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# The Effect of Nurses' Awareness of Infection Control Measures on Patient and Family Education

**Ph.D. thesis booklet**

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## INTRODUCTION

Healthcare-associated infections HAIs are major health issues recognized globally, as they negatively affect the quality of patient care. HAIs lead to increased morbidity and mortality and are associated with elevated treatment costs (Tartari et al., 2021). The European Centre for Disease Prevention and Control estimates that 3.1-4.6 million patients acquire an HAI annually in acute care hospitals in European countries (Suetens et al., 2018), while the Centers for Disease Control and Prevention (CDC) reported 1.7 million patients affected by HAIs annually in American hospitals. HAIs account for 37000 attributable deaths in Europe and 99000 deaths in the United States of America each year (WHO, 2015). The high prevalence of HAIs due to multidrug-resistant organisms (MDROs) has continued to spread widely in healthcare settings, making HAIs a patient safety concern (Wyer et al., 2015). In Hungary, HAIs due to MDROs have been reported by law via the National Surveillance System of Nosocomial Infections (A Nemzeti Nosocomialis Surveillance Rendszer) since 2004, where notification is compulsory to all hospitals. The overall incidence of multidrug-resistant (MDR) HAIs was 5.4/100000 patient days in 2005 and 14.7/100000 patient days in 2010 (Caini et al., 2013). The overall incidence of MDR HAIs increased to 29.35/100000 patient days in 2017. The most commonly reported HAIs due to MDROs in 2017 were urinary tract infections (UTIs), which accounted for 31% of all reported infections. Surgical site infections (SSIs) were the second most common, accounting for 22% of reported infections. Ventilator-associated pneumonia was the third most commonly reported HAI due to MDROs, with 21%. Finally, bloodstream infections were the lowest, at 15% (Országos Epidemiológiai Központ, 2017).

Since HAIs are avoidable, preventing HAIs remains a main concern for healthcare settings and is one of the highest priorities of modern medicine (Puto et al., 2020). Infection prevention and control (IPC) is one of the most effective interventions to prevent HAIs (Lacotte et al., 2020), which might result in a 70% reduction of this infection (Pryor et al., 2020). The poor adherence of healthcare workers (HCWs) to IPC guidelines is the major cause of a high rate of HAIs (Agreli et al., 2019). Attaining and preserving high levels of compliance with IPC are essential. Some studies have explored the barriers and opportunities to enhance compliance. Lack of knowledge/awareness of IPC among HCWs is the main barrier identified. Other common barriers include limited organizational resources, lack of experience, lack of training, and poor self-efficacy among HCWs (Bayleyegn et al., 2021; Kim & Hwang, 2020). Efforts should be continued to improve HCWs' knowledge to enhance compliance with IPC. Additionally, nurses are the largest group among HCWs and have the most frequent direct interactions with patients; thus, their knowledge and compliance with IPC deserve attention (Kim & Hwang, 2020).

In addition to education and training, the CDC recommends periodic assessment of HCWs' knowledge and compliance with IPC practices to control and avoid the transmission of HAIs (CDC, 2007). Similarly, the European Union (EU) Council recommendation on patient safety, including the prevention and control of HAIs (European Commission, 2009), recommends implementing regular training for all HCWs on basic measures of hygiene and IPC. At the same time, the Hungarian government regulation (20/2009. (VI. 18.) The Hungarian Act on the Prevention of Healthcare-associated Infections, 2009) that determines infection control (IC) practices in healthcare institutions in Hungary states that training is mandatory for all newly employed HCWs. The training shall cover topics on the significance, magnitude, mode of transmission and prevention of HAIs, hand hygiene (HH), isolation regulations, the use of personal protective equipment (PPE), activities to be done in the presence of MDR pathogens, and

institutional IPC policies. In-service training must be provided to all HCWs once a year in a documented manner.

Several studies have assessed the level of HCWs, focusing on nurses' knowledge and awareness of IPC both in and outside Europe. Tavolacci et al. (2008) conducted a study in France among 350 healthcare students using the infection control standardized questionnaire (ICSQ). An acceptable knowledge score was achieved in the overall IPC; however, the scores varied between IPC areas where standard precautions (SPs) and HH scores were acceptable, while HAIs' scores were not. In another study, D'Alessandro et al. (2013) surveyed 1461 nursing and medical students using the ICSQ in Italy. Acceptable knowledge scores were achieved in the overall IPC and SPs only.

Although HAI prevention approaches are mainly focused on the care delivered by HCWs, the significance of patient engagement in preventing HAIs remains to be stressed as a means of improving patient safety (Tartari et al., 2017). HCWs may encourage patients to engage in the care-providing process in several ways by educating them on IPC measures and motivating them to speak up about their care process (Croke, 2020). The World Health Organization (WHO) suggested several solutions to prevent HAIs, such as implementing proper IC measures (HH, SPs, etc.), improving reporting and surveillance systems, ensuring the availability of resources for HAI surveillance, improving staff education and accountability, and conducting research on the engagement of patients and their family members in HAI reporting and control (WHO, 2015). Furthermore, the CDC recommends patients' and family members' education on IC after showing that they can aid in preventing the spread of HAIs. This education includes sharing information on SPs, primarily HH, and respiratory hygiene/cough etiquette with patients upon hospital admission. Added information on transmission-based precautions and information about the rationale of isolation and the use of PPE can be shared with patients upon isolation initiation (CDC, 2007). Likewise, the EU Council recommendation on patient safety, including the prevention and control of HAIs, necessitates educating patients on the risk of HAIs and their prevention. Further information is given to patients who are colonized or infected with HAIs (European Commission, 2009).

Despite this interest, assessing patient education on IC in hospitals is poorly investigated. To date, studies examining patient education on IC have mostly focused on one IC measure, mainly HH and HAIs. However, the IC program in hospitals includes various measures and processes. Thus, education on other IC measures should be explored. Moreover, no systematic reviews were performed to examine patient education on IC. Hence, this research addresses this knowledge gap by systematically investigating studies that assessed patient education on IC measures in hospitals.

On the other hand, to date, most of the studies examining patient education on IPC have focused on patients' knowledge and attitudes. Relatively few studies have investigated the experience of HCWs themselves. One of those few studies conducted in Lebanon including 217 nurses showed that the highest percentage of education was on HH (90.7%) and the lowest on HAIs (34.6%); however, the research did not explore the obstacles of patient and family education (Hammoud et al., 2017).

Involving patients in IPC is challenging, given the diversity of hospitalized patients and their abilities to be involved (Agreli et al., 2019). Lack of knowledge and poor communication by HCWs have been reported as the prime obstacles to patient engagement (Tartari et al., 2017). However, there is a gap in research on the effect of HCWs' knowledge and awareness of IPC measures on implementing IPC patient and family education. This research was also meant to

address this gap by investigating the effect of nurses' awareness of IPC measures on implementing IPC patient and family education.

Based on what is presented above and since no studies have been conducted in Hungary to assess nurses' awareness of IPC or to determine whether patients and their family members are being educated on IPC, this necessitated our research. Therefore, we are conducting this research among nurses, patients, and family members in Hungary to address the objectives below.

## Objectives

We aim in this research to determine the effect of nurses' awareness of IC measures on implementing patient and family education.

*Detailed objectives*

1. Systematically review patient education on IC measures among hospitalized patients.
2. Assess patient and family members' education on IC measures from the patients' and family members' perspectives in Hungary.
3. Assess the level of IC awareness among nurses in Hungary.
4. Assess patient and family members' education on IC measures from the nurses' perspective in Hungary.
5. Explore the reasons that might prevent nurses from educating their patients and family members on IC.
6. Determine the effect of nurses' awareness of IC measures on implementing patient and family education.

## SUBSTUDY 1

### Patient Education on Infection Control: A Systematic Review

### Methods

We aim in this systematic review to investigate studies that assessed patient education on IC measures in hospitals, summarize them, and compare their results. The review was prepared according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009).

