SURGICAL NURSES´ KNOWLEDGE AND COMPETENCY TOWARDS HAND HYGIENE AND THE HOSPITAL ENVIRONMENTAL HYGIENE
VEDOMOSTI A KOMPETENCIE SESTIER V CHIRURGICKÝCH ODBOROCH V OBLASTI HYGIENY RÚK A HYGIENY NEMOCNIČNÉHO PROSTREDIA

HLINKOVÁ Edita[1], NEMCOVÁ Jana[1], FARSKÝ IVAN[1], BOHUNČÁKOVÁ Antónia[2]

[1] *Katedra ošetrovateľstva, Jesseniova lekárska fakulta, Univerzita Komenského Bratislava, Martin*
[2] *Oddelenie centrálnej sterilizácie, Univerzitná nemocnica Martin, Martin*

ABSTRACT
Background: Preventing and reducing the risk of the development and spreading of infections should be priorities in the activities of healthcare personnel. The basic requirement is compliance with hand hygiene and hospital environmental hygiene.
Aim: To identify the level of knowledge and competency of surgical nurses toward hand hygiene and the hospital environmental hygiene.
Design and method: This study employed a descriptive, cross-sectional, self-reported design. The research was carried out at University Hospital in Martin. The target group was nurses working in 11 surgical fields (n = 150). Empirical data was collected using a questionnaire developed for the purposes of the present research. The questionnaire consisted of 49 items divided into three thematic areas: 1) hand hygiene, hospital environmental hygiene, 2) epidemiologically important pathogens, 3) competency.
Results: Nurses demonstrated a satisfactory level of knowledge of the healthcare-associated infections (Likert scale 1 – 5). Incorrect answers were given concerning thematic areas: formaldehyde sterilisation (mean = 3.89; SD ± 0.06), plasma sterilisation (mean = 4.25; SD ± 0.83), only 40.7 % of nurses have knowledge if patients are colonized by MRSA and 32 % nurses have knowledge about the risk of infection from blood exposure from an HIV-positive person (mean = 3.52; SD ± 1.08). Statistically significant differences were found in relation to length of experience. Nurses with less than 5 years' experience would demonstrate a low level of knowledge of new important infectious diseases such as HCAI, AIDS and Ebola. Specialised study affected nurses' knowledge level, as did the surgery unit in which nurses worked. Nurses working in a multi-speciality surgical pavilion demonstrated a higher level of knowledge including the definition of basic terms ($p = 0.005$; $p = 0.025$), HCAI caused by CPE and in dimension nurse´s competency ($p < 0.001$; $p = 0.006$).
Conclusions: The study identified the knowledge level and competency of surgical nurses concerning the hospital environmental hygiene and points to factors that influence nurses' knowledge level - the length of their clinical experience, postgraduate specialised study and surgery unit management.

Key words: Hand hygiene. Hospital environmental hygiene. Surgical nurses. Knowledge. Competency.

ABSTRAKT
Východiská: Prevencia a znižovanie rizík vzniku a šírenia infekcie by mali byť prioritnými aspektmi v činnosti zdravotníckych pracovníkov. Základom je dodržovanie hygienicko-epidemiologického režimu a zdravotníckej prevencie.
Ciele: Cieľom štúdie bolo identifikovať úroveň vedomostí a kompetencie sestier v chirurgických odboroch o hygiene rúk a hygiene nemocničného prostredia.
Súbor a metódy: Prierezová štúdia bola realizovaná v Univerzitnej nemocnici v Martine. Cieľovú skupinu tvorili sestry pracujúce v 11 chirurgických odboroch (n = 150). Na získanie empirických údajov sme použili dotazník vlastnej konštrukcie. Dotazník obsahoval 49 položiek rozdelených do troch tematických oblastí: 1) hygiena rúk, hygienicko-epidemiologický režim, 2) epidemiologicky závažné infekcie, 3) kompetencie.
Výsledky: Sestry preukazovali uspokojivú úroveň vedomostí o definícií, vzniku a šírení nozokomiálnych infekcií (na Likertovej škále 1 – 5). Nesprávne odpovede sa týkali sterilizácie formaldehydom (priemer = 3,89; SD ± 0,06), sterilizácie plazmou (priemer = 4,25; SD ± 0,83), iba 40,7 % sestier má vedomostí o ošetrovaní pacientov kolonizovaných MRSA a 32 % má vedomosti o riziku infekcie pri expozícii krvou od HIV pozitívnej osoby (priemer = 3,52; SD ± 1,08). Štatisticky významné rozdiely boli zistené v súvislosti s dĺžkou praxe. Sestry s menej ako 5 -ročnou praxou preukázali nízku úroveň vedomostí o nozokomiálnych infekciách, AIDS a Ebole. Špecializačné štúdium ovplyvnilo vedomostnú úroveň sestier ako aj chirurgické pracovisko, kde sestry pracujú. Vyššiu úroveň vedomostí preukázali sestry pracujúce v spoločnom chirurgickom pavilóne so spoločnými operačnými sálami a to v oblasti definícii základných pojmov ($p = 0,005$; $p = 0,025$), nozokomiálnych infekcií spôsobených CPE aj v oblasti kompetencií sestry ($p < 0,001$; $p = 0,006$).
Záver: Štúdia odhaľuje vedomostnú úroveň chirurgických sestier v oblasti hygienicko-epidemiologického režimu, poukazuje na faktory ovplyvňujúce vedomostnú úroveň sestier – dĺžka klinickej praxe, postgraduálne špecializačné štúdium a manažment chirurgického pracoviska.

