PTE/32803-5/2022

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

Ph.D. Thesis

Sahar Hammoud

University of Pécs
Faculty of Health Sciences
Doctoral School of Health Sciences

Pécs, 2022

UNIVERSITY OF PÉCS

FACULTY OF HEALTH SCIENCES

DOCTORAL SCHOOL OF HEALTH SCIENCES

Head of Doctoral School: Prof. Dr. József Bódis

Programme Leader: Prof. Dr. Gábor L. Kovács

Supervisor: Dr. Med. habil. Béla Kocsis

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

Ph.D. Thesis

Sahar Hammoud

Pécs, 2022

DEDICATION

To my caring, loving, and supportive husband Ali, I dedicate this thesis. I appreciate all the time that you spent alone, without me by your side. Even though long distances separated us, we were still connected by the heart. Thank you for providing me with motivation, patience, and strength to reach my goal. Without you, this would not have been possible.

I would also like to dedicate this thesis to my parents Ali and Souha, the reason for what I become today. Thank you for raising me to believe that anything was possible. To my elder brother Hisham, thank you for believing in my capabilities and encouraging me to follow my dreams, especially this one. To my younger brother Eyad, thank you for your endless love and care. To my only sister Hala, my soulmate and best friend, your love and support were what sustained me this far. Thank you for always being there for me.

ACKNOWLEDGMENT

First, my deep gratitude to my Supervisor Dr. Med. habil. Béla Kocsis. Your support, follow-up, experience and knowledge facilitated my Ph.D. research until its final accomplishment. I appreciate all the time you gave to me during these four years.

I would like to take the opportunity to express my appreciation to the Doctoral School of Health Sciences at University of Pécs. First, to Prof. Dr. József Bódis, the Head of the Doctoral School, and to Prof. Dr. Endre Sulyok, Secretary of the Doctoral School. I am also grateful to Dr. Viktória Prémusz, Mrs. Piroska Bakonyi, and Mrs. Petra Szabó for their continuous help and support.

My sincere thanks also go to Diána Elmer, Noémi Németh, Adorján Varga, and Krisztina Kovács for their contribution in translating the questionnaires used in this research. In addition, to Dr. Gabor Rebek-Nagy for his assistance in the final steps of the translation process and finalization of the questionnaires.

Additionally, I would like to thank the financial support of the Stipendium Hungaricum scholarship awarded by Tempus Public Foundation.

I am grateful to the hospitals that were a part of my research. I would like to thank them for the trust they gave to me that enabled me to conduct the data collection.

Finally, I would like to thank Tavolacci MP, Ladner J, Bailly L, Merle V, Pitrou I, Czernichow P, Prevention of Nosocomial Infection and Standard Precautions: Knowledge and Source of Information among Healthcare Students. Infection Control and Hospital Epidemiology, Vol. 29, No. 7 (July 2008), pp. 642-647, reproduced with permission (license number 4522390775826).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ABHR:	Alcohol-based Hand Rub
AMOS:	Analysis of Moment Structures
AVE:	Average Variance Extracted
CAUTIs:	Catheter-associated Urinary Tract Infections
CDC:	Centers for Disease Control and Prevention
CFA:	Confirmatory Factor Analysis
CFI:	Comparative Fit Index
CI:	Confidence Interval
CICU:	Cardiac Intensive Care Unit
CLABSIs:	Central Line-associated Bloodstream Infections
COVID-19:	Coronavirus Disease 2019
CRE:	Carbapenem-resistant Enterobacteriaceae
CSF:	Cerebrospinal Fluid
CSSD:	Central Sterile Service Department
CVI:	Content Validity Index
ECDC:	European Center for Disease Prevention and Control
EFA:	Exploratory Factor Analysis
EU:	European Union
EVD:	Ebola Virus Disease
GFI:	Goodness-of-Fit Index
GLVS:	Gloves
HAIs:	Healthcare-associated Infections
HCWs:	Healthcare Workers

HH:	Hand Hygiene
HIV:	Human Immunodeficiency Virus
IC:	Infection Control
ICCs:	Infection Control Committees
ICC:	Intraclass Correlation Coefficient
ICNs:	Infection Control Nurses
ICOs:	Infection Control Officers
ICSQ:	Infection Control Standardized Questionnaire
ICSQ-H:	Hungarian version of the ICSQ
ICUs:	Intensive Care Units
I-CVI:	Item Content Validity Index
IIAB:	Institutional Infection Control Antibiotic Committee
IPC:	Infection Prevention and Control
KMO:	Kaiser-Meyer-Olkin
MDR:	Multidrug-resistant
MDROs:	Multidrug-resistant Organisms
MRSA:	Methicillin-resistant *Staphylococcus aureus*
NIs:	Nosocomial Infections
NICU:	Neonatal Intensive Care Unit
NNSR:	Nemzeti Nosocomiális Surveillance Rendszer
OB-GYN:	Obstetrics-Gynecology
OR:	Odds Ratio
PCA:	Principal Component Analysis
PICU:	Pediatric Intensive Care Unit