To be included, any primary study needed to meet all of the following criteria: 1) a study on patients of any age and gender admitted to hospitals or discharged patients who were previously hospitalized as inpatients; 2) not focusing on specific diseases; 3) assessing patients' education on one or more of the following IC measures: HH, respiratory hygiene/cough etiquette, HAIs and/or HAIs risks, reason for isolation, isolation precautions, and the use of PPE. Qualitative studies and studies conducted on the general population and out-service unit patients were excluded.

A systematic search strategy was developed using Medline via PubMed by combining terms for 'hospitalized patients', 'education', and 'infection control'. Then, the Medline strategy was adapted for Embase and CINAHL. Electronic searches were carried out from inception until May 6, 2020, without any restriction. To avoid selection bias, unpublished papers were searched using

OpenGrey, and hand searching was also performed on the reference lists of all the eligible articles. The selection of eligible studies was performed starting by inspecting the titles and abstracts. Then, full paper texts were carefully examined to decide the final papers' inclusion list. In the case of disagreements between reviewers, articles were discussed first, and then, a third reviewer was consulted in case the disagreement was not resolved.

We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) tool (Vandenbroucke et al., 2007) to assess the reporting quality of each eligible study. A data extraction form was designed based on the Cochrane guidelines for systematic reviews (Higgins & Deeks, 2008). To avoid selective reporting within studies, the authors were contacted to obtain additional information about missing data. All the mentioned steps were performed by two reviewers independently.

## Main Results

*Study selection and characteristics of the included studies*

A total of 6740 records were retrieved. Duplicates were removed (n= 1154), and irrelevant papers were excluded based on their titles and abstracts (n= 5434). As a result, 152 full-text studies were examined. Of them, 127 studies were excluded. Thus, 25 studies were eligible for the review, of which 19 were cross-sectional, three were pre-post intervention studies, two were quasi-experimental, and one was an observational cohort study. Studies were conducted in high-, upper-middle-, and middle-income countries.

*Results of individual studies and reporting quality assessment*

Patient education on HAIs was investigated in eight studies, where the percentages of education ranged between 4.8 and 34.5%. Education on central line-associated bloodstream infections (CLABSIs) was investigated in one study at 76%. Education on SSIs was investigated in two studies, where the percentages of education ranged between 54 and 95.2%. Education on HH was investigated in 12 studies, ranging from 0.9 to 74.2%. Education on respiratory hygiene/cough etiquette was investigated in one study at 21.1%. Education on isolation rationale, precautions, and use of PPE was investigated in three studies, where the percentages of education ranged between 36.6 and 82.4%. Finally, patient education on other IC measures was investigated, including hygiene measures to prevent UTIs and IC methods and the organization of IC in the hospital, where the percentages of education ranged between 6.2 and 28%.

Concerning the data collection tools used in the included studies, 23 studies employed questionnaires, while one study involved a developed audit tool, and one used patient medical records. Regarding the validity and reliability of the instruments, four studies indicated that the questionnaires were assessed for validity, but measures were not reported, and one study mentioned that the questionnaire was already validated. Only two studies mentioned the internal consistency measures of the reliability of the questionnaire. Regarding the reporting quality assessment, in general, the abstracts and introductions were well reported in all studies, whereas several gaps were found in reporting the methods, the results, and discussion sections.

## Discussion

The present systematic review identifies the studies that assessed hospitalized patients' education on IC measures. A low percentage of patient education was noticed in all studies that assessed education on HAIs, while a better percentage was noted in the study that assessed education on CLABSIs and in the two studies that assessed education on SSIs. This finding can be explained since patients with central lines and those undergoing surgeries are at a higher risk of acquiring an HAI and thus are given more attention by HCWs. A low percentage of education was also recognized when educating on HH, except in one study, although HH is suggested to be the most effective approach to prevent the transmission of HAIs (Alzyood et al., 2018). When educating on isolation rationale, precautions, and use of PPE, we recognized a high level of education by only one study, but it is notable here that the sample of isolated participants was small in the three studies (between 30 and 39). Thus, the small sample size might have overestimated the education level. Finally, when educating on other IC measures, a low level of education was also recognized. On the other hand, only two studies were found to assess patient education on more than one IC measure (Hammoud et al., 2017; Merle et al., 2005), which highlights the necessity of having more research that aims at assessing patient education on several IC measures and not only assessing education related to one IC measure.

### *Strengths and limitations*

This is the first systematic review that identifies the studies that assessed hospitalized patients' education on IC. The search was conducted without any restrictions. Additionally, the 25 studies included in this review have an international scope. However, our review has some limitations. First, studies that assessed the general population and those that assessed patient education on specific diseases were excluded. Second, qualitative studies were also excluded.

## Conclusion

In conclusion, the present systematic review reveals a low percentage of patient education on IC measures. This result highlights a gap in the present assessment of patient education and involvement in IC. Hospitals must emphasize the importance of patient engagement and education on IC and encourage patients to involve themselves in their process of care by asking their HCWs to provide them with information. Further studies are needed to assess patient education on IC, and such studies can reveal a validated and standardized questionnaire that can be used further by other researchers (Hammoud et al., 2020).

## SUBSTUDY 2

### Assessing Patient and Family Education on Infection Control in Hungary: A Cross-sectional Study

### Methods

We aim in this study to assess hospitalized patients' and family members' education on IC measures in Hungary.

This study used a multisite, cross-sectional design. Hospitals in the Southern Transdanubian region of Hungary were invited to take part in our study. Inclusion criteria for participation in this study included patients who were admitted to inpatient units, admitted for at least 24 hours, conscious, and willing to complete the questionnaire. Family members caring for the patients and willing to complete the questionnaire were also included. Self-administered questionnaires were distributed to a convenience sample of patients and family members who were eligible and present between February 2020 and June 2021. The required sample size (382 participants) was calculated using the Thompson equation (Thompson, 2012).

According to substudy one, only two studies examined patient education on several IC measures. The first study assessed patient education on HAIs, risk factors for HAIs, IC methods, and the organization of IC in the hospital (Merle et al. 2005), while the second examined patient and family education on several IC measures using a questionnaire that was developed according to the CDC guidelines for isolation precautions, the part related to patient and family education (Hammoud et al. 2017; CDC, 2007). Therefore, in this study, we used a modified version of the questionnaire developed by the latter. No permission was required to use the tool, as it is under the Creative Commons Attribution 4.0 International (CC BY-NC-ND 4.0). The questionnaire consisted of two parts: the demographics and the IC education part. The education part involved nine close-ended questions concerning patient and family education on HAIs, the risks of acquiring an HAI, HH, respiratory hygiene/cough etiquette, receiving fliers on HH and/or respiratory hygiene, isolation status, education on the reason for isolation initiation and the use of PPE, and the time of the provided education. Education on HH was the question that was added to the original questionnaire. Translation and back-translation were performed as per the guidelines (Sousa & Rojjanasrirat, 2011). After the final Hungarian version of the questionnaire was produced, content validity was assessed by a panel of four experts, where content validity was attained. Then, a pilot study on 15 patients and family members was performed to assess the readability and internal consistency of the questionnaire. Kuder-Richardson 20 coefficient was equal to 0.814, which is similar to the original questionnaire (0.877), showing a very good reliability coefficient.

Data curation and analysis were performed via SPSS. Frequencies and percentages were used for categorical variables, while the mean and standard deviations (SD) were used for the only continuous variable in our dataset (age). The chi-square ($X^2$) test or Fisher's exact test was used to compare the difference in IC education across demographics. Additionally, a logistic regression analysis was performed to identify independent predictors of patient and family education for each IC measure. The significance level was set at $p< 0.05$. For missing data management, incomplete questionnaires were disregarded. The study received ethical approval from the Regional Research Ethics Committee of the Medical Center, Pécs, Hungary (Record number: 7862 - PTE 2019). Written informed consent was signed by all participants.

## Main Results

*Demographic characteristics*

Of the seven included hospitals, one was a university hospital, two were county hospitals, and four were city hospitals. Regarding the geographical location, three hospitals were located in Baranya County, three in Tolna, and one in Somogy. A total of 418 participants responded with a 55% response rate. After checking incomplete questionnaires, 412 participants were included. Of them, 89.6% were patients, and 59.2% were females. The mean age ± (SD) was 52.67 ± 17.442 years.