Kľúčové slová: Hygienicko-epidemiologický režim. Hygiena rúk. Sestry v chirurgických odboroch. Vedomosti. Kompetencie.

INTRODUCTION

The prognosis for the incidence of epidemiologically important pathogens (EIP) in the early decades of the third millennium is not optimistic. New multi-resistant strains are emerging and rapid, globally spreading resistance of microorganisms to anti-infectives is increasing. These are significant risk factors for public health and patient safety. The ev-

idence of this is the COVID-19 (Coronavirus disease 2019) pandemic caused by the coronavirus SARS-CoV-2 of the family *Coronaviridae*. Hospitals and community facilities were not spatially, materially or personally prepared for the treatment of patients and a strict hygienic-epidemiological regime (The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team, 2020). Insufficient knowledge and the associated incorrect procedures, but also the incorrect competency of health professionals, increase the spread of the infection (McEachan et al., 2016; Wu et al., 2020).

In 2019 health institutions in the Slovak Republic reported a total of 13,955 healthcare-associated infections (HCAI), which is an increase of 17,7 % compared to 2018. As the total number of patients hospitalised in the Slovak Republic was 1,634,645, the incidence rate of reported HCAI was 0.8 %. The department with the highest incidence of HCAI in hospitalised patients was anaesthesiology and intensive medicine (12, 7 %) (Analysis of the Epidemiological Situation and the Activities of the Departments of Epidemiology in Slovak Republic for 2019). In the last ten years there has been a significant increase in cases of *Carbapenem-resistant Enterobacteriaceae* (CRE) or *Carbapenemase-producing Enterobacteriaceae* (CPE), which are often resistant to all available antibiotics (Albiger et al., 2015; European Centre for Disease Prevention and Control, 2016). In 2018 there were 383 positive findings of *Klebsiella pneumoniae carbapenemase* (KPC) in the Slovak Republic (Annual Report on the Activities of Public Health Offices in the SR According to Individual Public Health Departments for Year 2018). CDC's annual National and State Healthcare-Associated Infections Progress Report describes national and state progress in preventing HCAI. We can state 7 % statistically significant decrease in central line-associated bloodstream infections, 8 % statistically significant decrease in catheter-associated urinary tract infections between 2018 and 2019 in acute care hospitals, there was no significant change in surgical site infections related to the 10 select procedures tracked in previous reports between 2018 and 2019 and no significant changes in hospital onset Methicillin-resistant *staphylococcus aureus* (MRSA) bacteremia between 2018 and 2019. Research shows that when healthcare facilities, care teams, and individual doctors and nurses, are aware of infection problems and take specific steps to prevent them, rates of some targeted HCAI can decrease by more than 70 % (Centers for Disease Control and Prevention, 2019).

Patients infected with antibiotic-resistant bacteria had a higher risk of complications and a threefold higher risk of death caused by infection (Cecchini et al., 2015). It is estimated that mortality rates could be 10 million per year on the global level by 2050 if no countermeasures are taken (O'Neill, 2014).

In addition to HCAI, it is necessary to consider other severe infections that are spread throughout the world by international travel, including Human immunodeficiency virus (HIV), Ebola virus disease (EVD), COVID-19 and the like.

Preventing and reducing the risk of the development and spreading of infections should be priorities in the activities of healthcare personnel. The basic requirement is compliance with hand hygiene, hospital environmental hygiene (HEH) and health precautions. The performance of such activities requires a professional approach to health care, up-to-date knowledge and relevant skills in daily clinical practice (competency). Mustard defined competency as the actual performance of work in compliance with standards of care (Mustard, 2002). HEH is a comprehensive set of rules for operational and working procedures whose purpose is to prevent the development and spreading of infections in health institutions, to minimise the risk of wound infections and HCAI and to prevent the transmission of an infection from a source to a susceptible patient. According to the World Health Organisation, hand hygiene is the most important measure for preventing the transmission of bacteria in hospitals (WHO Guidelines on Hand Hygiene in Health Care, 2009 and 2014). A clean environment, staff training, compliance with antiseptic and aseptic procedures, barrier nursing techniques with an emphasis on hand disinfection, use of single-use materials are some of the techniques that can effectively eliminate the transfer of infections from exogenous sources (Štefkovičová et al., 2019).

Effective prevention of HCAI and EIP require that departmental and hospital management create optimal conditions for it. Important requirements are discipline, responsibility and the level of staff education. An intervention that can improve compliance is continuous training for healthcare personnel and successful education that changes hygiene performance in nursing (Špačilová, 2017).

AIM

The aim of the study was to identify surgical nurses' knowledge and competency of hand hygiene, HEH and EIP. The research investigated whether there was a relationship between nurses' knowledge level and competency in the specialisation of the surgery unit where the nurses work, between nurses' knowledge level and competency in their length of experience in surgery and whether nurses' level of knowledge of hand hygiene and HEH is affected by their level of education in health care.

SAMPLE AND METHODS

This study employed a descriptive, cross-sectional, self-reported design. The research was conducted in University Hospital in Martin. The target group was nurses working in surgical fields. The number of questionnaires distributed was 160. The return rate for questionnaires was 93.8 %. The target group was nurses working in 11 surgical fields in standard treatment units, intensive care units and operating theatres. The total number of respondents was 150. The set of respondents – nurses was chosen at random. The classifying criterion was to work as a nurse in a surgical field. Respondents were excluded if they were nurses who had only recently started work – i.e. who had completed their studies in the last three months. All participants were provided with information about the aims and methods of research. The data collection was anonymous and all participants signed an informed letter of consent. Hospital ethical committee approval for the research project was obtained.