PPE:	Personal Protective Equipment
PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QCSP:	Knowledge Questionnaire regarding Standard Precautions Measures
RMSEA:	Root Mean Square Error of Approximation
SARS:	Severe Acute Respiratory Syndrome
S-CVI/Ave:	Scale Content Validity Index
SD:	Standard Deviation
SPs:	Standard Precautions
SPSS:	Statistical Package for the Social Sciences
SRMR:	Standardized Root Mean Square Residual
SSIs:	Surgical Site Infections
STROBE:	Strengthening the Reporting of Observational Studies in Epidemiology
TLI:	Tucker-Lewis Index
UK:	United Kingdom
UPs:	Universal Precautions
USA:	United States of America
UTIs:	Urinary Tract Infections
VAP:	Ventilator-associated Pneumonia
VRE:	Vancomycin-resistant *Enterococci*
WHO:	World Health Organization

CHAPTER 1 Introduction

1.1 INTRODUCTION

For centuries, governments, healthcare organizations and Healthcare Workers (HCWs) have been worried about infection in community and healthcare settings, yet in recent decades, attention to prevent and control Healthcare-associated Infections (HAIs) has increased (1). HAIs, also known as Nosocomial Infections (NIs), are infections developed during hospital stay that were not present or incubating at admission; these include infections acquired after 48 hours of admission and those acquired in hospital but appearing after discharge (2). Additionally, HAIs include occupational-acquired infections among staff (3). Several invasive devices, such as catheters and ventilators used in modern medicine to treat patients, are associated with HAIs (4). On the other hand, HCWs may acquire an HAI when they have a direct interaction with patients during their daily practice or indirectly, for example, by handling and discarding contaminated equipment and during specimen collection, handling and disposal (5–8). Another method of indirect transmission of HAIs could be through vectors. Vectors include the organisms that act as carriers for the transmission of infection by spreading infectious agents (9). These infectious agents can be transmitted to patients either by direct contact or through indirect contamination of objects, surfaces, and equipment. Cockroaches, rodents, ants, and flies are pests presenting the highest health risks in healthcare settings (10).

HAIs are associated with increased length of stay, higher morbidity rates, increased antimicrobial resistance (11), and increased mortality rates (11–13). They are the second most common cause of death worldwide (14). Additionally, HAIs may result in an increase in socioeconomic disturbances (11) and are associated with elevated financial costs for healthcare systems (3,15,16). During recent decades, healthcare settings have continued to face the high spread of Multidrug-resistant (MDR) HAIs (17). *Clostridium difficile*, Carbapenem-resistant Enterobacteriaceae (CRE), Methicillin-resistant *Staphylococcus aureus* (MRSA), and Vancomycin-resistant *Enterococci* (VRE) are frequently occurring and difficult-to-treat pathogens (18). According to the latest Centers for Disease Control and Prevention (CDC) report on antibiotic resistance threats, *Clostridium difficile* and CRE are classified as urgent threats that need urgent and aggressive action, whereas MRSA and VRE are classified as serious threats that require quick and continued action (19). Although the burden of HAIs due to MDR Organisms (MDROs) might extensively differ according to the geographical location,

healthcare setting, type of pathogen and antimicrobial substance, its significance to public health and patient safety remains to be emphasized at the national and international levels (20).

1.2 TYPES OF HAIs

The most frequent types of HAIs include Central Line-associated Bloodstream Infections (CLABSIs), Catheter-associated Urinary Tract Infections (CAUTIs), Ventilator-associated Pneumonia (VAP), and Surgical Site Infections (SSIs) (4).

1.2.1 CLABSI

CLABSIs are infections that arise when microorganisms penetrate into the bloodstream through central lines, which are catheters used to give patients medication or fluids or to collect blood for medical tests. Central lines differ from intravenous catheters because they access a main vein that is close to the heart. They can stay inserted for weeks or months and are more likely to cause serious infection (21). CLABSIs commonly occur in Intensive Care Units (ICUs) and units of acute care facilities (22) and are associated with increased mortality rates ranging between 12 and 25% (23).

1.2.2 CAUTI

Urinary Tract Infections (UTIs) are the most common type of HAIs acquired in hospitals (24,25). Around 75% of hospital-acquired UTIs are associated with urinary catheters, which are tubes inserted into the bladder through the urethra to drain urine. It is estimated that approximately 15 to 25% of admitted patients receive urinary catheters during their hospitalization. The prolonged use of urinary catheters is the most significant risk factor for acquiring CAUTI (26).

1.2.3 VAP

VAP is a common lung infection that develops in patients receiving mechanical ventilation. It occurs in 9 to 27% of patients on mechanical ventilation (27). About 86% of healthcare-associated pneumonia cases are associated with mechanical ventilation (28). A ventilator is a machine that is used in helping patients breathe by providing oxygen through a tube inserted in the patients' mouth or nose or through a hole in the front of the neck. VAP might occur if microorganisms enter into a patient's lungs through the tube (29).

1.2.4 SSI

SSIs are the second most common type of HAIs acquired in hospitals (25,30). They are infections that occur after surgery and involve the body part where the surgery was performed. SSIs can be superficial involving the skin only or can be more serious by involving the tissues under the skin, organs, or implanted material (31). SSIs occur in 2 to 5% of patients undergoing surgeries (30).

In Hungary, the most commonly reported HAIs due to MDROs in 2017 were UTIs, which accounted for 31% of all reported infections. SSIs were the second most common, accounting for 22% of reported infections. VAP was the third most commonly reported HAI due to MDROs, with 21%. Finally, bloodstream infections were the lowest, at 15% (32).