*IC education of patients and family members*

The highest percentage of education was on respiratory hygiene (89.8%), followed by HAIs (82.5%) and HH (82%). The lowest was on receiving fliers on HH and/or respiratory hygiene (75.7%).

The percentage of IC education varied across different counties and departments. For example, participants from Somogy had the highest percentages of education on HAIs ($p= 0.001$), the risks of HAIs ($p< 0.001$), and the highest percentage of receiving fliers on HH and/or respiratory hygiene ($p< 0.001$). On the other hand, participants from Tolna had the highest percentages of education on HH ($p= 0.018$), respiratory hygiene ($p< 0.001$), and the use of PPE ($p= 0.012$). Additionally, participants from pediatrics and hematology-oncology departments had the highest percentage of education on HAIs ($p= 0.001$) and the highest percentage of receiving fliers on HH and/or respiratory hygiene ($p= 0.019$). Similarly, participants from the surgery, hematology-oncology, and pediatrics departments had the highest percentage of education on respiratory hygiene ($p< 0.001$). Moreover, education on respiratory hygiene varied across different hospitals; the highest percentage of education was among participants from the county hospitals ($p< 0.001$). Finally, education on HAIs differed across participants' admission status; those with their first hospital admission were more educated than their counterparts ($p= 0.032$).

*Logistic regression analysis*

The logistic regression analysis showed a significant association between Hungarian counties and patient and family IC education. Participants from Somogy County were 3.5 times more likely to be educated on HAIs (95% confidence interval (CI): 1.723-7.064), 4.8 times more likely to be educated on the risks of HAIs (95% CI: 2.413-9.605), and 2.6 times more likely to receive fliers on HH and/or respiratory hygiene during their hospitalization (95% CI: 1.420-4.764) than participants from Baranya. Additionally, participants from Tolna and Somogy were two times more likely to be educated on HH (95% CI: 1.142-4.075 and 95% CI: 1.103-3.644, respectively). Moreover, being in Tolna increased the likelihood of being educated on respiratory hygiene by 12 times (95% CI: 3.672-41.280) and being in Somogy by seven times (95% CI: 2.837-17.342).

## Discussion

This study aimed to assess patient and family education on IC measures in Hungary. The results show a high percentage of IC education compared to the systematic review results of substudy one. The percentage of education on respiratory hygiene, HAIs, the risks of HAIs, HH, and receiving fliers on HH and/or respiratory hygiene are higher than those of similar studies

(Hammoud et al. 2017; Seale et al. 2015; Srigley et al. 2020). While the results of education on the reason for isolation and the use of PPE are much better than the results of Guilley-Lerondeau et al. (2017); however, they are similar to those of Hammoud et al. (2017).

The high level of IC education could be explained by three main reasons. First, our research was conducted during the coronavirus disease (COVID-19) pandemic, where patient education becomes critical so that patients may aid in combating the virus (Szmuda et al., 2020). Consequently, strict regulations were applied in Hungarian hospitals to fight against the virus. Perhaps this was reflected in having the highest percentage of education on respiratory hygiene, followed by HAIs and HH, as HH and respiratory hygiene are the key recommended IC measures to fight against COVID-19 (WHO, 2021). The second reason that might explain the high IC education is related to the EU Council recommendation for patient safety, including the prevention and control of HAIs (European Commission, 2009), where all the healthcare institutions of member states are required to provide their patients with information on the risks of HAIs and the required IC measures to prevent them. Additionally, patients who are colonized or infected with pathogens should be provided with the needed IC measures and information. Third, although the government regulation that determines IC practices among healthcare institutions in Hungary (20/2009. (VI. 18.) The Hungarian Act on the Prevention of Healthcare-associated Infections, 2009) does not mention or state patient education on IC, it clearly states that healthcare institutions should conform to the EU Council recommendation. This may explain the high percentage of education on all IC measures.

The higher percentage of education among pediatrics, hematology-oncology, and surgery departments could be because patients in these units are usually given more attention due to their conditions. The results of the regression analysis showed that the counties were significant predictors of IC education. These findings may guide Hungarian health authorities to focus on Baranya County, where participants are less likely to be educated on certain IC measures.

*Strengths and limitations*

Since hospitals of different types and from different counties were included in our study, we believe that our results may be generalized to reflect the situation of patient and family education across Hungary. Nevertheless, our study has some limitations. First, using convenience sampling may have introduced selection bias. Second, the health literacy of participants was not assessed; however, simple words were used in translating the questionnaire into Hungarian. Third, since the participants were the outcome assessors (IC education), this might have resulted in recall bias; however, the researchers tried to minimize this bias by collecting the data during hospitalization, not after discharge. Fourth, the proportion of family members in our sample was low because of the COVID-19 restrictions that were applied in hospitals. Future studies are recommended to conduct a separate study to assess family members' education on IC measures. Finally, our study took place during the COVID-19 pandemic, so we expect that our results might have been affected by the COVID-19 situation. Researchers are suggested to reassess patient and family education after the pandemic.

*Implications for practice*

With the rise of MDR infections, patient and family members' engagement in IC is receiving more attention. Although patient education on IC is considered a passive strategy to reduce the burden

of HAIs, it is the keystone of patient engagement and the first step to patient empowerment. To support the active role of patients in preventing the transmission of HAIs, nurses have vital roles through proper education about IPC measures. Efforts are needed at the national and institutional levels to maintain the high percentage of IC education in Hungary and for further improvements. Based on our findings, we recommend adding patient and family education on IC measures to the existing Hungarian government regulations that determine IC practices in hospitals. This can be implemented by listing all the measures that patients and family members should be educated on and the preferred time of education. At the institutional level, Hungarian hospitals are encouraged to enhance the environment of participation of patients and family members in IC by involving them in discussions and allowing them to ask questions about the information provided.

## Conclusion

In summary, the present study reveals a high percentage of patient and family education on IC measures in Hungary compared to the existing literature. The highest percentages of education were on respiratory hygiene, HAIs, and HH. Despite the high percentage of IC education, we believe that maintaining this high percentage is challenging, especially after the COVID-19 pandemic. To do so, we encourage Hungarian health authorities to add IC patient and family education to the government regulations that determine IC practices in Hungarian hospitals. In our opinion, this addition is necessary and might even enhance the IC education performance of nurses, since it is mandatory for all hospitals to abide by these guidelines. Future researchers are encouraged to conduct similar studies after the COVID-19 pandemic, as it might be the main reason for the high percentage of education in our study.

## SUBSTUDY 3

### Examining the Effect of Infection Prevention and Control Awareness among Nurses on Patient and Family Education: A Cross-sectional Study

### Methods

This study was conducted among nurses in Hungary to (a) determine the level of nurses' awareness of IPC measures, (b) assess patient and family education on IPC measures from the nurses' perspective and explore the reasons that might prevent nurses from educating patients and their family members, and (c) examine the effect of nurses' IPC awareness on implementing patient and family education.

The study used a cross-sectional, multisite design among the seven previous hospitals that were included in substudy two. Concerning the inclusion criteria for the participants, all nurses in the inpatient units were eligible to participate. Self-administered questionnaires were distributed to a convenience sample of nurses who were on duty between February 2020 and April 2021. To reduce response bias, questionnaires were voluntary and anonymous. To minimize nonresponse bias, printed questionnaires were distributed instead of sent via emails. The required sample size (381 nurses) was determined using the Thompson sample size equation (Thompson, 2012).

