego. **Wyniki** Analiza wyników wykazała korelację między rokiem studiów a wynikiem testu.

- 1 Department of Medical Microbiology, Medical University of Warsaw
- 2 Hospital Infection Control Team, Infant Jesus Clinical Hospital in Warsaw
- 3 Foundation "Institute of Infection Prevention"
- 4 Department of Microbiology and Clinical Immunology Children's Memorial Health Institute in Warsaw
- 5 Faculty of Tourism and Recreation Józef Piłsudski University of Physical Education in Warsaw

✉ BEATA SOKÓŁ-LESZCZYŃSKA
Department of Medical Microbiology,
Medical University of Warsaw,
5, Chałubińskiego Str.,
PL-02004 Warsaw, Poland,
e-mail: beata.sokol-leszczynska
@wum.edu.pl

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*according to the order on the list of Authors

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Badania wskazują na potrzebę wprowadzenia informacji dotyczących HH od samego początku edukacji medycznej. Główne zasady higieny rąk zostały lepiej zrozumiane przez młodszych studentów ($p > 0,05$). Kwestie częstotliwości stosowania zasad higieny rąk po dotknięciu skóry pacjenta lub otaczającego obszaru w pobliżu chorego i oszczędność czasu podczas dezynfekcji rąk zamiast mycia mydłem oraz wodą, a także świadomość, że preparaty na bazie alkoholu mniej wysuszają skórę niż mydło i woda również były lepiej znane młodszemu studentom ($p < 0,05$). Głównym czynnikiem wpływającym na lepsze wyniki był zapewne rok studiów; słabsze wyniki prawdopodobnie związane były z mniejszą ilością czasu spędzonego w szpitalu. Starsi studenci częściej wybierali właściwe odpowiedzi na pytania dotyczące wskazań do HH (95,7% grupa 2 vs. 79,3% grupa 1), prawidłowej kolejności czynności podczas mycia rąk (83% grupa 2 vs. 65,5% grupa 1) i znajomości najważniejszych etapów mycia rąk (89,4% grupa 2 vs. 69,0% grupa 1). Kobiety częściej niż mężczyźni udzielały prawidłowych odpowiedzi na pytania dotyczące potrzeby przeprowadzenia HH po kontakcie z pacjentem lub środowiskiem (96,08% vs. 85,19%). **Wnioski** Uczelnie medyczne powinny dążyć do wprowadzenia szkoleń w zakresie higieny rąk wśród studentów już od wczesnych lat edukacji, tak aby w momencie ukończenia studiów i dołączenia do pracowników służby zdrowia potrafili oni stosować procedury HH w codziennej praktyce. Wskazania do wykonania higieny rąk powinny być często powtarzane podczas studiów uniwersyteckich. Należy rozważyć inne podejście do zagadnienia HH u mężczyzn i kobiet.

SŁOWA KLUCZOWE: higiena rąk, nauczanie, studenci wydziału lekarskiego

INTRODUCTION

Hand hygiene (HH) is a key element in preventing nosocomial infection, especially the spread of multidrug-resistant microorganisms [9, 11]. The knowledge of and compliance with the rules, as well as awareness of the need for such knowledge plays a key role in the daily work of medical personnel within various hospital departments [17, 21, 23]. Clear explanation of HH importance seems to be a significant task in medical education [16, 24]. Evaluation of hand hygiene practices and related perception and knowledge at a health-care facility is a vital element of the strategy of improving HH. Semmelweis' original work focused on medical students. HH awareness and compliance among students seem to be an important factor in medical education [18, 19]. It has been reported that medical health care workers were less likely compliant with hand hygiene than the paramedics, even at a student level [16].

Tools for evaluation and feedback given by the World Health Organization (WHO), such as a questionnaire with technical questions, assess actual knowledge of the essential aspects of hand transmission and HH during patient care as suggested [30]. The aim of the study was to evaluate the knowledge regarding hand hygiene and its role in hospital infection control among students.