1.3 EPIDEMIOLOGY OF HAIs

As per the European Centre for Disease Prevention and Control (ECDC) point prevalence survey that was conducted in 2016 and 2017, 8.9 million HAIs are acquired annually in European hospitals (33). At the same time, the CDC in the United States of America (USA) estimates that each year, approximately one in 25 patients is diagnosed with at least one HAI (34). Moreover, the spread of HAIs is noticeably worrisome in low- and middle-income countries (14,15). In every 100 hospitalized patients, seven may acquire one HAI in developed countries, while the number increases to 10 patients in developing countries (11). Patients at higher risk of acquiring HAIs are those admitted to ICU and burn units and neonates and patients undergoing organ transplant surgeries (11). A cohort study on the prevalence of infection in the ICU reported that 51% of patients were infected (35).

In Hungary, HAIs due to MDROs have been reported by law via the National Surveillance System of Nosocomial Infections (Nemzeti Nosocomiális Surveillance Rendszer, NNSR) (36) since 2004, where notification is compulsory to all hospitals. Between 2005 and 2010, 8732 HAIs were reported in Hungary. The overall incidence of MDR HAIs was 5.4/100000 patient days in 2005 and 14.7/100000 patient days in 2010. The annual HAI incidence/100000 patient days was 9.4 in primary hospitals, 9.1 in secondary hospitals, 11.2 in tertiary hospitals, 7.5 in specialized hospitals and 3.2 in chronic care/rehabilitation hospitals (20). The overall incidence of MDR HAIs increased to 29.35/100000 patient days in 2017 (32).

1.4 DETERMINANTS OF HAIs

There are three main risk factors determining HAIs.

1.4.1 The environment

The healthcare environment where care is provided (11). Healthcare facilities' cleanliness is a significant predictor of the quality of healthcare and patient safety (37). Microorganisms living in the environment, including air, water, food, and equipment, may be a source of transmission. Another source of transmission is vectors, such as pests. Pests may transmit the bacteria they carry on their bodies to patients through direct or indirect contact. For instance, cockroaches transmit almost 33 diverse kinds of bacteria, such as *Escherichia coli* and *Salmonella* that might contaminate food and equipment and could also affect the sterility of the operating room environment and the cleanliness of patient rooms. Additionally, cockroaches spread nearly six kinds of parasitic worms and no less than seven kinds of human pathogens. Food and food preparation surfaces can be easily contaminated by rodents and flies since they defecate repeatedly and by ants that may transmit more than 12 disease pathogens, including *Salmonella* and *Streptococcus pyogenes* (10). Poor hygiene, improper waste management, and inappropriate pest management increase the risk of HAI transmission (11).

1.4.2 Patient's condition and susceptibility

Immunocompromised patients, increased stays in the ICU, and extended use of antibiotics also increase the risks of HAIs (11).

1.4.3 Lack of knowledge and awareness among HCWs

Lack of knowledge and awareness of basic Infection Control (IC) measures among HCWs and absence of control policies also increase the transmission of HAIs (11).

In developing and low-income countries, these risk factors are also associated with poor financial support, lack of supplies and equipment, and poverty (11).

1.5 PREVENTING THE TRANSMISSION OF HAIs

Recently, healthcare organizations have emphasized the importance of reducing the transmission of HAIs globally. HAIs can be prevented by applying measures and practices that have been proven to be successful in reducing the transmission of microorganisms in healthcare

settings. In recent years, many studies have been published by healthcare organizations and scientific institutions, including evidence-based guidelines on the prevention of HAIs (38). The Joint Commission's National Patient Safety Goals address this concern annually in its seventh goal, which is specific to reducing the risk of HAIs (39). Infection Prevention and Control (IPC) is an essential constituent of quality and patient safety in healthcare settings (37,40) and has been recommended to significantly contribute to the reduction in the transmission of HAIs (41,42). More than three decades ago, the Study on the Efficacy of Nosocomial Infection Control project reported that 30 to 35% of HAIs could be prevented by the implementation of effective IC programs (43). Later, in 2003, Harbarth et al. (44) reported in their systematic review that a great potential existed to decrease the rates of HAIs, from a minimum reduction rate of 10% to a maximum of 70%, depending on several factors, including the setting, study design, baseline infection rates and type of infection. In 2018, Schreiber et al. (45) reported in their meta-analysis a preventable rate of HAIs of 30 to 55%, which is associated with multifaceted interventions irrespective of a country's income level.

1.6 DEVELOPMENT OF IC

For centuries, hospitals have been considered risky places (46). In 1847, Hungarian physician Ignaz Semmelweis discovered the cause of childbed fever, also known as puerperal, which was the leading cause of maternal mortality (47). Semmelweis noted that the childbed fever mortality rate among women who had delivered by physicians was three times higher than that of women who had delivered by midwives (48). After a deep analysis of the differences between the two groups, Semmelweis determined that the high mortality rate was caused by cadaverous particles on the hands of medical students who performed autopsies directly before their duties in the obstetric clinic. These particles were introduced into the birth canal of the pregnant women through the hands of the medical students upon examination. Based on these findings, Semmelweis recommended the implementation of chlorinous handwashing before patients were examined in the labor ward. Subsequently, the mortality rate among women who delivered their babies by physicians dropped (49,50). Semmelweis's significant findings were not accepted and adopted immediately throughout European hospitals, which had to wait for the adoption of the "Germ Theory of Disease", which discovered bacteria as the cause of infection (49). Afterward, surgeons gradually adopted aseptic and antiseptic techniques to reduce the transmission of postoperative infections (46).