The study used a modified version of the ICSQ developed by Tavolacci et al. (2008). Approval for using the questionnaire was obtained from Cambridge University Press. The first part of the

questionnaire focused on demographics, while the second part included 23 true/false questions (instead of 25 in the original questionnaire) concerning nurses' awareness in three IPC areas: HAIs (three questions), HH (eight questions), and SPs (12 questions). Due to the situation in Hungary, two items of the original questionnaire were deleted during content validity assessment: the prevalence of HAIs and the number of annual deaths due to HAIs in Hungary. The response to each question was coded and scored as aware (1) or not aware (0). A continuous variable of IPC awareness score was constructed with a maximum score of 23. Additionally, a categorical variable was constructed for each IPC area as nonacceptable/low awareness (a score < 70%) and acceptable/high awareness (score ≥ 70%). The 70% cutoff level was set as per Tavolacci et al. (2008). This was equivalent to a score ≥ 2.1 for HAIs, ≥ 5.6 for HH, ≥ 8.4 for SPs, and ≥ 16.1 for total awareness. To assess the education of patients and family members on IPC, the questionnaire included a third part. This part involved four close-ended questions. The first was meant to determine whether nurses are educating patients and family members on IPC measures. In the second question, the IPC measures were selected according to the CDC guidelines for isolation precautions (CDC, 2007). These measures included education on HAIs and their risks, HH, respiratory hygiene/cough etiquette, the reason for isolation, and the use of PPE. The third question assessed when the education was provided, and the fourth was meant to explore the reasons that might prevent nurses from educating the patients and family members on IPC. After developing the questions, content validity was assessed by a panel of four experts. All members accepted the proposed questions.

Translation was performed similarly to substudy one following guidelines. After the Hungarian version of the questionnaire was finalized, a pilot study on 15 nurses yielded a Cronbach's alpha of 0.76 (IPC awareness part) compared to 0.61 of the original questionnaire and a Cronbach's alpha of 0.704 (education part), both showing good reliability coefficients.

The collected data were analyzed using SPSS. Frequencies and percentages (categorical variables), as well as means and SD (continuous variables), were used to summarize the data. The Shapiro-Wilk test was used to test the normality of the continuous variable (IPC awareness score). The nonparametric Mann-Whitney U test and Kruskal-Wallis test were used to compare the difference in IPC awareness score mean ranks across demographics, and the chi-square ($\chi 2$) test was used to compare the difference in IPC patient and family education across demographics and IPC high/low awareness groups. A logistic regression analysis was performed to identify independent predictors of a high awareness level for each IPC area. The significance level was set at $p< 0.05$. To manage missing data, partially completed questionnaires were disregarded. The study was approved by the Regional Research Ethics Committee of the Medical Center, Pécs, Hungary (Record number: 7862 - PTE 2019). All nurses provided written, informed consent to participate in the study.

## Main Results

*Nurses' demographics*

In total, 597 of 810 nurses completed the questionnaires, resulting in a 73.7% response rate. After disregarding 31 incomplete questionnaires, the final number of participants included was 566 nurses. Of them, 91.7% were females, 16.6% had a university nursing degree, and 60.2% had been working in the hospital for more than 10 years. The mean age (±SD) was 42.07 ± 10.205 years. Of all nurses, 98.4% were trained on IPC measures, whereas 75.8% attended the training sessions

during the last year. The highest percentages of training were on HH (87.1%) and the use of PPE (82.3%), while the lowest were on isolation precautions (44.2%) and managing hospital blood/body fluid spills (38.9%).

*IPC awareness*

The mean overall awareness score (± SD) was 16.69 ± 2.504. The mean score (± SD) was 10.11 ± 1.509 for SPs, 4.69 ± 1.403 for HH, and 1.89 ± 0.722 for HAIs. A total of 61.7% of nurses had a high overall awareness level, 83.4% had a high awareness of SPs, 29.7% had a high awareness of HH, and 19.4% had a high awareness of HAIs.

*Patient and family education on IPC*

Of all nurses, 76.1% mentioned that they educated patients and their family members on IPC measures, while 5.1% implemented the education upon hospital admission, 68.9% upon admission and during the hospital stay, and 20.7% upon discharge. The highest percentages of education were on HH (71.9%) and respiratory hygiene (57.2%), while education on the reason for isolation, the use of PPE, and the risks of acquiring HAIs were all below 50%. Concerning the barriers to educating patients and family members on IPC, the shortage of nurses (67.3%), time limits (62.5%), and stress (17.3%) were the most mentioned barriers to education as per the nurses.

*Variance analysis (IPC awareness score)*

The Shapiro-Wilk test results showed that the data (IPC awareness score) were not normally distributed; thus, nonparametric tests were used to assess the variance across demographics. The overall mean awareness did not significantly differ across gender, age, and hospital type. However, it differed across nursing units ($p$= 0.029), where intensive care unit (ICU) nurses had the highest mean rank, while those working in hematology units had the lowest. Additionally, when comparing across educational degrees and years of service, the highest mean ranks of awareness were achieved by university degree holders ($p$< 0.001) and those who had been working in the hospital for more than 10 years ($p$= 0.026).

*Logistic regression analysis*

Only one independent variable (educational degree) had a significant association with having a high level of awareness in the three IPC areas as well as the total IPC awareness. It was revealed that nurses holding a vocational nursing certificate were less likely to have a high awareness of total IPC (odds ratio (OR) = 0.281, 95% CI: 0.156-0.507), HH (OR= 0.543, 95% CI: 0.339-0.868), and SPs (OR= 0.271, 95% CI: 0.106-0.695) than those holding a university nursing degree. Additionally, nurses holding a secondary school certificate were less likely to have a high awareness of total IPC (OR= 0.179, 95% CI: 0.092-0.351), HAIs (OR= 0.275, 95% CI: 0.125-0.608), HH (OR= 0.488, 95% CI: 0.268-0.889), and SPs (OR= 0.171, 95% CI: 0.063-0.466) than those holding a university nursing degree.

*Variance analysis (patient and family education on IPC)*

The percentage of education varied across hospital types. When educating on the reason for isolation ($p$= 0.003) and the use of PPE ($p$= 0.001), the highest percentages of education were among nurses working at university hospitals, while in educating on HH ($p$< 0.001), respiratory hygiene ($p$= 0.002), and HAIs ($p$< 0.001), the highest percentages were achieved by those working at county hospitals. When educating on the reason for isolation, the percentage of patients and

family education was the highest among nurses holding a university degree ($p$= 0.029) and those with more than 10 years of service ($p$= 0.033). Last, when educating on HAIs, the percentage of education was the highest among nurses working in the hematology, neonatal intensive care unit-pediatric intensive care unit (NICU-PICU), and oncology departments ($p$< 0.001).

Finally, when comparing patient and family education across groups with high and low IPC awareness, the results showed that nurses with high awareness educated patients and family members more than those with low awareness. However, the results were only significant when educating on respiratory hygiene and the reason for isolation as follows: education on IPC measures in general (78.8% and 71.9%, $p$= 0.061), education on HH (73.6% and 69.1%, $p$= 0.245), education on respiratory hygiene (62.8% and 48.4%, $p$= 0.001), education on the reason for isolation (40.7% and 30.9%, $p$= 0.019), education on the use of PPE (46.1% and 39.6%, $p$= 0.129), and education on the risks of acquiring HAIs (42.7% and 40.1%, $p$= 0.542).

## Discussion

We sought to assess the level of IPC awareness among Hungarian nurses and to examine the effect of this awareness on implementing patient and family education. Nurses revealed a high IPC mean awareness score, which is consistent with the results of D'Alessandro et al. (2013) and Tavolacci et al. (2008). Nevertheless, awareness varied across the IPC areas where the SPs score was only acceptable, which is similar to the findings by Brosio et al. (2017) and D'Alessandro et al. (2013). We believe that the high scores of the total IPC and SPs awareness might be related to COVID-19, as our data were collected during the pandemic. Previous studies have shown that HCWs caring for COVID-19 patients experienced fear of transmitting the virus to family and friends (Ness et al., 2021; Xiang et al., 2020). Additionally, a recent review on HCWs' knowledge, attitudes, and practices during COVID-19 has reported a considerable level of knowledge about symptoms, transmission, spread, and prevention of COVID-19 (Puspitasari et al., 2020). IPC practices have been recommended by the CDC for many years as a means of preventing disease outbreaks and ensuring HCW safety (Hammoud et al., 2021). Since SPs are considered the main strategy to ensure the safety of HCWs (CDC, 2007), we think the high IPC overall and SPs awareness in our study could be related to the pandemic and the high alertness of HCWs during this situation.