MATERIAL AND METHODS

A total number of 105 students at the English Division Faculty of Medicine at the Medical University of Warsaw,

Poland, participated in an optional course on hospital infection control. During the course, some elements of HH training were introduced. The training was designed to promote key concepts of hand hygiene and standard precautions for healthcare professionals, including "Save lives – clean your hands", known as "5 Moments for Hand Hygiene" [2, 28]. At the end of the course, the students participated in a survey. Questions 1–18 were taken from the training "Hand Hygiene in Healthcare Settings – Supplemental" by CDC [2], questions 19, 20, 30, 31, 32 and 33 were taken from "WHO HH Knowledge Questionnaire for Health-Care Workers" [29] and questions 21–29 were taken from the test given to medical students after a hand hygiene training course, available at the Indiana University School of Medicine website [12]. The questionnaire is presented in Table 1A and 1B. For the purpose of data analysis, the students were divided into two groups where group 1 consisted of 58 students from the first to third year of studies (1 student from the 1st, 37 from the 2nd, 20 from the 3rd, 25 women, 33 men) and group 2 consisted of 47 students from the fourth and sixth year of studies (46 from the 4th and 1 student from the 6th, 26 women, 21 men).

Statistical analysis was performed by applying the Pearson's test and Fisher's test.

RESULTS

The questionnaire consisted of 33 questions. Questions 1–11 and 19–23 had one correct answer, 13–18 had two possible answers, 12, 24–29 were of the true/false type, 30–33 yes/no type. The results of the questionnaire are presented in Table 2.

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Table 1A. Questions included in the questionnaire, questions 1–12 and 19–34 – one correct answer, 13–18 – two correct answers. The correct answers are bolded. The answer key was taken from the literature [2, 12, 29].

Questions included in the questionnaire	Answers
1. In your opinion what is the hand hygiene compliance among healthcare providers.	a) 95%; b) 10%; c) 40%* ; d) 65%
2. How often do doctors should clean hands after touching a patient's intact skin (for example, when measuring a pulse or blood pressure)?	a) Always ; b) Often; c) Sometimes; d) Never
3. Which of the following hand hygiene agents is least drying to the skin?	a) Plain soap and water; b) Antimicrobial soap and water; c) Alcohol-based handrub
4. In your opinion how much time would an ICU nurse save during an 8 hour shift by using an alcohol-based hand rub instead of soap and water?	a) 15 minutes; b) 30 minutes; c) 1 hour** ; d) 2.5 hours
5. What is the single most important reason for HCWs to practice good hand hygiene?	a) To remove visible soiling from hands; b) To prevent transfer of bacteria from the home to the hospital; c) To prevent transfer of bacteria from the hospital to the home; d) To prevent infections that patients acquire in the hospital
6. Alcohol-based hand rub may be used instead of soap and water when hands are not visibly soiled.	True False
7. In your opinion which method do doctors should use to clean their hands at work?	a) Plain soap and water; b) Antimicrobial soap and water; c) Alcohol-based handrub
8. In your opinion how often do doctors should clean their hands after touching an environmental surface near a patient (for example, a countertop or bedrail)?	a) Always ; b) Often; c) Sometimes; d) Never
9. When washing hands, which of the following is important to remember?	a) Wash with hottest water possible; b) The focus of good hand washing is the palms; c) Turn faucet off after disposing of your paper towel; d) Lather and rub hands together for 15 seconds
10. Which of the following is the correct order when performing hand hygiene?	a) Wet hands; apply soap; rub vigorously; rinse hands; b) Apply soap; wet hands; rub vigorously; rinse hands; c) Apply soap; rub vigorously; rinse hands; turn off faucet; d) Wet hands; apply alcohol based hand rub; rub vigorously; turn off faucet
11. When hands are visibly soiled and water is not available, how is hand hygiene performed?	a) Using a moist towelette; b) Using alcohol based hand rub; c) Using a moist towelette followed by alcohol-based hand rub; d) Using a disinfectant wipe
12. Hand hygiene is the most important way to prevent the spread of microorganisms.	True False
13. It is acceptable for HCWs to supply their own lotions to relieve dryness of hands in the hospital.	a) Strongly agree; b) Agree; c) Don't know; d) Disagree; e) Strongly disagree
14. Healthcare-associated organisms are commonly resistant to alcohol.	a) Strongly agree; b) Agree; c) Don't know; d) Disagree; e) Strongly disagree
15. When a HCW touches a patient who is colonized, but not infected with resistant organisms (e.g. MRSA or VRE), the HCW's hands are a source for spreading resistant organisms to other patients.	a) Strongly agree; b) Agree; c) Don't know; d) Disagree; e) Strongly disagree
16. A co-worker examines a patient with VRE, after touching the patient with VRE, the patient with VRE borrows your pen without cleaning his/her hands. Is it likely to contaminate your pen with VRE?	a) Strongly agree; b) Agree; c) Don't know; d) Disagree; e) Strongly disagree
17. Use of artificial nails by HCWs poses no risk to patients.	a) Strongly agree; b) Agree; c) Don't know; d) Disagree; e) Strongly disagree
18. Glove use for all patient care contacts is a useful strategy for reducing risk of transmission of organisms.	a) Strongly agree; b) Agree; c) Don't know; d) Disagree; e) Strongly disagree
19. Which of the following is the main route of cross-transmission of potentially harmful germs between patients in a healthcare facility?	a) HCW's hands when not clean; b) Air circulating in the facility; c) Patient's exposure to colonized surfaces (i.e., beds, chairs, tables, floors) between patients; d) Sharing non-invasive objects (i.e., stethoscopes, blood pressure cuffs, etc.) between patients
20. What is the minimal time needed for alcohol-based hand rub to kill most germs on your hands?	a) 20 seconds ; b) 3 seconds; c) 1 minute; d) 10 seconds