A more detailed overview of respondents' characteristics – gender, education, specialisation, length of experience and surgery unit – is given in Table 1.

Empirical data was collected using a questionnaire developed for the purposes of the present research. The content of the questionnaire related to nurses' knowledge of hand hygiene and HEH. It is based on applicable legislation of the Ministry of Health of the Slovak Republic, internal operational recommendations and infection prevention procedures in health institutions, hygienic and epidemio-

Table 1 Demographic characteristics

Parameter	n = 150	%
Gender		
female	148	98.70
male	2	1.30
Level of education		
secondary education and higher education	65	43.30
a level I. university education, Bachelor's degree in Nursing	48	32.00
a level II. university education, Master's degree in Nursing	37	24.70
Specialised education		
Nursing Care in Surgery	64	42.70
Intensive nursing care for adults	26	17.30
Instrumentation in the operating room	30	20.00
No	30	20.00
Years of experience (nurse)		
< 5	25	16.80
6 – 10	17	11.30
11 – 20	29	19.30
21 – 30	47	31.30
> 31	32	21.30
Surgery unit		
Multi-speciality surgical pavilion	85 (18∗)	56.7 (12∗)
Clinic of Surgery and Transplant Centre (n=38); Clinic of Thoracic Surgery (n=5); Clinic of Neurosurgery (n=8); Department of Vascular Surgery (n=9); Department of Plastic Surgery (n=15); Clinic of Paediatric surgery (n=10)		
Separate buildings	65 (20∗)	43.3 (13,3∗)
Orthopaedic Clinic (n=15); Clinic of Otorhinolaryngology and Head and Neck Surgery (n=10); Clinic of Urology (n=15); Clinic of Ophthalmology (n=13); Clinic of Stomatology and Maxillofacial Surgery (n=12)		

Legend: ∗ number of nurses in operating room

logical measures and recommendations of the CDC concerning multi-resistant strains of microorganisms. The questionnaire consisted of 49 items divided into three subscale: 1) hand hygiene, definition of concepts of hand hygiene and HEH (Q1 to Q18), 2) HEH for the occurrence of EIP (Q19 to Q38) and 3) competency (Q39 to Q49). Respondents were asked to express a degree of agreement or disagreement (5 – I agree, 4 – I partly agree, 3 – I don't know, 2 – I partly disagree, 1 – I disagree). The questionnaire ended with items of a demographic nature concerning the participant's gender, level of education, specialised education, and number of years of experience and specialised surgery unit.

The reliability of the questionnaire according to Cronbach's Alpha was 0.78 which was sufficiently satisfactory result. In subscale hand hygiene, definition of concepts of hand hygiene and HEH Cronbach's Alpha was 0.884, in subscale HEH for the occurrence of EIP 0.751, in subscale nurses' competency 0.670.

The acquired data was processed using statistical analysis software – SPPS software, version 15.0. In the domain of descriptive statistics, the category values of variables were described using frequency tables and for ordinary values of variables the arithmetic mean, standard deviation, median and minimum/maximum values of sets were calculated. Hypotheses were tested using the non-parametric Mann-Whitney Test, Kruskal-Wallis Test with a significance level $p < 0.05$.

RESULTS

Nurses (n = 150) had a satisfactory level of knowledge of hand hygiene and the definition of the fundamental concepts of HEH (Likert scale 1 – 5). Incorrect answers were given concerning sterilisation with formaldehyde (mean = 3.89; SD ± 0.06) and plasma sterilisation (mean = 4.25; SD ± 0.83). On question concerning whether the hands of healthcare personnel are the most common transmission route of HCAI, not all respondents gave a clear answer (mean = 4.47; SD ± 0.72). In category the HEH for the occurrence of EIP were several uncertain and incorrect answers. Half of the respondents consider the using of disposable devices (tweezers, forceps, kidney dishes, bed linen, plates, cups) to be a significant intervention in preventing the spread of HCAI (mean = 3.75; SD ± 1.50). Only 40.7 % of nurses have knowledge if patients are colonized by MRSA, their body cavities (ears, nose) must be swabbed three times daily with disinfectant solution (mean=3.71; SD ± 1.15).
Other incorrect answers concerned nursing interventions, namely blood collection, when admitting a patient suspected of being infected by EVD (mean=3, 66; SD±1.44). We have also received ambiguous answers in the last questions about the treatment of AIDS patients. The questions were focused on knowledge about the source of AIDS, as many as 27.4% of nurses cannot answer unambiguously (mean=3.83; SD±1.43). Only 32 % nurses have knowledge about the risk of infection from blood exposure from an HIV-positive person (mean=3.52; SD±1.08). In this last question, we recorded up to 39.3 % of respondents who said that they could not answer. Detailed results can be seen in Table 2.

Significant findings were obtained for length of experience. We divided the nurses into five groups: up to 5 years of practice, 6 to 10 years, 11 – 20 years, 21 – 30 years and over 30 years. Evidence was found of a significant relationship between the length of a nurse's experience the profession and the level of their knowledge in defining the basic concepts of HEH and their level of knowledge of HEH for dealing with HCAI. Using the Kruskal-Wallis test, the most statistically significant differences were confirmed in the second subscale as we can see in Table 3. In the Table 4 we present mean and SD for better interpretation of results.