Although high scores were achieved in the overall IPC and SPs scores, our results show scores that fail to meet the expectations since the HAIs and HH awareness scores were not acceptable. Despite the high percentage of participating in IPC training by nurses, which reflects the fact that Hungarian hospitals abide by the regular IPC training obligations as per the Hungarian government regulation that determines IPC practices in healthcare institutions in Hungary (20/2009 (VI. 18.) Hungarian Act on the Prevention of Healthcare-associated Infections, 2009), acceptable scores were not achieved in HAIs and HH. Given the importance of HAIs as a major threat to patient safety (Liu et al., 2020) and the prominence of HH as being the approach that is mostly supported by scientific evidence for its effectiveness in reducing the transmission of HAIs in healthcare settings (Tartari et al., 2021), nurses' knowledge of HAIs and HH should still be improved.

The results showed that nurses working in the ICU had the highest mean IPC awareness, while nurses working in hematology had the lowest. This could be explained by the IPC program in hospitals often being focused on high-risk units, such as ICUs, where the risk of occupation-related exposure is high (Kim & Hwang, 2020). Thus, more attention should be given to IPC training

programs in other nursing units where HCWs are at lower risks of exposure to improve staff awareness. Our findings also showed that nurses who had been working in the hospital for more than 10 years had the highest mean rank of IPC awareness, while those working for less than one year had the lowest. This may be attributed to the fact that senior nurses have achieved greater knowledge about IPC measures and practices by caring for infected patients, and this knowledge was additionally enriched by training newly employed nurses (Kim & Hwang, 2020). Therefore, the provision of continual IPC training is especially recommended for newly employed nurses to improve their knowledge and raise their awareness.

The logistic regression results showed that nurses holding lower nursing degrees were significantly less likely to have a high awareness of IPC than nurses holding university degrees. Our results are consistent with the results of El-Gilany et al. (2012). This finding can be explained by IPC practices not being emphasized similarly in the core curriculum in vocational training institutions and university curricula (El-Gilany et al., 2012).

Regarding patient and family education on IPC, as stated by nurses, the highest level of education was on HH, which is similar to the results of Hammoud et al. (2017), while the lowest was on the reason for isolation (36.9%), unlike the results of Hammoud et al. (2017), where the lowest education was provided on HAIs. Respiratory hygiene was the second highest measure patients were educated on. These findings are consistent with the findings of substudy two, which assessed IC patient and family education from the patients' and family members' perspective in Hungary, where respiratory hygiene, HAIs, and HH had the highest percentages of education. The higher frequency of education on HH and respiratory hygiene could be explained since our study was conducted during the COVID-19 pandemic, where these two measures were and are still among the most important and recommended measures to prevent the spread of this virus (CDC, 2020; WHO, 2020). Nevertheless, our findings could not be considered promising since the education on other IPC measures were all below 50%. The significantly higher percentage of education on all IPC measures in university and county hospitals could be explained by the fact that such hospitals are much larger than city hospitals and have stricter policies and guidelines. Additionally, the significantly higher percentage of education on HAIs in hematology, NICU-PICU, and oncology can be explained by the critical conditions of patients in these units that require more attention from the nurses.

The shortage of nurses, time limits, and stress were the most stated barriers to patient and family education as per the nurses. This is not surprising, since it reflects the current difficult situation of all nurses worldwide during the COVID-19 pandemic. Motivating and encouraging HCWs can support efforts to prevent the transmission of HAIs (Gaughan et al., 2020). Nurses should be encouraged to engage in and educate patients and family members on IPC measures, but the more crucial thing for the nursing leaders is to build and enhance the culture that believes in the partnership between the nurses and their patients. Although important, patient education is criticized as it reflects a passive strategy and tends to limit patient involvement to adhering to what they are instructed to do rather than empowering patients as real partners. Active strategies encourage patient engagement beyond the development of their knowledge and skills, taking into consideration patients' preferences, beliefs, and experiences. When recognized in an active role, patients could add further insights to the development of IPC regulations and become educators themselves (Agreli et al., 2019). However, this involvement is sometimes ineffective unless patients are encouraged to do these tasks (Hostiuc et al., 2018). We believe the initial step for nurses is to admit that patients can and should have an active role in HAIs' prevention, which is

often a demanding task. This could be done by developing and implementing training programs for nurses that emphasize the active role that patients and their relatives can play in attaining patient safety, especially through IPC.

Finally, our results showed that nurses with high IPC awareness provided more patient and family member education than those with low awareness, but the differences were only significant for respiratory hygiene and the reason for isolation. These results highlight the importance of improving nurses' knowledge and awareness of IPC as a way to enhance patients' and family members' education on IPC and to improve nurses' compliance with IPC guidelines that have a critical role in preventing the spread of HAIs and maintaining patient safety.

*Strengths and limitations*

We believe our results may be generalized to all nurses across Hungary since the participants were included from hospitals of different types and different counties. However, this study has some limitations. First, it is a descriptive study based on a self-reported questionnaire, so there might be a difference in the patient and family education rate reported by nurses compared to studies based on direct observation and assessment of educational sheets. Hence, future studies are recommended to use such tools. Second, using a convenience sample of nurses could have possibly introduced selection bias. Finally, our study was conducted during the COVID-19 pandemic, so we are uncertain if our results were affected by factors due to the pandemic. It would be of interest to re-conduct a similar study after the pandemic and compare the results.

*Implications for practice*

It is essential to strengthen patient and family education on IPC measures. Organizational efforts are needed to improve nurses' awareness of patient and family education. Together with leadership support, such as motivating and encouraging nurses to overcome the barriers to patient and family education that were identified in this study and enhancing the culture that is based on the partnership between nurses and their patients, along with implementing training of nurses emphasizing the importance of engaging patients and family members in IPC and its impact on patient safety. Additional institutional efforts are needed to improve IPC awareness among nurses, which might improve the level of patient and family education provided by nurses, at least on some IPC measures, as shown in this study. Our findings suggest that hospitals should work on creating standardized communication plans to disseminate essential information to nurses in a timely and organized manner. This information might include videos and posters about IPC practices as well as reminders on the importance of engaging patients and family members in IPC and the active role that they can play. While improved communication can enhance nurses' awareness of IPC, this alone is not sufficient in tackling this complex problem. We further recommend that hospitals motivate and encourage nurses to acquire high levels of IPC knowledge and practice by engaging them in a performance feedback process. This could be done through reward and recognition programs as motivational tools to enhance nurses' knowledge and compliance with IPC practices. We believe an organizational culture that focuses on IPC practices will enhance the efforts of nurses to prevent HAIs and improve patient safety. Further interventional studies are needed to assess the effect of such programs on nurses' performance in patient and family education.

## Conclusion

This study shows high scores of IPC overall and SP awareness as well as low scores of HAIs' and HH awareness among nurses in Hungary. Even with regular IPC training in Hungarian hospitals, gaps have been identified in the awareness of nurses. Perhaps the manner of communication of information could be an issue. This underscores the need for creating standardized communication plans to disseminate essential information to nurses in a timely and organized manner. The study also highlights a low level of patient and family education on IPC measures that might be improved by improving nurses' awareness of IPC and at the top management level by building and enhancing the culture that is based on the partnership between nurses and their patients and encouraging the nurses to engage in and educate patients and family members on IPC (Hammoud et al., 2022).

## SUBSTUDY 4

### Translation and Validation of the Hungarian Version of the Infection Control Standardized Questionnaire: A Cross-sectional Study

### Methods

In the previous substudy, we used the ICSQ to assess nurses' awareness of IPC measures. However, due to the slow data collection process as a result of the COVID-19 pandemic, validation of the tool using factor analysis was not applicable earlier due to sample size requirements; thus, it was left until the end, after the data collection was finished. Hence, this study was conducted to assess the validity and reliability of the Hungarian version of the ICSQ (ICSQ-H).