In the 1950s, a nationwide epidemic of nosocomial penicillin-resistant *Staphylococcus aureus* occurred in American hospitals, especially in nursery departments, that caught the public's attention and emphasized the urgent need for procedures to prevent the spread of HAIs, which was recognized as the beginning of the discipline of IC after Semmelweis's findings in 1847 (50). By the mid-20th century, some studies on the epidemiology and prevention of HAIs were conducted and published mainly by microbiologists, infectious disease physicians, and surgeons (51,52). These studies highlighted the concept that hospitals had the abilities and obligations to prevent the transmission of HAIs (46).

In the 1960s, huge IC efforts were made in different hospitals throughout the USA. In 1970, the number of hospitals with HAI control programs increased (46) after the CDC recommended that hospitals establish positions for IC Nurses (ICNs) and hospital epidemiologists (53). The crucial significance of HAIs as preventable hospital adverse events was emphasized after the Joint Commission on Accreditation of Health Care Organizations issued standards for organization, surveillance, reporting, evaluation, record maintenance, and other requirements for IPC activities as a requirement for hospital accreditation (54). By the 1990s, almost all hospitals in the USA had programs to control the spread of HAIs (46). In Europe, more specifically in the United Kingdom (UK), things began to move forward after two serious outbreaks of NI that occurred in England in the mid-1980s (55). The first outbreak was *Salmonella* food poisoning that occurred in 1984 and led to the death of 19 elderly residents (56). The second outbreak was a Legionnaires' disease outbreak, where 22 out of 68 confirmed cases died (57). Subsequently, IPC programs were strengthened at the national level (55). In 1986, a survey conducted by the Hospital Infection Society reported that 98% of hospitals had IC Officers (ICOs), and 92% had IC Committees (ICCs). Additionally, the percentage of health districts having an ICN increased from 64% in 1979 to 89% in 1984. Nevertheless, the ratio of ICNs per acute hospital bed did not improve (1 ICN/741 beds in 1979 and 1 ICN/785 beds in 1984) (58). In mid-1992, there was still a lack of a specific IPC budget in most UK hospitals (59).

1.7 IC PROGRAM AND RESPONSIBILITIES

IPC is the discipline where epidemiology and statistical analysis are used to prevent and control the prevalence and incidence of HAIs. The major role of the IPC program is to reduce the risk of HAI transmission, thus enhancing patient and staff safety (50). Preventing HAIs is the responsibility of all workers and units providing healthcare, including staff

delivering direct patient care, microbiologists, management, physical plants, provision of materials and supplies, and training of HCWs. For instance, physicians have essential responsibilities in preventing HAIs by providing patient care following IPC practices, notifying the admission of infected patients to the IC and nursing teams as well as reporting cases of HAIs, following IPC policies and procedures confirmed by the ICC, complying with the antimicrobial use committee recommendations on the use of antibiotics, and advising patients, visitors, and staff on the practices to prevent the spread of HAIs (2). Similarly, clinical microbiologists have a vital role in preventing the spread of HAIs by detecting HAI outbreaks, screening for MDRO, monitoring sterilization and disinfection when necessary, guiding clinicians on the judicious use of antibiotics, and being a vital member of the ICC (60). At the same time, the IPC program cannot succeed without having an appropriate infrastructure and organizational support, including supplies and leadership support. The structure and functions of the IPC program might differ between institutions, with the main aim of reducing HAIs (50).

1.7.1 IC program at the national level

The national IC program is developed by health authorities to support hospitals in controlling and preventing the spread of HAIs. This support is done through the following:

- Setting national objectives that are aligned to the hospital objectives.
- Developing and updating guidelines for surveillance, prevention and practice.
- Developing a system at the national level to monitor infections and evaluating the effectiveness of actions taken.
- Organizing and coordinating IC training programs for HCWs regularly.
- Assisting the availability of supplies and materials that are essential for safety and hygiene.
- Encouraging healthcare institutions to monitor HAIs rates, with feedback to the professionals (2).

1.7.2 IC program at the hospital level

The hospital IC program's key preventive effort is concentrated in hospitals and other healthcare settings (54). All HCWs are responsible for maintaining the safety of patients, visitors, and staff, supported by the top management of the institution. The IC program includes activities, procedures and policies designed to reduce the spread of infections within the facility (61). An annual plan should be developed to monitor and evaluate the quality of care provided,

proper isolation of infected patients, sterilization, training programs, HAIs and communicable disease surveillance. It is the responsibility of top management to provide appropriate resources to support the IC program (2). There are major components that are common to IC programs worldwide:

ICC: ICC is a main component of the IC program. It is a multidisciplinary committee that usually includes representatives from management, physicians, microbiologists, pharmacy, the Central Sterile Services Department (CSSD), environmental services, maintenance, nursing, and others (62). The ICC advices and assists with the management of IC programs, policy development, procurement issues, patient safety, risk management, HCWs' training and education, antimicrobial and disinfectant/antiseptic use, and surveillance of HAIs (61). The committee reports directly either to the hospital administration or to the medical department (2).