A statistically significant relationship in terms of length of experience among groups of respondents have also verified using the Mann-Whitney test. We did not obtain any statistically significant differences between nurses working up to 5 years and nurses between 6 and 10 years of experience. We also did not confirm any statistical relationships between nurses with a length of practice of 6 to 11 years versus 21-30 years and over 30 years. The highest level of knowledge was demonstrated by nurses with 21 years' experience or more and the statistically most significant comparison was with nurses with less than 5 years' experience. Table 5 shows some of the several items where statistical significance has been confirmed.

A statistically significant relationship was identified between *level of professional education in nursing* (secondary and higher vocational education vs. master's degree) and level of knowledge of HEH. Surprisingly, nurses with a master's degree demonstrated less knowledge of HEH compared to

Table 2 Nurses knowledge of HEH, subscale EIP

Thematic areas	Likert scale – Absolute / relative frequency (n=150)					mean SD
	5	4	3	2	1	
Alcohol-based disinfection od hands	120 (80.0)	18 (12.0)	10 (6.7)	0 (0.0)	2 (1.3)	4.69 ± 0.49
Barrier nursing techniques	124 (82.7)	22 4.7)	3 (2.0)	0 (0.0)	1 (0.7)	4.79 ± 0.35
Staff education is an HEH priority if CPE is detected	114 (76.0)	30 (20.0)	4 (2.7)	2 (1.3)	0 (0.0)	4.71 ± 0.45
Isolation/cohorting of patients	116 (77.3)	25 (16.7)	7 (4.7)	2 (1.3)	0 (0.0)	4.70 ± 0.46
ATB revision	83 (55.3)	40 (26.7)	11 (7.3)	8 (5.3)	8 (5.3)	4.21 ± 0.87
CPE can survive on the skin	89 (59.3)	28 (18.7)	28 (18.7)	4 (2.7)	1 (0.7)	4.33 ± 0.79
CPE can survive on an undisinfected work surface	86 (57.3)	29 (19.3)	31 (20.7)	3 (2.0)	1 (0.7)	4.31 ± 0.80
Patient isolation in a separate room /cubicle	109 (72.7)	22 (14.7)	6 (4.0)	6 (4.0)	7 (4.7)	4.47 ± 0.78
Equipping personnel with protective aids	138 (92.0)	10 (6.7)	0 (0.0)	1 (0.7)	1 (0.7)	4.89 ± 0.21
The use of single-use	88 (58.7)	10 (7.3)	10 (6.7)	11 (6.7)	31 (20.7)	3.75 ± 1.50
Risk factors of MRSA	103 (68.7)	9 (6.0)	4 (2.7)	17 (11.3)	17 (11.3)	4.17 ± 1.12
Day care of a patient colonized by MRSA	61 (40.7)	11 (7.3)	37 (24.7)	26 (17.3)	15 (10.0)	3.71 ± 1.15
Patient and family education	129 (86.0)	17 (11.3)	2 (1.3)	0 (0.0)	2 (1.3)	4.81 ± 0.33
Patient admission with EVD	78 (52.0)	11 (7.3)	22 (14.7)	10 (6.7)	29 (19.3)	3.66 ± 1.44
Patient isolation with EVD	136 (90.7)	10 (6.7)	2 (1.3)	0 (0.0)	2 (1.3)	4.85 ± 0.27
Limited number of personnel in isolation room/cubicle	136 (90.7)	10 (6.7)	0 (0.0)	3 (2.0)	1 (0.7)	4.85 ± 0.27
Source of an AIDS	89 (59.3)	18 (12.0)	2 (1.3)	10 (6.7)	31 (20.7)	3.83 ± 1.43
Risk of HIV transmission	48 (32.0)	20 (13.3)	59 (39.3)	8 (5.3)	15 (10.0)	3.52 ± 1.08

Legend: Likert scale: 5 – I agree, 4 – I partly agree; 3 – I don't know, 2 – I partly disagree, 1 - I disagree; SD – standard deviation

Table 3 Kruskal-Wallis Test - length of experience

Thematic areas	Mean Rank					χ2	df	p
	< 5 n = 25	6 – 10 n = 17	11 – 20 n = 29	21 - 30 n = 47	> 30 n = 32			
Barrier nursing techniques	64.14	65.44	75.91	79.18	83.94	9.649	4	0.047
Staff education as an HEH priority	55.38	70.15	79.81	76.29	89.00	16.293	4	0.003
ATB revision	70.42	58.62	86.07	68.73	88.80	10.805	4	0.029
CPE can survive on the skin of the hands	52.14	77.82	77.29	80.93	82.92	11.557	4	0.021
Patient isolation in a separate room/cubicle	66.26	80.50	70.16	69.34	93.95	13.888	4	0.008
Patient and family education	61.88	81.03	70.90	82.89	76.52	12.239	4	0.016
Patient isolation with EVD	61.58	69.15	77.47	79.22	82.50	16.373	4	0.003

Legend: n = absolute frequency; χ2 - Chi-square; Kruskal-Wallis Test with a significance level $p < 0.05$