As in the previous two substudies, this substudy used a cross-sectional, multisite design among the same seven hospitals. The study used the ICSQ that was previously used in substudy three. However, in this substudy, the questionnaire included only two parts, the demographics part and the IPC awareness part, with 25 true/false questions (as per the original questionnaire) regarding nurses' awareness in HAIs (five questions), HH (eight questions), and SPs (12 questions). Translation and back-translation were performed following the recommended guidelines (Sousa & Rojjanasrirat, 2011). Then, the original ICSQ and ICSQ-H were presented to a panel of four experts to assess the content validity of the ICSQ-H. The panel included an IPC specialist, a physician, and two nurses. Content validity was established by calculating the item content validity index (I-CVI) and scale content validity index (S-CVI/Ave) (Polit & Beck, 2006). An I-CVI= 1 for a panel with ≤ 5 members (Lynn, 1986) and an S-CVI/Ave≥ 0.90 were acceptable (Polit & Beck, 2006). After that, a pilot study was performed among 15 nurses. The nurses were asked to respond to the questionnaire and provide their comments on any items that they had difficulty understanding. None reported language problems or difficulty in answering the questions.

Concerning the sample size, in the case of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), it is recommended to recruit 300-500 participants (Sousa & Rojjanasrirat, 2011). Based on this, we decided to include at least 500 nurses. The inclusion criteria for participation were the same as those applied in substudy three. Questionnaires were distributed to a convenience sample of nurses who were on schedule between February 2020 and May 2021.

For statistical analysis, the Shapiro-Wilk test was used to check the normal distribution of the data. Frequencies as well as means and SD were used to summarize the demographics of the

participants. To manage missing data, incomplete questionnaires were disregarded. The structural validity of the ICSQ-H was assessed using principal component analysis (PCA) and CFA in a two-step process. Taking into consideration the recommendation of splitting the sample in construct-cross validation (Knafl & Grey, 2010), we used a sample of 355 nurses who had more than 10 years of experience at their current hospital for the PCA. For the CFA, a sample of 236 nurses who had less than 10 years of experience was used.

In step one, SPSS was used. The Kaiser-Meyer-Olkin (KMO) was calculated to confirm the suitability of the data used for PCA (a value > 0.5 was acceptable), as well as a significant Bartlett's test of sphericity ($p$-value< 0.05) (Williams et al., 2010). For the extraction of factors, PCA was used, and Varimax with Kaiser Normalization was used as a rotation method in addition to an eigenvalue above one (Brown, 2009). The rotated component matrix, scree plot, and parallel analysis were used to confirm the accurate number of factors to be retained (Williams et al., 2010).

In step two, a confirmative approach was adopted to validate the factor structure using AMOS version 23. Both the original model of the ICSQ and the PCA-suggested model were applied. Structural equation models in the CFA were evaluated by the overall goodness of fit for the models and by the value and significance of each parameter in the model. The goodness of fit for the model was evaluated through the following indices: the goodness-of-fit index (GFI> 0.95 well fit), the comparative fit index (CFI> 0.95 good fit), the Tucker-Lewis index (TLI> 0.95 good fit), the root mean square error of approximation (RMSEA< 0.06 good fit), the standardized root mean square residual (SRMR< 0.05 well fit), and the chi-square ($\chi 2$/df ratio < 3) with an insignificant $p$-value (> 0.05) (Hooper et al., 2008).

Convergent and discriminant validities were evaluated using the Fornell and Larcker criterion (Fornell & Larcker, 1981). Convergent validity was met when the average variance extracted (AVE) value was above 0.5. Discriminant validity was evaluated by calculating the Spearman correlation coefficient between the constructs. A value of r< 0.3 indicated discriminant validity (Bookter, 1999). Additionally, discriminant validity was met when the square root of the AVE had a greater value than the correlations with other latent constructs (Ab Hamid et al., 2017).

The interitem correlations and the corrected item-total correlations were calculated. For the interitem correlation, a value between 0.2 and 0.85 was considered to indicate good consistency (Kamya et al., 2021). Correlations above 0.85 were considered redundant. For the corrected item-total correlations, a value ≥ 0.3 was considered acceptable (Kamya et al., 2021). Additionally, the internal consistency was evaluated by calculating Cronbach's alpha. A value > 0.6 was considered sufficient (Janssens et al., 2008).

This study was approved by the Regional Research Ethics Committee of the Medical Center, Pécs, Hungary (Record number: 7862 - PTE 2019). All nurses signed written, informed consent forms.

## Main Results

### *Demographic characteristics*

Of the 810 distributed questionnaires, 622 were returned, resulting in a response rate of 76.8%. Of them, 31 questionnaires were excluded due to missing data. Therefore, data from 591 nurses were analyzed. The mean age (± SD) of the participants was 41.93 ± 10.262. Nurses with more than 10 years of experience composed 60.1% of the sample.

*Content validity*

After calculating the I-CVIs for each item in the ICSQ, two questions (Q 1D and 1E) had I-CVIs< 1. Therefore, both items were deleted. All other items had an I-CVI= 1. The S-CVI/Ave of the remaining 23 questions resulted in 1. Thus, our final questionnaire included 23 questions. This version of the questionnaire was used in substudy three.

*Structural validity*

The suitability for PCA was confirmed with a KMO measure of sampling adequacy of 0.650 and a significant Bartlett's test of sphericity ($\chi 2$= 2565.992; $p$< 0.001). PCA was performed on the ICSQ with 23 items. Six-factor solutions with eigenvalues greater than one were identified. The rotated component matrix, scree plot, and parallel analysis confirmed the six components, which accounted for a cumulative variance of 53.74%. Four items that failed to load at < 0.5 were removed (Q 1B, Q 2B, Q 2C, and Q 6C). Additionally, seven items were removed due to low interitem correlation, corrected item-total correlation, and alpha construct (Q 3C construct one, Q 3B construct two, Q 3A construct five, Q 1A and Q 4A construct six, and construct four including Q 2A and Q 2D). The remaining 12 items loaded on the following five constructs: use of gloves (GLVS), use of PPE, alcohol-based hand rub (ABHR) indications on unsoiled hands, SPs, and HAIs, which are presented in Table 1.

**Table 1** PCA of the ICSQ-H (N= 355)

| | | | Component | | | | |
|---|---|---|---|---|---|---|---|
| Component | Item Nb | Item | 1 | 2 | 3 | 4 | 5 |
| Use of gloves (GLVS) | Q 4D | The standard precautions recommend the use of gloves: When healthcare workers have a cutaneous lesion. | 0.838 | | | | |
| | Q 4B | The standard precautions recommend the use of gloves: When there is a risk of contact with the blood or body fluid. | 0.831 | | | | |
| | Q 3D | Hand hygiene is recommended: after the removal of gloves | 0.717 | | | | |
| | Q 4C | The standard precautions recommend the use of gloves: When there is a risk of a cut. | 0.664 | | | | |
| Use of Personal Protective Equipment (PPE) | Q 5B | When there is a risk of splashes or spray of blood and body fluids, the healthcare workers must wear: Only eye protection. | | 0.918 | | | |
| | Q 5C | When there is a risk of splashes or spray of blood and body fluids, the healthcare workers must wear: Only a gown. | | 0.878 | | | |
| | Q 5A | When there is a risk of splashes or spray of blood and body fluids, the healthcare workers must wear: Only mask. | | 0.805 | | | |
| Alcohol-based Hand Rub (ABHR) indications on unsoiled hands | Q 6D | The indications for the use of alcohol-based hand rub (on unsoiled hands) are: Traditional handwashing must be done before handwashing with an alcohol-based hand rub. | | | 0.732 | | |
| | Q 6B | The indications for the use of alcohol-based hand rub (on unsoiled hands) are: Instead of antiseptic handwashing (30 seconds). | | | 0.700 | | |
| | Q 6A | The indications for the use of alcohol-based hand rub (on unsoiled hands) are: Instead of traditional handwashing (30 seconds). | | | 0.684 | | |
| Standard Precautions (SPs) | Q 5D | When there is a risk of splashes or spray of blood and body fluids, the healthcare workers must wear: Mask, goggles, and gowns. | | | | 0.596 | |
| Healthcare-associated Infections (HAIs) | Q 1C | Invasive procedures increase the risk of nosocomial infection. | | | | | 0.534 |
| Eigenvalues | | | 3.504 | 3.021 | 1.729 | 1.537 | 1.333 |
| Percentage of variance | | | 15.233 | 13.133 | 7.517 | 6.684 | 5.796 |