IC professionals: Qualified IC practitioners (usually nurses) and IC physicians who are responsible for the daily functions of the IC, as well as developing the annual work plan to be reviewed by the ICC and administration. IC professionals are also responsible for developing, revising, auditing and implementing policies, surveillance and research, evaluation of supplies and products, monitoring sterilization and disinfection, and implementation of HCWs' training programs. The size and structure of the IC team will vary between facilities depending on the type, needs, and resources. However, the reporting structure must warrant that the IC team have proper authority to manage an effective IC program. In large hospitals, IC teams usually report to senior administration directly (2).

IC manual: An IC manual including recommended guidelines and practices for patient care. The manual is developed and updated by the IC team and reviewed and approved by the ICC. The manual must be made available to all patient care staff and should be updated in a regular manner (2).

Although the basic values of the IC program apply internationally, each country and healthcare institution will need to modify and add to the core components of the program based on their unique circumstances, e.g., differences in patient population, infectious disease profiles, and type of healthcare services provided (61).

1.7.3 IC obligations in European Union countries, including Hungary

As per the European Union (EU) Council recommendation on patient safety, including the prevention and control of HAIs (63), all member states shall develop and implement a strategy to prevent and control HAIs with the following objectives:

- IPC measures should be implemented at the national and regional levels to prevent the transmission of HAIs.
- Enhancing IPC at the healthcare institution level by promoting institutions to have an IPC program, organizational support for the implementation and monitoring of the IPC program, and organizational arrangements and qualified staff to implement the IPC program.
- Developing or reinforcing active surveillance systems at the national or regional level, as well as at the level of healthcare institutions.
- Promoting education and training of HCWs at the national or regional level and the level of health institutions by encouraging the implementation of regular training on IPC practices for IC personnel specifically and other HCWs.
- Encouraging healthcare institutions to improve the information provided to the patients during their hospital stay.
- Promoting research in epidemiology and on the cost-effectiveness of IPC measures.

In addition to the EU Council recommendations and obligations that apply to all member states of the EU, there is government regulation that determines IC practices in healthcare facilities in Hungary "20/2009. (VI. 18.) EüM decree on the prevention of HAIs" (64). According to this decree, IC activities should include:

- A surveillance system includes surveillance on HAIs, microbiological surveillance, antibiotic resistance surveillance, and surveillance on the use of antimicrobials.
- Analysis of healthcare processes for the development of infection through identifying risk factors, development and implementation of local policies and procedures to minimize risks, and monitoring implementation.
- Implementation of preventive actions through developing IPC policies and procedures and monitoring staff compliance with them. Policies include environmental,

disinfection procedures, processes of supply of sterile material devices, and pest control.

- Identification of communicable diseases and HAIs at the facility and reporting them to the required health authorities in accordance with special legislation.
- Investigation of HAIs in the facility and taking action accordingly.
- Contribution to the development of antibiotic use policies to prevent the development of antibiotic resistance.
- Monitoring of activities to promote staff safety by preventing the transmission of infections in HCWs.
- Participation in the development of disaster management and pandemic plans.
- Planning and implementing a training program on IPC activities for HCWs.
- Development and implementation of an IC plan including all activities.
- Audits on compliance with IPC policies and HCW training on IPC measures to be conducted and documented at least once a year per organizational unit.

In accordance with this decree, all healthcare facilities providing inpatient care, with over 400 beds, should operate an independent organizational unit of hospital hygiene to perform the IC activities mentioned above.

- The hospital hygiene unit is managed by a specialist with certain professional qualifications specified by the current decree.
- The head of the hospital hygiene unit is responsible for the supervision of the production and supply of sterile materials and devices at the facility.
- The hospital hygiene unit is responsible for
    - Providing data to the NNSR, semiannually to the national database on the use of antimicrobials, on the use and recovery of antimicrobials by class and by antibiotic group and to the national microbiological database annually.
    - Participating, twice a year, in the round examinations of the National Institute of Public Health “OKI”.
    - Preparing an annual report on the IC activities mentioned above, in accordance with the criteria issued by the national chief medical officer and sending it to the capital and county government offices acting in the field of public health by 20 February of the following year. The annual report should also include a

summary report on the annual activities of the Institutional Infection Control and Antibiotic Committee (IIAB) operating at the facility.

- A healthcare facility providing inpatient care shall operate an IIAB committee regardless of the number of beds. The IIAB is an advisory committee to the management of the facility with the right to make proposals and suggestions. It is chaired by the general director. The secretary is an IC specialist. The members include the nursing director, an infectologist or infectious disease specialist, a microbiologist, a pharmacist, and a representative of clinicians. The IIAB shall meet at least twice a year and shall be arranged by its chairperson.
- The organizational structure and operation of IC activities of healthcare facilities providing inpatient care shall be included in an IC manual, which must be reviewed at least every two years.

In early 2000, the Hungarian government intended to introduce an accreditation program for the healthcare sector to trail the movement of the European countries. Twelve years later, in December 2012, the EU-funded Social Renewal Operating Programme "TAMOP" two-year project was created to generate a Hungarian accreditation program for healthcare. At the end of the project, accreditation standards for inpatient and outpatient organizations and public pharmacies were created known as The Accreditation of Healthcare Providers for Safe Patient Care "BELLA". In 2014, the accreditation program was initiated, where 30 hospitals and 15 outpatient organizations were assessed (65).