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Table 1B. Questions included in the questionnaire, questions 1–12 and 19–34 – one correct answer, 13–18 – two correct answers. The correct answers are bolded. The answer key was taken from the literature [2, 12, 29].

Questions included in the questionnaire	Answers
21. Indications for hand hygiene include focus on both point of care and general indications not related to patient care. Which of the following are correct?	a) Wash your hands with soap and water if they are visibly dirty or soiled; b) Wash your hands with soap and water if caring for a patient with diarrhea or <i>Clostridium difficile</i> ; c) Wash your hands with soap and water before eating, after using the restroom and after coughing, sneezing or blowing your nose; d) All of the above
22. Which of the following situations apply to moment #2, performing hand hygiene before a clean/aseptic procedure?	a) Before shaking hands, taking a pulse, assisting a patient to walk; b) Before brushing a patient's teeth, dressing a wound, starting an IV, preparing medications; c) After giving an injection, after cleaning a blood spill, after hanging a urinary bag on a stretcher
23. The proper technique for performing hand hygiene using soap and water is:	a) Turn on faucet, apply soap, scrub for 5 seconds, rinse, turn off faucet, and dry hands; b) Turn on faucet, wet hands, apply soap, scrub all surfaces, rinse, dry hands and turn off faucet with wrists; c) Turn on faucet, wet hands, apply soap, scrub all surfaces for at least 15 seconds, rinse, dry hands and turn off faucet with paper towel; d) All of the above are correct
24. If hands are not visibly soiled, the preferred means for routine hand hygiene is the use of an alcohol hand rub.	True False
25. To comply with routine hand hygiene recommendations, HCWs should ideally perform hand hygiene when and where care is provided. This means at the point of care within the patient zone and at the moments indicated.	True False
26. Moment #1 takes place upon entering the patient's room or the immediate surroundings whether or not you anticipate touching the patient or the environment. The rationale for moment #1 is to protect the patient against colonization or infection related to harmful germs on your hands.	True False
27. Upon exiting a room after touching a patient or the environment it is not necessary to perform hand hygiene because you are done taking care of that patient.	True False
28. Only use hand lotions that are approved by your hospital and only apply to clean hands.	True False
29. Only doctors and nurses need to be concerned about hand hygiene. It does not matter that other disciplines such as facilities, housekeeping, phlebotomy lab techs, respiratory therapy, dietary, and EKG techs perform hand hygiene because they spend less time with the patients.	True False
30. Does washing hands immediately after risk of body fluid exposure prevent transmission of germs to the patient?	Yes No
31. Does washing hands after exposure prevent transmission of germs to the immediate surroundings of a patient.	Yes No
32. Does washing hands immediately before a clean/ aseptic procedure prevent transmission of germs to the patient.	Yes No
33. Does washing hands before touching a patient prevent transmission of germs to the patient.	Yes No

ICU – intensive care unit; IV – intravenous line; MRSA – methicillin-resistant *Staphylococcus aureus*; VRE – vancomycin-resistant *Enterococcus*.

* – correct answer to question 1 is 40% based on WHO evaluation [31];

** – the correct answer to question 4 is 1 hour, based on 12 opportunities per hour for 8 hours with a hand washing time (including walking to the sink and back) of 60 seconds per wash, and an alcohol-based hand rub time of 20 seconds per hand rub [12].