Table 4 Nurses' level of knowledge of HEH in relation to length of experience

Thematic areas	mean SD				
	< 5 n=25	6-10 n=17	11-20 n=29	21-30 n=47	> 30 n=32
Barrier nursing techniques	4.600 ± 0.645	4.471 ± 1.068	4.828 ± 0.384	4.872 ± 0.337	4.938 ± 0.246
Staff education as an HEH priority	4.440 ± 0.583	4.529 ± 0.874	4.724 ± 0.702	4.745 ± 0.488	4.938 ± 0.246
ATB revision	4.200 ± 1.000	3.824 ± 1.185	4.448 ± 1.088	4.021 ± 1.242	4.500 ± 1.016
CPE can survive on the skin of the hands	3.800 ± 0.957	4.353 ± 0.996	4.379 ± 0.942	4.489 ± 0.777	4.469 ± 0.915
Patient isolation in a separate room/cubicle	4.280 ± 1.100	4.412 ± 1.372	4.345 ± 1.111	4.319 ± 1.181	4.969 ± 0.177
Patient and family education	4.600 ± 0.645	4.765 ± 0.970	4.793 ± 0.412	4.957 ± 0.204	4.781 ± 0.751
Patient isolation with EVD	4.640 ± 0638	4.647 ± 0.996	4.931 + 0.258	4.894 ± 0.598	5.000 ± 0.000

Legend: n = absolute frequency; SD – standard deviation

Table 5 Mann-Whitney Test - length of experience

Thematic area	< 5 vs 11-20	< 5 vs 21-30	< 5 vs > 31	6-10 vs 11-20	6-10 vs 21-30	6-10 vs > 31	21-30 vs > 31
Barrier nursing techniques	0.173	**0.020**	**0.011**	0.267	0.548	0.182	0.349
Staff education as an HEH priority	**0.016**	**0.016**	**<0.001**	0.343	0.619	0.166	**0.043**
ATB revision	0.107	0.828	0.056	**0.023**	0.065	0.707	**0.026**
CPE can survive on the skin of the hands	**0.016**	**0.002**	**0.007**	0.927	0.665	0.499	0.732
Patient isolation in a separate room/cubicle	0.717	0.722	**<0.001**	0.366	0.935	**0.001**	0.001
Patient and family education	0.285	**0.001**	0.081	0.221	**0.024**	0.431	0.171
Patient isolation with EVD	**0.035**	**0.005**	**0.002**	0.246	0.638	0.134	0.240

Legend: vs – versus; Mann-Whitney Test with a significance level $p < 0.05$

Table 6 Nurses ' level of knowledge of HEH in relation to level of education

Thematic areas	Level of education		
	secondary, higher (n = 65)	university Master (n = 37)	P value
	mean ± SD	mean ± SD	
I. Hand hygiene, definition of HEH concepts			
Transmission route for HCAI	4.323 ± 0.986	4.78 ± 0.652	**0.023**
Definition of asepsis	4.954 ± 0.372	4.73 ± 0.932	**0.038**
Definition of decontamination	4.954 ± 0.211	4.622 ± 0.828	**0.006**
II. HEH for the occurrence of EIP			
Staff education	4.831 ± 0.517	4.676 ± 0.53	**0.038**
Equipping personnel with protective aids	4.938 ± 0.39	4.784 ± 0.712	**0.048**
The use of single-use aids	3.169 ± 1.816	4.162 ± 1.482	**0.012**
Patient isolation with EVD	4.938 ± 0.496	4.892 ± 0.315	**0.042**
Risk of HIV transmission	3.292 ± 1.271	3.838 ± 1.323	**0.031**

Legend: SD – standard deviation; Mann - Whitney test with a significance level $p < 0.05$

Table 7 Nurses ' level of knowledge of HEH in relation to specialised education

Thematic areas	Specialised education		
	yes (n=120)	no (n = 30)	P value
	mean ± SD	mean ± SD	
I. Hand hygiene, definition of HEH concepts			
Definition of asepsis	5.0 ± 0.0	4.94 ± 0.25	***0.001***
Definition of antisepsis	4.84 ± 0.74	4.69 ± 1.01	***0.021***
Definition of sanitation	4.84 ± 0.42	4.69 ± 0.48	***0.032***
II. HEH for the occurrence of EIP			
CPE survive on the skin	4.56 ± 0.89	4.50 ± 0.82	***0.020***
Risk factors of MRSA	4.00 ± 1.29	4.62 ± 0.94	***0.011***
Patient isolation with EBV	3.78 ± 1.70	3.06 ± 1.69	***<0.001***

Legend: SD – standard deviation; Mann - Whitney test with a significance level $p < 0.05$

nurses with secondary or higher vocational education. The nurses with a master's degree have achieved unsatisfactory results in several thematic areas: in the transmission route for HCAI ($p = 0.023$), definition of asepsis ($p = 0.038$), definition of decontamination ($p = 0.006$), patient isolation with EVD (0.042) and others (Tab. 6).

Postgraduate education – specialised nursing studies – affect the level of knowledge regarding HEH. In the questions on the basic concepts of HEH and on measures against HCAI, the research hypotheses were confirmed, and several statistically significant relationships were identified (Tab. 7).

The participating nurses came from 11 surgery units, of which 6 units were centralised in a multi-speciality surgical pavilion with shared operating theatres. The other 5 surgery units were in separate buildings with their own operating theatres. Nurses

from units in the multi-speciality surgical pavilion demonstrated greater knowledge in several areas of HEH including the definition of basic terms ($p = 0.005$; $p = 0.025$), HCAI cause.d by CPE and in dimension nurses' competency. We have identified several significant results in the nurses´ competency dimension ($p < 0.01$; $p = 0.006$). Only 57 % of nurses correct disposal of syringes and needles. On the isolation box, only 67 % throws devices into the container. Only 77 % of nurses use protective gloves when inserting a peripheral venous cannula, and 83 % of nurses use protective gloves when transporting a central venous catheter.