The handbook of Hungarian healthcare standards (66) (Version 2), which was published in October 2019, includes a chapter (chapter 15) entitled "Standards For the Prevention and Care of Nosocomial Infections". The chapter involves standards that determine IC obligations in healthcare facilities, including IC practices, prevention of HAIs in healthcare facilities, operation of IC, identification of interventions with a risk of infection, use of an infectologist, provision of material conditions, disinfection procedures, sterilization, disposable devices, sampling of high-risk areas, Hand Hygiene (HH), surveillance system operation, and regulated antibiotics policy. Additionally, the Hungarian accreditation standards for inpatient and outpatient care (67) that were published in 2016 include a chapter for IC (chapter five) that determines IC obligations and practices in outpatient care and inpatient care services. The standards related to the IC obligations of inpatient care services include standards related to surveillance systems, IPC practices, IC training, screening protocols for MDROs in high-risk areas, HAI surveillance, management

of antibiotics, handling and management of contaminated equipment, disinfection and sterilization of medical devices, and waste management.

1.8 STANDARD PRECAUTIONS

There are two levels of recommended precautions to prevent and control the transmission of infections in healthcare settings. The first level of precautions is Standard Precautions (SPs) that are used for all patient care regardless of the patient's infectious status. SPs are based on a risk assessment and apply common sense practices and the use of Personal Protective Equipment (PPE) that protect HCWs from infection and prevent the transmission of infection from patient to patient (68). Since their announcement, SPs have been implemented worldwide, with several updates since they were first released (1). First, in 1983, the CDC published the "Guideline for Isolation Precaution in Hospitals", which recommended the use of blood and body fluid precautions when a patient is suspected or confirmed to be infected with blood-borne pathogens (69). In 1987, the CDC published Universal Precautions (UPs), which included all precautions taken to prevent infections, including Human Immunodeficiency Virus (HIV), hepatitis B virus, and other blood-borne pathogens, when providing healthcare services in healthcare facilities. UPs included the precautions taken to prevent contamination by blood and specific body fluids from all patients who were visibly contaminated with blood regardless of the patient's infection status (69,70). In 1996, the CDC replaced UPs with SPs (70). SPs differ from UPs by applying the concept of body substance isolation that emphasizes HCWs protecting themselves from all potentially infectious body substances. Later, SPs were updated to include precautions that involve protection from the whole body (71,72). In 2003, and after the emergence of Severe Acute Respiratory Syndrome (SARS), respiratory hygiene/cough etiquette was added as a component of SPs (73,74). Then, safe injection practices were added after four hepatitis B and hepatitis C outbreaks that occurred at ambulatory care services in the USA. In 2004, and after the occurrence of an outbreak of eight cases of *Streptococcus* species in blood and Cerebrospinal Fluid (CSF) that were aligned with oropharyngeal flora and changes in CSF indices and a clinical indication of bacterial meningitis, the use of masks during placement of catheters or injections into spinal or epidural space was added (74). Furthermore, the emergence of Ebola Virus Disease (EVD) has included protection from sweat, whether contaminated with blood or not (73,75).

SPs include several measures: HH, use of PPE, waste disposal, cleaning contaminated surfaces, respiratory hygiene/cough etiquette, safe injection practices, use of masks for

lumbar puncture or contact with CSF, linen handling, and patient care equipment (76). Below is a brief definition of each measure:

HH: Includes the application of alcohol-based hand sanitizers; before patient contact, before performing a clean or aseptic procedure, before moving from work on a soiled body site to a clean patient site on the same patient, after touching a patient, after touching the patient's environment, after contact with blood, body fluids or contaminated surfaces, and immediately after removing gloves. While handwashing with soap and water is applied when hands are visibly soiled, after caring for a patient with known or suspected diarrhea, and after exposure to known or suspected spores (e.g., *Bacillus anthracis*, *Clostridium difficile*). HH also includes the application of surgical hand antisepsis before surgical procedures (77).

The use of PPE: Includes the use of gloves when touching blood, body fluids, secretions, excretions, mucous membranes, and nonintact skin. It also includes the use of facial protection (eye, nose, mouth) and gown during procedures that are likely to generate splashes or sprays of blood, body fluids, secretions, and excretions (76).

Waste disposal: Ensuring safe waste management by considering waste contaminated with blood and body fluids, secretions and excretions as clinical waste and treating it accordingly. In addition, human tissues and laboratory waste associated with specimen processing are treated as clinical waste. Finally, proper disposal of single-use items (76).

Cleaning contaminated surfaces: Includes the use of appropriate procedures for cleaning and disinfection of environmental and other frequently touched surfaces (76).

Respiratory hygiene/cough etiquette: Placing patients with acute febrile respiratory symptoms at least 1 meter (3 feet) away from others in common waiting areas, if possible, posting visual alerts and signs at the entrance of the facilities, instructing persons with respiratory symptoms to practice respiratory hygiene/cough etiquette, and providing available supplies of HH, tissues, and masks in common areas and areas used for evaluating patients with respiratory illnesses. Additionally, patients with respiratory symptoms should be educated about covering their nose and mouth when coughing/sneezing with tissue or mask, discarding the used tissue and mask, and performing HH after having contact with respiratory secretions and contaminated objects/materials (76). Moreover, HCWs are instructed to wear a surgical or procedure mask (for close contact) when examining a patient with symptoms of a respiratory infection (78).