Question 5, regarding the most important reason why HCWs (Health Care Workers) should respect the principle of HH was correctly answered by 94.85% students from group 1 and 93.62% from group 2 ($p > 0.05$). This issue was better understood by men ($p < 0.05$). Question 7, concerning the way doctors should use to clean their hands at work with alcohol-based hand rub was correctly answered by 72.41% and 68.09%, students from group 1 and 2, respectively ($p > 0.05$). The minimal time needed for alcohol-based

hand rub in order to kill most germs on the hands (question 20) – 20-seconds – was known only to 44.83% of students from group 1 and 55.33% from group 2; 52.94% females and 46.30% males. A total of 5.17% of students from group 1 selected one minute as their correct answer and 5.17% – 10 seconds unlike students from group 2: 19.14% chose 10 seconds and 8.5% only 3 seconds.

In question 12 regarding HH, the most important way to prevent the spread of microorganisms appeared true for

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Number of question	% of correct answers		Statistical significance (p)	% of correct answers		Statistical significance (p)	% of correct answers all participants (n=105)
	Group 1 (n=58)	Group 2 (n=47)		Females (n=51)	Males (n=54)		
1.	39.66	61.07	p<0.05	60.78	38.89	p<0.05	49.5
2.	55.17	4.26	p<0.05	29.41	35.19	p>0.05	32.4
3.	50.00	2.13	p<0.05	15.69	40.74	p<0.05	28.6
4.	53.45	27.66	p<0.05	41.18	42.59	p>0.05	41.9
5.	94.83	93.62	p>0.05	90.20	98.15	p<0.05	94.3
6.	72.41	70.21	p>0.05	66.67	75.93	p>0.05	71.4
7.	72.41	68.09	p>0.05	72.55	66.67	p>0.05	69.5
8.	34.48	2.13	p<0.05	15.69	24.08	p>0.05	20.0
9.	68.97	89.36	p<0.05	78.43	77.78	p>0.05	78.1
10.	65.52	82.98	p<0.05	70.59	75.93	p>0.05	73.3
11.	43.10	78.72	p<0.05	64.71	53.70	p>0.05	59.0
12.	94.83	97.87	p>0.05	96.08	96.30	p>0.05	96.2
13.	53.45	40.43	p>0.05	41.18	53.70	p>0.05	47.62
14.	65.52	57.45	p>0.05	49.02	70.07	p<0.05	61.90
15.	86.21	87.23	p>0.05	90.20	83.33	p>0.05	86.67
16.	75.86	68.09	p>0.05	68.63	75.93	p>0.05	72.38
17.	87.93	89.36	p>0.05	90.20	97.04	p>0.05	88.57
18.	82.76	95.74	p<0.05	88.24	88.89	p>0.05	88.57
19.	60.34	68.09	p>0.05	70.59	57.41	p>0.05	63.8
20.	44.83	55.32	p>0.05	52.94	46.30	p>0.05	49.5
21.	81.03	95.74	p>0.05	90.2	83.33	p>0.05	86.7
22.	31.0	46.8	p<0.05	45.1	31.5	p>0.05	38.1
23.	72.41	89.36	p<0.05	84.31	75.93	p>0.05	80.0
24.	74.14	74.47	p>0.05	68.63	79.63	p>0.05	74.3
25.	82.76	93.62	p<0.05	92.20	85.19	p>0.05	87.6
26.	94.83	100.00	p>0.05	98.04	96.30	p>0.05	97.1
27.	86.21	95.74	p<0.05	96.08	85.19	p<0.05	90.5
28.	60.34	63.83	p>0.05	66.67	57.41	p>0.05	61.9
29.	86.21	97.87	p<0.05	100.00	83.33	p<0.05	91.4
30.	5.17	14.89	p<0.05	13.73	5.56	p>0.05	9.5
31.	17.24	19.15	p>0.05	13.73	22.22	p>0.05	18.1
32.	87.93	97.87	p<0.05	94.12	90.74	p>0.05	92.4
33.	96.55	97.87	p>0.05	98.04	96.30	p>0.05	97.1

Table 2. Results of the questionnaire.

94.83% of students from group 1 and 97.87% from group 2. In question 13, regarding the acceptability for HCWs to supply their own hand lotions at work 53.45% and 40.43%, students from group 1 and group 2, respectively, responded correctly. However, in question 28 concerning the same issue, but differently formulated, the correct answer was provided by 60.34% and 63.83%, group 1 and 2, respectively ($p>0.05$). In question 14, the correct answer was chosen more often by men than women (70.07% vs. 49.02%) ($p<0.05$). However, when group 1 and 2 were compared, results were 65.52% vs. 57.45%, respectively ($p>0.05$).