CFA was conducted using maximum likelihood. First, the original structure of the ICSQ (23 items) was tested by CFA and resulted in a poor fit model with the following fit indices: $\chi^2$/df= 10.125; $p$< 0.001, GFI= 0.740, CFI= 0.487, TLI= 0.425, RMSEA= 0.124, SRMR= 0.1334. Therefore, our findings failed to support the original structure of the ICSQ. As a second step, our five-factor model identified by PCA was tested, which showed much-improved fit indices. However, this

model showed a poor model fit ($\chi^2$/df= 2.410; $p$< 0.001, GFI= 0.933, CFI= 0.933, TLI= 0.899, RMSEA= 0.077, SRMR= 0.0590). Afterward, we removed Q 6A from the ABHR construct due to low loading (0.29). Additionally, the SP construct including one item (Q 5D) was deleted. The new four-factor model including 10 items was tested again. The model showed a good fit, as all the indices indicated ($\chi$2/df= 1.183; $p$= 0.231, GFI= 0.972, CFI= 0.994, TLI= 0.990, RMSEA= 0.028, SRMR= 0.0315). The final four-factor model with the item loadings is shown in Figure 1.

*Convergent and discriminant validities*

Convergent validity was met except for the ABHR construct, which had an AVE value of 0.467, which is slightly less than 0.5. Discriminant validity was met for all constructs since the square roots of the AVE were higher than the off-diagonal correlations between constructs. Additionally, weak correlations (r< 0.3) were found between the four constructs.

*Internal consistency, interitem correlations and corrected item-total correlations*

The interitem correlations and the corrected item-total correlations of all constructs were acceptable. The internal consistency was satisfactory for the GLVS and PPE constructs, with Cronbach's alpha values of 0.780 and 0.897, respectively. The ABHR construct had a Cronbach's alpha of 0.529.

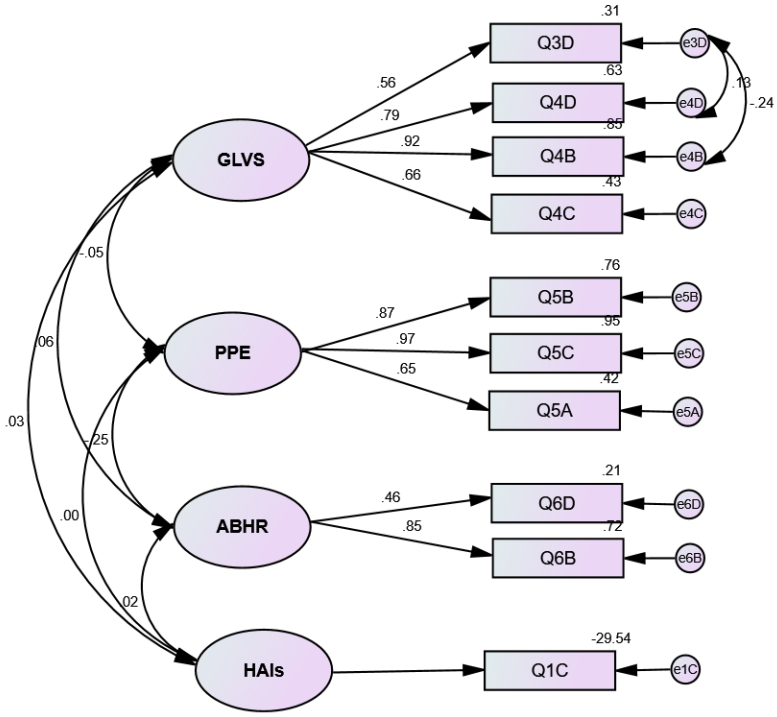


**Figure 1** CFA of the four-factor model of the ICSQ-H.

## Discussion

This study aimed to evaluate the validity and reliability of the ICSQ-H. The final results of PCA suggested a five-construct model with 12 items. Afterward, the CFA confirmed a four-construct model with 10 items that showed a good model fit, where all the fit indices passed the requirements.

Convergent validity was met for the GLVS and PPE constructs, which indicates a satisfactory level of correlation of multiple items of the same construct (Ab Hamid et al., 2017). However, the AVE of the ABHR construct was slightly below 0.5, which could still be considered acceptable. The weak correlations between the four constructs proved the discriminant validity of each. This means that the measures of distinct constructs share a little common variance and support the uniqueness of the items and the construct (Bookter, 1999). Concerning the interitem correlations and the corrected item-total correlations, they were acceptable for all constructs. Furthermore, the internal consistency of the ABHR construct was below 0.6; however, its interitem correlations and the corrected item-total correlations were acceptable. This could be due to the low number of items in this construct (two items) (Tavakol & Dennick, 2011). Finally, the removal of 15 items during the different stages of this study might considerably modify the original factor structure of the ICSQ, bearing in mind that they could hold valuable and important constructs in IPC. Nevertheless, these findings further suggest the existence of repetitions of similar items measuring similar factors that compromise the construct validity of the original ICSQ (Alnaami et al., 2020).

Few studies have been conducted to test the psychometric properties of some IPC questionnaires that are used to assess HCWs' knowledge about IPC measures. For instance, Duarte Valim et al. (2017) validated the Knowledge Questionnaire regarding Standard Precautions Measures (QCSP) for Brazilian nurses. Convergent validity was tested using known-group methods. Reliability was tested by calculating the intraclass correlation coefficient by applying the test-retest method. Similarly, the Infection Control Evaluation tool was developed by Wu et al. (2008) to assess nursing students' knowledge about standard and additional IPC precautions. The tool was a modified version derived from two previously developed tools including 15 questions. Content validity was assessed using the content validity index (CVI). Another tool was developed by Chan et al. (2008) to examine nurses' knowledge of SPs and transmission-based precautions using four multiple-choice questions. Content validity was assessed using CVI. Structural validity was assessed using EFA. The scale reliability was assessed via test-retest. Finally, we noticed that only one study assessed the structural validity of the scale using EFA (Chan et al., 2008), while neither study performed CFA, which suggests that further research is needed to test the structural validity of these scales using EFA and CFA.

### *Strengths and limitations*

Our study is the first to test the psychometric properties of the ICSQ-H. Although the study was performed in the Southern Transdanubian region of Hungary, we included all hospital types from different counties, so we believe that our results could be generalized to reflect the situation across Hungary. However, our study has some limitations. First, using convenience sampling might have introduced selection bias. Another limitation is that we could not compare our results to other existing models. Although the ICSQ has been used in several countries to assess HCWs' knowledge of IPC, its psychometric properties have not been tested and reported in other languages. Thus, future studies are needed to test the psychometric properties of the ICSQ in other

languages and settings. Finally, our data were collected during the COVID-19 pandemic, so we are uncertain if the awareness level of nurses was affected due to their high alertness during this period.

*Implications for practice*

Given that Hungarian is the official language in Hungary, it was necessary to validate a Hungarian tool to facilitate a more comprehensive and precise measurement of knowledge about IPC among nurses in Hungary. Based on our findings, we believe that the ICSQ-H could pave the way for more research regarding nurses' IPC knowledge to be conducted in Hungary. Nevertheless, its validation among other HCWs is important to tailor effective interventions to enhance knowledge and awareness.

## Conclusion

This study did not support the original three-factor structure of the ICSQ tool. However, the ICSQ-H based on the four-factor structure revealed by PCA and CFA demonstrated an adequate degree of good fit and was found to be reliable. Further research is needed to test the psychometric properties of the ICSQ across different countries and languages.