Safe injection practices: Include the use of aseptic techniques during the preparation and administration of injected medications, including using a single-use, sterile and disposable needle/syringe for each patient and at each administration. Using medications packaged as single-use vials for only one patient. Assigning medications packaged as multiuse vials to a single patient whenever possible and prohibiting the use of bags or bottles of intravenous solution as a common source of supply for more than one patient (79). Additionally, proper handling of needles, scalpels, and other sharp instruments or devices, proper cleaning of used instruments, and proper disposing of used needles and other sharp instruments (76).

Use of masks for lumbar puncture procedures: Includes wearing a face mask during the placement of catheters or during injections into spinal or epidural space (74).

Linen handling: Includes handling, transporting, and processing used linen in a way that prevents skin and mucous membrane exposures and contamination of clothing and prevents the transfer of pathogens to other patients and/or the environment (76).

Patient care equipment: Includes handling equipment that is contaminated with blood, body fluids, secretions, and excretions in a way that avoids skin and mucous membrane exposures, contamination of clothing, and transfer of pathogens to other patients or the environment. It also includes cleaning, disinfecting, and reprocessing reusable equipment appropriately (76).

1.9 TRANSMISSION-BASED PRECAUTIONS

The second level of recommended precautions to prevent and control the transmission of infections in healthcare settings is transmission-based precautions, also known as isolation precautions. These are used in addition to SPs for patients who are suspected or confirmed to be infected or colonized with certain infectious agents (68). Isolation precautions should be applied empirically based on clinical suspicion and the presence of defined disease guidelines associated with pathogens, while tests confirming the disease are pending (80). Isolation precautions include contact, droplet, and airborne precautions.

Contact precautions: These are applied to patients with known or suspected infectious agents that can be transmitted by direct or indirect contact with the patients or their environment. Patients placed in contact isolation should be placed in a single room when applicable. HCWs providing services for patients in contact isolation should use PPE properly while wearing gloves and gowns before entering the patient room and doffing them before

leaving. Patient movement and transport should be limited to medically necessary purposes. The use of disposable or dedicated patient-care equipment is recommended. In addition to, prioritizing cleaning and disinfection of contact isolation rooms and ensuring that rooms are frequently cleaned and disinfected (81).

Droplet precautions: These are applied to patients with known or suspected infectious agents that are transmitted by respiratory droplets (>5 μm) that are generated by a patient who is coughing, sneezing, or talking. Patients placed in droplet isolation should be placed in a single room when applicable. HCWs providing services for patients in droplet isolation should place a mask when entering the patient room. Patient movement and transport should be limited to medically necessary purposes. When necessary, the patient should be instructed to put a mask and apply respiratory hygiene/cough etiquette (81).

Airborne precautions: These are applied to patients with known or suspected infectious agents that are transmitted by the airborne route, usually particles with a size <5 μm (e.g., tuberculosis, measles, chickenpox, disseminated herpes zoster) (81). These particles may remain infectious over long times and distances when suspended in the air. Additionally, these pathogens may travel long distances by air flows and can be inhaled by people who are not in direct contact with the infectious patient, even outside the patient room (80). Patients placed in airborne isolation should be placed in a single room that is prepared with negative pressure. In the case of the unavailability of airborne isolation rooms with negative pressure, masking the patient and placing him/her in a single room while keeping the door closed is recommended. HCWs who are susceptible should be restricted from entering the room. HCWs entering the patient room should wear fit tested NIOSH-approved N95 or higher level respirators for healthcare personnel. Patient movement and transport should be limited to medically necessary purposes. When necessary, the patient should be instructed to wear a surgical mask, if possible, and respiratory hygiene/cough etiquette should be applied. Moreover, susceptible individuals should be immunized as soon as possible after unprotected contact with vaccine-preventable infections (e.g., measles, varicella or smallpox) (81).

1.10 HCWS' KNOWLEDGE AND AWARENESS OF IC

Recently, improving patient safety has received more attention globally, as one of the chief goals of the World Health Organization (WHO) World Alliance for Patient Safety is to reduce HAIs (82–85). Adopting IC guidelines in healthcare facilities is less than what is recommended to reduce HAIs and has been proven to be challenging (82,86,87). Additionally,

low compliance rates with IC practices among HCWs have been revealed internationally (86,88). Several factors that might be related to the low compliance with IC were reported. Of them are lack of supplies and equipment, managerial commitment issues, and individual factors such as lack of awareness or knowledge and experience. However, lack of awareness is the most reported factor (82,89–91).

In addition to education and training, the CDC recommends periodic assessment of HCWs' knowledge and compliance with IC practices to control and prevent the transmission of HAIs (74). Similarly, the EU Council recommendation on patient safety, including the prevention and control of HAIs (63), recommends implementing regular training for all HCWs on basic measures of hygiene and IPC and providing regular specific training for personnel having particular tasks related to the prevention and control of HAIs. At the same time, the Hungarian government regulation (64) that determines 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, HH, isolation regulations, the use of 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. In addition, the Hungarian inpatient and outpatient accreditation standards (67) and the handbook of Hungarian healthcare standards (66) necessitate educating HCWs on IC measures on employment and annually.

Many studies have been conducted to assess the level of knowledge and awareness of IC measures in healthcare settings. In 2002, Chan et al. (92) conducted a study in Hong Kong among 306 nurses using a developed questionnaire to investigate their knowledge and compliance with SPs. The results showed that the nurses' knowledge of SPs was inadequate (7.28 of 11). Later, the same questionnaire was used in several studies that were conducted in Jordan (93,94), Afghanistan (95), and Taiwan (96).