A total of 89.36% students from group 2 and 80.36% from group 1 as well as 97.40% males and 90.20% females disagreed or strongly disagreed with the statement that the use of artificial nails by HCW poses no risk to patients (question 17) (both $p>0.05$).

HH mechanisms needed to prevent transmission of microorganisms to the patient were not well understood. When not clean, HCW hands are the main route of cross-transmission of potentially harmful germs among patients in the health-care facility (question 19) – that was known to 68.09% students from group 2 and 60.34% from group 1 as well as to

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70.50% females and 57.41% males (both $p > 0.05$). No need to wash hands immediately after risk of body fluid exposure was better understood by students from group 2 (question 30). Question 2 concerning the need for HH after contact with the patient, eg. when measuring heart rate or pressure, was correctly answered by 55.2% of students from group 1 and only 4.3% of students from group 2 ($p < 0.05$). In question 6, regarding the use of alcohol-based hand rub instead of soap and water, when the hands are not dirty as seen with the naked eye, the correct answer was given by 72.41% and 70.21%, group 1 vs. group 2, respectively ($p > 0.05$). However, in question 24 which inquired about the same issue, but differently formulated, the correct answer was provided by 74.14% and 74.47%, group 1 vs. 2, respectively ($p > 0.05$). In question 31, regarding the prevention of germ transmission to the surroundings of patients by hand washing, a correct answer was provided by 17.24% students from group 1 and 19.15% from group 2 and by 13.73% women and 22.22% men.

A total 48.26% of students from group 1 chose answer A (95%) and D (65%) as hand hygiene compliance rate among healthcare providers (question 1) and only 23.40% of students from group 2 (data not presented). In our survey, 61.7% students from group 2 selected answer C (40% – data obtained by the WHO [31]) unlike 39.66% students from group 1 ($p < 0.05$). Furthermore, students from group 1 provided the correct answer to questions 3, 4 and 8 ($p < 0.05$) and they were better observers in HCW HH compliance (questions: 2, 3, 4, 8). The students from group 2 were much more likely to choose the correct answers to questions about indications for HH (79.3% group 1 vs. 95.7% group 2) (question 21), the correct sequence of work when washing hands (65.5% group 1 vs. 83% group 2) (question 10), and knowledge of the most important stage of washing hands (69.0% group 1 vs. 89.4% group 2) (question 9). The percentage of correct answers as for the issues regarding the fact that not only doctors and nurses should follow HH, but also people from other professional groups (eg.: dietician, employee performing ECG, phlebotomy lab techs, physiotherapist, housekeeping service), whose contact with the patient is sporadic and takes less time, was higher for students from group 2 – 97.9% unlike for students from group 1 – 86.2% ($p < 0.05$) (question 29). All students from group 2 correctly answered the question concerning the application of moment #1 of the WHO program (main assumptions are presented in Table 3) unlike 94.8% of students from group 1 (question 26). Answer to the question on moment #5 was obvious – for 95.7% students from group 2 ($p < 0.05$) and for 96.08% female students ($p < 0.05$) (question 27). Students from group 2 had better knowledge on the application of HH procedures. They gave a higher number of correct answers to questions 1, 9, 10, 11, 18, 21–23, 25, 27, 29, 30 and 32 ($p < 0.05$). In question 18 concerning glove use in reducing the risk of transmission of organisms, 95.74% students

from group 2 answered correctly ($p < 0.05$). Male students were good at choosing the right agent for HH (questions 3, 6 and 14). The issue regarding the transmission of MDROs (Multidrug Resistant Microorganisms) (question 15 and 16) was more familiar to students from group 2 ($p > 0.05$) and to men ($p > 0.05$). In questions: 22, 25–27, 30, 32 and 33 related to the application of various moments of HH a higher number of students from group 2 provided correct answers ($p < 0.05$) (see Table 3).