## SUMMARY OF NOVEL FINDINGS

1. To our knowledge, substudy one was the first systematic review to assess patient education on IPC measures. Of the included articles, only two assessed patient education on more than one measure. The review concluded a low percentage of patient education on IPC.

2. Substudy two revealed a high percentage of patient and family education on IPC in Hungary. The highest percentages of education were on respiratory hygiene, HAIs, and HH.

3. The regression analysis showed that participants from Somogy and Tolna were more likely to be educated on IPC than participants from Baranya. Our findings may guide Hungarian health authorities to focus on Baranya County hospitals, where participants are less likely to be educated on IPC.

4. Substudy three showed a high percentage of IPC training as stated by nurses. Nurses had high scores of IPC overall and SP awareness as well as low scores of HAI and HH awareness.

5. The regression analysis showed that nurses holding a secondary school certificate and those holding a vocational nursing certificate were less likely to have a high awareness than nurses holding a university degree. Thus, we recommend giving more attention to IPC practices in the curriculum in vocational training institutions in Hungary.

6. Concerning patient and family education on IPC from the nurses' perspective, nurses educated patients and family members the most on HH and respiratory hygiene. Education on other measures was low. Nurses' shortages, time limits, and stress were the most common barriers to patient education, as stated by nurses.

7. Nurses with high IPC awareness educated patients and family members more than those with low awareness; however, the results were only significant when educating on respiratory hygiene and the reason for isolation.

8. Substudy four showed that the ICSQ-H based on the four-factor structure revealed by PCA and CFA demonstrated an adequate degree of good fit and was found to be reliable. Based on our findings, we believe that this tool could pave the way for more research regarding nurses' IPC awareness to be conducted in Hungary.

9. To the best of our knowledge, this was the first study to examine the effect of nurses' IPC awareness on patient and family education in Hungary. Even with regular IPC training in hospitals, gaps have been identified in the awareness of nurses. This underscores the need for creating standardized communication plans to disseminate essential information to nurses in a timely and organized manner. Concerning patient and family education on IPC, it might be enhanced by improving nurses' awareness of IPC, at least on some measures as shown by substudy three, and at the management level by building and enhancing the culture that is based on the partnership between nurses and their patients. Finally, at the national level, we suggest adding patient and family education on IPC to the existing government regulations that determine IPC practices in hospitals in Hungary.

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## Metrics

Full texts: 12, Abstracts: 13
Number of SJR articles: Q1 - 4, Q2 - 5, Q3 - 2
IF: 22.527
Citations (without self-citations): 37
H-index: 4
ORCID: 0000-0003-4682-9001
Scopus ID: 57217487901
Web of Science Researcher ID: AAK-5526-2021
Publons ID: https://publons.com/researcher/4361415/sahar-hammoud/
ResearchGate: Sahar Hammoud
RG Score: 12.58
https://www.researchgate.net/profile/Sahar-Hammoud

### List of Publications

*Published articles related to the thesis*

**Hammoud S,** Amer F, Kocsis B. Examining the effect of infection prevention and control awareness among nurses on patient and family education: A cross-sectional study. NURSING & HEALTH SCIENCES. 2022; 24(1):140-151. https://doi.org/10.1111/nhs.12905

**Hammoud S**, Khatatbeh H, Zand A, Kocsis B. A survey of nurses' awareness of infection control measures in Baranya County, Hungary. NURSING OPEN. 2021; 8(6):3477-3483. https://doi.org/10.1002/nop2.897

**Hammoud S**, Amer F, Lohner S, Kocsis B. Patient education on infection control: A systematic review. AMERICAN JOURNAL OF INFECTION CONTROL. 2020; 48(12): 1506–1515. https://doi.org/10.1016/j.ajic.2020.05.039

*Article related to the thesis currently under review*

**Hammoud S**, Amer F, Khatatbeh H, Kocsis B. What is the current state of patient and family education on infection control measures? A descriptive study during the COVID-19 pandemic.

**Hammoud S**, Amer F, Khatatbeh H, Alfatafta H, Zrínyi M, Kocsis B. Translation and validation of the Hungarian version of the Infection Control Standardized Questionnaire: A Cross-sectional study. https://doi.org/10.21203/rs.3.rs-1231304/v2

*Additional published articles "Health Sciences"*

**Hammoud S**, Onchonga D, Amer F, Kocsis B. The burden of communicable diseases in Lebanon: Trends in the past decade. DISASTER MEDICINE AND PUBLIC HEALTH PREPAREDNESS. 2021 (In press): 1-3. https://doi.org/10.1017/dmp.2021.200

Amer F, **Hammoud S**, Khatatbeh H, Lohner S, Boncz I, Endrei D. The deployment of Balanced Scorecard in health care organizations: Is it beneficial? A systematic review. BMC HEALTH SERVICES RESEARCH. 2022; 22(65):1-14. https://doi.org/10.1186/s12913-021-07452-7

Amer F, **Hammoud S**, Khatatbeh H, Lohner S, Boncz I, Endrei D. A systematic review: The dimensions to evaluate health care performance and an implication during the pandemic. BMC HEALTH SERVICES RESEARCH. 2022; 22(621):1-22. https://doi.org/10.1186/s12913-022-07863-0

Khatatbeh H, **Hammoud S**, Khatatbeh M, Oláh A, Pakai A. Paediatric nurses' burnout and perceived health: The moderating effect of the common work-shift. NURSING OPEN. 2022; 9(3): 1679-1687. https://doi.org/10.1002/nop2.1192

Alfatafta H, Onchonga D, **Hammoud S**, Khatatbeh H, Zhang L, Boncz I, Lohner S, Molics B. Effect of the knee replacement surgery on activity level based on ActivPAL: A systematic review and meta-analysis study. BMC MUSCULOSKELETAL DISORDERS. 2022 (Accepted for publication on June 6th, 2022). https://doi.org/10.21203/rs.3.rs-1261100/v1

Khatatbeh H, Al-Dwaikat T, Oláh A, Onchonga D, **Hammoud S**, Amer F, Prémusz V, Pakai A. The relationships between paediatric nurses' social support, job satisfaction and patient adverse events. NURSING OPEN. 2021; 8(6):3575-3582. https://doi.org/10.1002/nop2.907

Onchonga D, **Hammoud S**, Kuriakose S, Khan Muhammad, EA. Exploring fear of childbirth in Kenya through evaluation of the readability of Wijma Delivery Expectancy/Experience Questionnaire Version A (W-DEQ-A). SEXUAL & REPRODUCTIVE HEALTHCARE. 2021; 28:1–7. https://doi.org/10.1016/j.srhc.2021.100605

Amer F, **Hammoud S**, Farran B, Boncz I, Endrei D. Assessment of countries' preparedness and lockdown effectiveness in fighting COVID-19. DISASTER MEDICINE AND PUBLIC HEALTH PREPAREDNESS. 2020; 15(2): e15-e22. https://doi.org/10.1017/dmp.2020.217

**Hammoud S**, Ghazi B, Nassredine M, Abou Haidar M. Nurses' awareness of infection control measures, and the role and effect in patient and family education. EUROPEAN SCIENTIFIC JOURNAL. 2017; 13(27):59–76. https://doi.org/10.19044/esj.2017.v13n27p59

*Additional articles "Health Sciences" currently under review*

Amer F, **Hammoud S**, Khatatbeh H, Alfatafta H, Alkaiyat A, Nour AI, Boncz I, Endrei D. How to engage health care workers in the evaluation of hospitals: Development and validation of BSC-HCW - a cross-sectional study. https://doi.org/10.21203/rs.3.rs-1377267/v2

Amer F, **Hammoud S**, Onchonga D, Alkaiyat A, Nour AI, Boncz I, Endrei D. Assessing patient experience and attitude: BSC-PATIENT development, translation, and psychometric evaluation - a cross-sectional study. https://doi.org/10.21203/rs.3.rs-1143609/v2

Khatatbeh H, Khatatbeh M, **Hammoud S**, Amer F, Alfatafta H, Kurnianto A, Al-Dwaikat T. A theoretical model on nurses' burnout during the COVID-19 pandemic.