DISCUSSION

The results of the overall sample of respondents show that nurses have a satisfactory level of knowledge of hand hygiene and HEH. However, we also noted several uncertain and incorrect answers regarding the use of single-use aids improves HEH, the risk of transmission of AIDS, the admission of a patients with EBV, the treatment of a patient colonized with MRSA etc. The experience of nurses when treating patients colonized with MRSA was investigated by Swedish authors (Andersson et al., 2016). A qualitative study identified that nurses have fear and uncertainty in treatment of such patients resulted from lack of knowledge. The more knowledge nurses gained, the more the attitude towards their treatment changed. They acquired a sense of competence and safety.

Using nonparametric tests, we obtained statistically significant relationships in terms of length of clinical practice, the highest level of education and postgraduate specialization studies. Similar findings have been reported by several authors (Kalantarzadeh et al., 2014; Parmeggiani et al., 2010; Alwadai et al., 2018).

We recorded the most statistically significant relationships in terms of the length of clinical practice in the EIP subscale. The hypothesis that nurses with less than 5 years' experience would demonstrate a greater level of knowledge of EIP such as EVD, AIDS and HCAI caused by CPE and MRSA was not proved. Nurses in this category achieved unsatisfactory and middling results. Similar findings were reported by Baack and Alfred, who found that most nurses were uncertain how to respond to Ebola virus infections. Nevertheless, nurses who had experience of an epidemic were more self-confident and demonstrated more knowledge. It can be assumed that they had longer professional experience. Nurses should receive regular training updates on epidemiologically important infections (Baack et al., 2013). Training in this area should also be provided to nursing students so that they are able to respond to potential epidemics and pandemics, and the issue should be included in teaching materials (Verkat et al., 2015). In the current epidemiological situation, new information on the care of patients with COVID-19 are needed. Clinical practice highlights the need for vocational education and training at all levels in which nurses receive intensive preparation for treating patients suspected of having COVID-19. We also examined the knowledge of HIV transmission. Once again, younger professional nurses without experience showed low level of knowledge. Similar conclusions are confirmed by Phetlhu et al. (2018).

Why did younger nurses show a lower level of knowledge than nurses over 21 years of experience? The highest level of education attained is also a factor that could have entered the level of knowledge. In the category up to 5 years ($n = 25$) we recorded 88 % with university education (master's degree 24 %), in the category 21 – 30 years ($n = 47$) were 70 % with university education (master's degree 52 %) and in the category over 31 of the 32 nurses, 9 had a university degree (master's degree 2). Surprisingly, nurses with a master's degree demonstrated less knowledge of HEH compared to nurses with secondary or higher vocational education. As in our study, Balodimou et al. (2018) obtained statistically significant correlations in terms of age, length of work experience, and level of education. E.g. older nurses correctly answered questions about the safest method of hair removal from the surgical site, administering anti-microbial prophylaxis, and so on. The younger nurses correctly answered questions regarding the use of a surgical mask and a post-operative bath. In addition, there was a correlation between the level of education and the issues relating mainly to the time factor. University-educated respondents gave some incorrect answers.

Eldeen et al. conducted an intervention study among nurses with the aim of improving the knowledge level of infection control, with subsequent patient safety improvements (Eldeen et al., 2016). According to the results of this study, the knowledge of infection control at the was low be-

fore the intervention phase of the study. This extremely alarming finding can be attributed to the low level of nursing qualification – one nurse with an additional specialization. The impact of postgraduate education – a specialist knowledge-based nursing study on prevention of HCAI – was also confirmed in our study.

Nurses' compliance with the rules of hand hygiene and HEH for several situations was influenced by both individual and environmental factors. The present research provided additional evidence that nurses working in a newly opened surgical pavilion with centralised operating theatres and centralised sterilisation demonstrated greater knowledge and competency than nurses in small surgery units in separate buildings with old facilities. The new pavilion was designed and equipped in line with the latest recommendations and standards for surgery. An example is the installation of dispensers of disinfectants in front of every room, by every bed, at the entrance to departments, in corridors etc. The management of the unit had regular training sessions with staff from the hospital hygiene department. They elaborated internal directives and guidelines on the use of sterile and non-sterile gloves. The new surgical pavilion cancelled departments' use of surgical instruments in trays and began to pack and sterilise them individually. Chatfield et al. studied such environmental and individual factors in hand hygiene using Bandura's social cognitive theory. According to their respondents, compliance with hand hygiene rules was significantly influenced by the safety culture in the environment and the nurses' own internal motivation, i.e. a combination of environmental factors (including managers' behaviour) and individual factors (internally motivated behaviour). High priority was given to the role of the immediate superior, the supervision that they carried out and their management skills (Chatfield et al., 2017).

Similarly, the systematic review and expert consensus of Zigg et al. shows that prevention of infection depends not only on the knowledge and clinical skills of the health care team, but also on the management of hospitals, the occupancy of beds and the workload of nurses and doctors (Zingg et al., 2015). Zhang et al. (2019) studied relationship between nursing workloads and adherence to hand hygiene. Adherence to hand hygiene was independently associated with actual hour worked per shift. Smiddy et al. (2015) and Lieber et al. (2014) in a systematic assessment of qualitative studies indicate that the influence of management and the head nurse is important. A number of authors from both the US and Canadian hospitals identified the work site as a significant predictor of the knowledge level of nurses, they also identified differences between individual departments of the same hospital (Létourneau et al., 2018; Rozenbojm et al., 2015).