DISCUSSION

The analysis of our results revealed a correlation between the number of years of study and the test result. Our research demonstrates the need for the introduction of HH from the very beginning of the education process at the medical faculty. In questions concerning the frequency of hand cleaning after coming in contact with the patient's intact skin or his surrounding environment, as well as time saving by hand rubbing instead of washing with soap and water and the knowledge that alcohol based hand rubs dry the skin far less than plain soap and water, or antimicrobial soap and water, younger students scored better ($p < 0.05$). Furthermore, the main principles of HH were better understood by younger students (questions, 5, 6, 7, 13, 14, 15) ($p > 0.05$). Students from group 1 participated in courses, which were not provided at the hospital (eg.: anatomy, histology, physiology, etc.) and their contact with hospital staff was brief. Students from group 1 have a theoretical knowledge of what should be done to prevent hospital acquired infections while students from group 2 are subject to "real life" experiences. Students from group 2 observed the behavior of more experienced colleagues and this had an influence on their perception from a "theoretical" and "practical" perspective (questions 9–12 and 16–33). Contradictory observations were reported by Legeay et al. [16]. Student background factors significantly associated with better scores were their current year of study; with lower scores associated with less time spent working in the hospital. After each completed year of studies, students participating in our survey, take part in monthly internships at various departments in hospitals of their choice in Poland or their home country. There, they come on contact with the hospital staff (nurses and doctors) who serve as their role models. Mentor hand hygiene practices influence student hand hygiene rates [3, 4, 25]. As reported previously, it appears that older students with a greater hospital background were more knowledgeable [16]. According to data obtained by the WHO, adherence of HCWs to recommended hand hygiene procedures has been reported as variable, with means baseline rates ranging from 5% to 89% and an overall average of 38.7% [31]. Our research shows that 48.26% students from group 1 believed in higher compliance (65–95%) to HH of

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health care providers than WHO overall coverage (40%) and 23.40% for students from group 2 (question 1). The behavior of students might be strongly influenced by their mentor's (role model) attitude at the bedside [3, 4]. Unfortunately, it often seems that there is a lack of role models when complying with HH procedures. Role models change with each passing year of training from teachers to senior colleagues and if any of these role models were performing faulty HH, as is very common in the hospital setting, then the students were likely to be less compliant [3, 25]. Graf et al. presented a decline of HH compliance among medical students as they reach higher positions in the medical hierarchy [8]. The results obtained by Roberto et al. pointed out that medical students from the 1st year of study followed the professors and their 6th year colleagues [22]. Sixth year students' intention was better predicted by a norm that interferes with compliance; whereas intentions from 1st year students were better predicted by a norm that favors compliance. Role models and mentors are the key factors in teaching HH in medical undergraduate curricula [3]. Kovacs-Litman et al. observed that physician trainees showed markedly better compliance when attendings staff cleaned their hands compared with encounters when attending did not (79.5% vs. 18.9%; $p < 0.0002$) [15]. HH should become an educational priority and should be incorporated into all undergraduate clinical assessments and into teaching quality assessments. Part of the curriculum for medical students should be devoted to presenting clear evidence that healthcare workers' hands become contaminated by pathogens after patient contact, and the alcohol hand rubs are the easiest and most effective means of decontaminating hands between physical contact with patients [7]. Studies reveal differences in knowledge and attitude between students and doctors towards HH. Herbert et al. reported adherence to hand hygiene in 49% among medical students and Kasperczyk only in 30% [10, 14]. However, Basurrah et al. reported that 70% of medical students and 9.1% of senior medical staff adhered to HH procedures [1]. Johnson et al. reported that female students had a higher hand hygiene compliance (59%) than males (32%) [13]. Elkhawaga et al. has also observed that female students had a higher statistically significant rate of HH practices than males especially after: visiting the toilet (87% vs. 63%), caring for a wound (91.6% vs. 80.5%), contact with blood or body fluids (97.2% vs. 90.6%), contact with a patient (27.1% vs. 12.4%), exiting an isolation room (20.3% vs. 11.9%), contact with patient secretions (94.6% vs. 77.5%), and if felt that their hands were dirty (90.7% vs. 70.5%), respectively [4]. In our survey, the females presented with a higher knowledge than men which was statistically significant in questions regarding the need for HH performance after touching a patient or the environment (96.08% vs. 85.19%). The females' higher compliance might be associated with their tendency to practice socially acceptable behaviors [13].

Table 3. Save lives, clean your hands – WHO program assumptions [2, 9, 28].

WHO program "5 Moments for Hand Hygiene" recommends HCW to clean hands:	
BEFORE TOUCHING A PATIENT when approaching him/her to protect the patient against harmful germs carried on HCW's hands	moment #1
BEFORE CLEAN/ASEPTIC PROCEDURE to protect the patient against harmful germs, including the patient's own, from entering his/her body, including his/her own germs	moment #2
AFTER BODY FLUID EXPOSURE RISK (and after glove removal) to protect yourself and the health-care environment from harmful patient germs	moment #3
AFTER TOUCHING A PATIENT and her/his immediate surroundings, when leaving the patient's side to protect yourself and the health-care environment from harmful patient germs	moment #4
AFTER TOUCHING PATIENT SURROUNDINGS (any object or furniture in the patient's immediate surroundings) when leaving – even if the patient has not been touched to protect yourself and the health-care environment from harmful patient germs	moment #5

Mann et al. reported that 58% of medical students were not familiar with the correct indications for using alcoholic hand gel and 49% thought that there was an insufficient emphasis on infection control in their course [18]. According to Kasperczyk 73% ($p < 0.05$) of students from medical faculty thought they should be trained in proper techniques of hand-washing [13]. Multifaceted and dedicated efforts should be undertaken to rectify attitude and behavior from early on, to modify and enhance the curriculum in order to improve hand hygiene practices understanding of infection control and HH among students. This is expected to play a major role in curbing disease transmission when the students graduate and join the healthcare workforce in the future [3, 8]. According to Foote et al., the self-reported compliance rate among undergraduate nursing students was 74.8% [6]. Logistic regression analysis revealed that the independent predictors of hand hygiene compliance included concern about reprimand or discipline, motivation to protect patients from infection, number of clinical placements and role modeling by the clinical instructor, busyness, forgetfulness and perceptions of alcohol rub-related skin damage – the findings of their study provide research-based evidence that could be used by educators to better understand hand hygiene practices among undergraduate nursing students [6].

In the study conducted by Graf et al., medical students were questioned about their knowledge and beliefs on hand hygiene before entering the clinical phase of education [8]. Authors noticed a lack of knowledge concerning the correct indications for hand disinfection. In our study, 29% of medical students were able to identify all the indications for HH, much less significant than in Van de Mortel's study – 56% [27]. The question concerning washing hands immediately after the risk of body fluid exposure to prevent transmission of microorganisms to the patient (question 30) was

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troublesome. Nair et al. believe that the correct answer is “yes” as well as 87.8% medical students surveyed by them. However, Vaishnav et al. considered “no” as the correct answer just as 26.71% doctors and 8.10% medical students tested by them [20, 26]. In our study, only 8.5% of medical students have chosen the answer “no”. The question concerning HH after exposure in order to prevent transmission of MDROs to the patient’s immediate surroundings (question 31) was the most difficult for students. It concerned prevention of infection transmission to the immediate surroundings of a patient. The correct answer “no” was chosen only by 17.2% of students from group 1 and 19.2% from group 2. The majority of students presumed there was a need for HH. In comparison, in Nair’s study 26.7% of medical students and in Vaishnav’s research 56.49% of doctors and 70.27% of medical students chose the correct answer [26].

To summarize, the results of the questionnaire, confirm the results obtained by other researchers regarding medical student knowledge on HH. Students from different countries, different economic and educational backgrounds, present a similar view on hand hygiene and its role in hospital acquired infections. Therefore, poor knowledge about HH practice prevails among medical students who are the future physicians [4, 19]. Medical universities should work to improve hand hygiene practices among students, so that when students complete their university education and join the healthcare workforce, they will comply with HH procedures in everyday practice. Practical rounds in an ICU (Intensive Care Unit) or infectious diseases department, under supervision of a senior physician serving as role model, might be an option to improve medical students’ sensitivity to HAIs (Hospital-Acquired Infection) [16]. An idea for improving medical students’ sensitivity to standard precautions might be to engage them as covert observers in hospitals departments so that they can monitor hand hygiene compliance [16]. Scheithauer et al. suggested implementation of regular education and practical training on HH from early on in the medical studies curriculum to improve the overall quality of patient care [5, 19].

Due to the small size of the groups, the obtained results should be considered as preliminary. The variety of questions regarding different aspects of hand hygiene to the students in the questionnaire draws attention as to the seriousness of the problem. The education process of medical students should take these issues into account. The research on this topic will be continued.

CONCLUSIONS

1. Medical universities should strive to improve HH practices among student from early years of education. This way, future physicians will apply HH procedures in their daily practice.

2. HH indications, correct understanding as well as application should be frequently repeated during medical university education.
3. A different approach to HH problems by men and women should be taken into consideration.

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