Several authors agree on the need for further education of nurses (Qasem et al., 2017; Chun et al., 2015). It is essential that they undergo courses and training focused on control and infection prevention, hand hygiene and HEH as the main health care and patient safety priorities. In the current epidemiological situation with COVID-19 is necessary to increase attention to the issue of hand hygiene and HEH. For workplace management more ensure continuing education and training with subsequent knowledge tests, competence assessment, audits based on preliminary checklists (Špačilová, 2020). The dissemination of guidelines and regulations alone is inadequate. Their compliance depends on the level of knowledge of the health care professionals, their conviction, motivation and professional responsibility, self-assessment and attitude of healthcare workers to hand hygiene and prevention of HCAI as well as other epidemiologically important infections (Kelčíková et al., 2019).

CONCLUSION

The results show that the experience of nurses, the length of their practice, affects the level of knowledge in selected topics of the hygienic-epidemiological regime. It is essential to provide professional training for younger nurses. Workplace management – head nurses cannot rely on the fact that they should have knowledge from school. These findings are also important for educational institutions. We achieved a positive finding on the impact of level of education, specialization studies on the level of knowledge and the impact of working conditions. Nurses should know the relevant legal and internal directives, regulations, legislative standards, laws, decrees and guidelines on the treatment of patients with epidemiologically important infections. Nursing management should monitor compliance with standard nursing procedures for minimising the risk of patient infection. Unit management should ensure appropriate unit layout, adequate staffing levels, the quality of instruments and materials and the error-free provision of all services

necessary to create conditions for prevention of infection.

REFERENCES

ALBIGER B., GLASNER C., STRUELENS M.J. et al. Carbapenemase-producing Enterobacteriaceae in Europe: assessment by national experts from 38 countries. *Eurosurveillance*. 2015; 20 (45): 30344.

ALWADAI M.M., GHALEB M.A. Knowledge and Practice of Nurses on Healthcare Associated Infection. *Nuring & Health Care International Journal.* 2018; 2 (5): 1-6.

Analýza epidemiologickej situácie a činnosti odborov epidemiológie v Slovenskej republike za rok 2019. (Analysis of the Epidemiological Situation and the Activities of the Departments of Epidemiology in Slovak Republic for 2019) [online]. 2020 [cit. 2021-08-10] Available from: https://www.epis.sk/InformacnaCast/Publikacie/VyrocneSpravy/Files/VS_SR_2019.aspx.

ANDERSSON H., ANDREASSEN GLEISSMAN S., LINDHOLM C. et al. Experiences of nursing staff caring for patients with methicillin-resistant Staphylococcus aureus. *International Nursing Review.* 2016; 63 (2): 233-241.

BAACK S., ALFRED D. Nurse´s Preparedness and Perceived Competence in Managing Disasters. *Journal* of *Nursing Scholarship.* 2013; 45 (3): 281-287.

BALODIMOU S.A., PAPAGEORGIOU E.G., DOKOUTSIDOU E.E. et al.Greek nurses' knowledge on the prevention of surgical site infection: an investigation. *Journal of Wound Care.* 2018; 27 (12): 876-884.

CECCHINI M., LANGER J., SLAWOMIRSKI L. *Antimicrobial Resistance in G7 Countries and Beyond: Economic Issues, Policies and Options for Action*. Paris: OECD, 2015. 75 p.

Centers for Disease Control and Prevention, Healthcare-associated infections data statistics. National and State Healthcare-Associated Infections Progress Report 2019 [online]. 2019 [cit. 2020-01-16]. Available from: http://www.cdc.gov/hai/data/portal/progress-report.html.

CHATFIELD S.L., NOLAN R., CRAWFORD H. et al. Acute care nurse´s responses and recommendations for improvement of hand hygiene compliance: A cross-sectional factorial survey research study. *American Journal of Infection Control.* 2017; 45 (6): 620-625.

CHUN H.K., KIM K.M., PARK H.R. Effects of hand hygiene education and individual feedback on hand hygiene behaviour, MRSA acquisition rate and MRSA colonization pressure among intensive care unit nurses. *International Journal of Nursing Practice.* 2015; 21 (6): 709-715.

ELDEEN A.I.E., ABD-ELAZIZ M., MOGHAZY A.M. et al. Evaluation of an Infection Control Measures Protocol Application by Nurses on Patients' Safety at Burn Units. *Journal of Surgery. Special Issue: Surgical Infections and Sepsis.* 2016; 4 (3-1): 1-9.

European Centre for Disease Prevention and Control. Rapid risk assessment: Carbapenem-resistant Enterobacteriaceae [online]. 2016 [cit. 2020-01-02] Available from: https://ecdc.europa.eu/en/publications-data/rapid-risk-assessment-carbapenem-resistant-enterobacteriaceae-14-april-2016.

KALANTARZADEH M., MOHAMMADNEJAD E., EHSANI S.R. et al. Knowledge and Practice of Nurses about the Control and Prevention of Nosocomial Infections in Emergency Departments. *Archives of Clinical Infectious Diseases.* 2014; 9 (4): e18278.

KELČIKOVÁ S., MAZÚCHOVÁ L., BIELENÁ L. et al. Flawed self-assessment in hand hygiene: A major contributor to infections in clinical practice? *Journal of Clinical Nursing.* 2019; 28 (11-12): 2265-2275.

LÉTOURNEAU J., ALDERSON M., LEIBING, A. Positive deviance and hand hygiene of nurses in a Quebec hospital: What can we learn from the best? *American Journal of Infection Control.* 2018; 46 (5): 558-563.

LIEBER S. R., MANTENGOLI E., SAINT S. et al. The effect of leadership on hand hygiene: assessing hand hygiene adherence prior to patient contact in 2 infectious disease units in Tuscany. *Infection Control & Hospital Epidemiology.* 2014; 35 (3): 313-316.

McEACHAN R., TAYLOR N., HARRISON R. et al. 2016). Meta-Analysis of the Reasoned Action Approach (RAA) to Understanding Health Behaviors. *Annals of Behavioral Medicine*. 2016; 50 (4): 592-612.

MUSTARD L.W. Caring and Competency. *JONA´S Healthcare Law, Ethics and Regulation*. 2002; 4 (2): 36-43.

O'NEILL J. *Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations*

[online] 2014. 20 p. [cit. 2021-08-10] Available from: https://www.jpiamr.eu/wp-content/uploads/2014/12/AMR-Review-Paper-Tackling-a-crisis-for-the-health-and-wealth-of-nations_1-2.pdf.

PARMEGGIANI C., ABBATE R., MARINELLI P. et al. Healthcare workers and health care-associated infections: knowledge, attitudes, and behavior in emergency departments in Italy. *BMC Infectious diseases*. 2010; 10 (35): 1-9.

PHETLHU D.R., BIMEREW M., MARIE-MODESTE R.R. et al. Nurses' Knowledge of Tuberculosis, HIV, and Integrated HIV/TB Care Policies in Rural Western Cape, South Africa. *Journal of Association of Nurses in AIDS Care*. 2018; 29 (6): 876-886.

QASEM M.N. HWEIDI I. M. Jordanian Nurses' Knowledge of Preventing Surgical Site Infections in Acute Care Settings. *Open Nursing Journal*. 2017; 7 (5): 561-582.

ROZENBOJM M.D., NICHOL K., SPIELMANN S. et al. Hospital unit safety climate: relationship with nurses' adherence to recommended use of facial protective equipment. *American Journal of Infection Control*. 2015; 43 (2): 115-120.

SMIDDY M.P., O'CONNELL R., CREEDON, S. Systematic qualitative literature review of health care workers' compliance with hand hygiene guidelines. *American Journal of Infection Control*. 2015; 43 (3): 269-274.

ŠPÁČILOVÁ Z. Výchova, vzdelávanie, vyučovanie, edukácia - vymedzenie pojmov vo vzťahu k ošetrovateľskej teórii, klinickej praxi a vzdelávaniu (Education, teaching - definition of terms in relation to nursing theory, clinical practice and education). In: Archalousová A (ed.). *Teoretické vymezení pojmů ve vztahu k implementaci ošetřovatelských intervencí (Theoretical definition of concepts in relation to the implementation of nursing interventions)*. Plzeň: Západočeská univerzita, 2017. pp. 109-122.

ŠPÁČILOVÁ Z, MESÁROŠOVÁ J, GOSTÍKOVÁ M. Kompetencie sestier v zariadeniach Ústavnej starostlivosti (Competencies of nurses in institutional health facilities). In SPAČILOVÁ Z (ed.). *Sestry: Hlas v popredí – ošetrovateľstvom ku globálnemu zdraviu*. Nitra: Univerzita Konštantína filozofa v Nitre, Fakulta sociálnych vied a zdravotníctva, 2020. s. 137. ISBN 978-80-558-1596-1.

ŠTEFKOVIČOVÁ M., LITVOVÁ S., MIKAS J. et al. Druhé bodové prevalenčné sledovanie nozokomiálnych nákaz na Slovensku ako súčasť európskeho sledovania (Second point prevalence survey of healthcare-associated infections in the Slovak Republic of European survey). *Zdravotnícke listy*. 2019; 7 (7): 12-18.

The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)-China. *China CDC Wkly.* 2020; 2: 113-122.

VERKAT A., WOLF L., GEIDERMAN J. M. et al. Ethical issues in the response to EVD Virus Disease in US emergency departments: A position paper of the American College of Emergency Physicians, the Emergency Nurses Association, and the Society for Academic Emergency Medicine. *Journal of Emergency Medicine.* 2015; 41 (2): e5-e16.

Výročná správa o činnosti úradov verejného zdravotníctva v SR podľa jednotlivých odborov verejného zdravotníctva za rok 2018. (Annual Report on the Activities of Public Health Offices in the SR According to Individual Public Health Departments for Year 2018) [online]. 2019; 970 p. [cit. 2021-08-10] Available from: https://www.uvzsr.sk/docs/vs/vyrocna_sprava_SR_2018.pdf.

World Health Organization. WHO Guidelines on Hand Hygiene in Health Care. Geneva: Switzerland [online]. 2009 [cit. 2021-01-22] Available from: http://apps.who.int/iris/bitstream/10665/44102/1/9789241597906_eng.pdf.

World Health Organization. Guidelines on Hand Hygiene in Health Care. Evidence of hand hygiene to reduce transmission and infections by multidrug resistant organisms in health-care settings. Geneva, Switzerland [online]. 2014 [cit. 2021-01-22] Available from: https://www.who.int/ gpsc/5may/MDRO_literature-review.pdf.

WU Z., McGOOGAN J.M. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. *JAMA*. 2020; 323 (13): 1239-1242.

ZHANG S., KONG X., LAMB K.V. et al. High nursing workload is a main associated factor of poor hand hygiene adherence in Beijing, China:

An observational study. *Internation Journal of Nursing Practice.* 2019; 25 (2): e12720.

ZINGG W., HOLMES A., DETTENKOFER M. et al. Systematic review and evidence-based guidance on organization of hospital infection control programmes (SIGHT) study group. (2015). Hospital organisation, management, and structure for prevention of health-care-associated infection: a systematic review and expert consensus. *The Lancet Infectious Diseases*. 2015; 15 (2): 212-224.