In 2008, Tavolacci et al. (97) conducted a study in France among 350 healthcare students using the Infection Control Standardized Questionnaire (ICSQ) to evaluate their knowledge of IC and to identify sources of information. The mean overall IC knowledge score (21.5 of 30), SP (8.5 of 10), and HH (7.4 of 10) were acceptable, while the HAI (5.7 of 10) score was not. Then, the ICSQ was used in several studies that were conducted in Italy (98–100), Saudi Arabia (101,102), Ghana (103), the Philippines (104), South Africa (105), and India (106).

Brosio et al. (98) conducted a study in 2017 in Italy among 339 nursing students using the ICSQ to investigate their knowledge of SPs, HH, and HAIs. A sufficient level of knowledge was only reached in SPs. The level of knowledge scores were as follows: SPs (8.9 of 10), HH (6.6 of 10), and HAIs (5.8 of 10). Similarly, Khubrani et al. (101) conducted a study in 2018 at five Health Sciences colleges in Saudi Arabia among 129 clinical students using the ICSQ to assess their knowledge of IC and SPs. The highest scores were attained in SPs (81.6%), HH (68.2%), and PPE (66.5%), whereas the lowest were in the disposal of sharp objects and injuries from sharp objects (54.5%) and HCW care (53.05%). Additionally, Goyal and Chaudhry (106) conducted a study in India in 2019 among 728 healthcare students using the ICSQ to assess their knowledge of IC measures and determine the impact of educational and training programs on the participants' knowledge. Acceptable knowledge scores were achieved in the overall IC knowledge (38.11 of 50) and in SPs (20.81 of 24), while HAIs (6.61 of 10) and HH (9.88 of 16) knowledge scores were not acceptable. The overall mean IC knowledge significantly increased (42.03) after the educational and training program was implemented.

To our knowledge, no studies have been conducted in Hungary to assess the level of nurses' awareness of IC measures.

1.11 PATIENT EMPOWERMENT

To improve health services and patient safety, patient empowerment was suggested decades ago (107). The concept was introduced to permit patients to shed their passive role and play an active part in making decisions about their healthcare services (108,109). Patient empowerment is commonly used to refer to patients' ability to control their health and their ability to be more involved in their care process. It is highly recognized as a fundamental value of high-quality patient-centered care (110–112). During the 1960s, the model of empowerment was embedded in the social action and civil rights movement (110,113,114), and the concept was additionally extended by highlighting the rights and abilities of persons and communities more than concentrating on their deficits and needs (108,115). In the 1970s, the concept of empowerment was embraced by the self-help movement (108,109) to encourage the rights of ethnic and sexual minorities (110,113,114). In the 1980s, the concept of empowerment was introduced in healthcare settings, particularly in patient care and education with long-term conditions (110,116,117). During the past three decades, a sequence of policy modifications paved the way for the global consideration that patient empowerment presently attracts (108). The WHO has developed guidelines that highlight that patients' opinions should be taken into

consideration (118). The prominence is on supporting individuals in attaining control over the causes that might affect their health (108).

The concept of patient empowerment is multidimensional with various definitions (110). Numerous studies have tried to illuminate the concept of patient empowerment. Concepts that are connected to empowerment, such as enablement, engagement, activation and personal control (110,119–122), collaboration, and patient-centered care, have been found (107). The WHO HH guidelines define patient empowerment as "A process in which patients understand their role, are given the knowledge and skills by their healthcare provider to perform a task in an environment that recognizes community and cultural differences and encourages patient participation" (123). Previous research has shown that patient empowerment is related to positive health outcomes (110,124–127) such as well-being, self-management (116,128,129), health status (130), health-related quality of life (131), and cost-effectiveness (110).

In developed countries such as the USA and the UK, the Institute of Medicine reports on health quality and safety have significantly influenced patient empowerment. Several campaigns have been developed in these countries to encourage patient involvement in safety (107). The EU Commission 2009 Council recommendation on patient safety, including the prevention and control of HAIs, stresses promoting patient safety by reducing adverse event occurrence (63). Similarly, the Hungarian inpatient and outpatient accreditation standards (67) and the handbook of Hungarian healthcare standards (66) were prepared with a prominence on patient safety following the requirements of the International Society for Quality in Healthcare (65) and the EU Commission 2009 guidelines, respectively.

1.12 PATIENT EDUCATION ON IC

Patient education is the first step to patient empowerment. Patients can be empowered only after having collected sufficient information, understanding the use of such information, and being persuaded that this information gives them mutual accountability with their HCWs (123). Studies have revealed that patients prefer to receive specific information from their HCWs and printed sheets or fliers (123,132).

Creating a facilitating environment is essential to patient empowerment. A facilitating environment is a place in which patients are encouraged to build and practice open communication regarding their health status in an environment without any barriers (123).

There are three preconditions that HCWs need if they are supposed to empower their patients. First, having a workplace with a structure to encourage empowerment. Second, believing in patients' ability to be empowered. Third, admitting that the HCW-patient relationship can be powerful (123,133). A person is not able to create personal empowerment in another person, but the HCW-patient partnership may assist the empowerment process. If knowledge and information are shared with patients in an environment of shared respect and support, then a facilitating environment for patient empowerment will grow (123).

Despite the progress in patient safety and healthcare services in recent decades, HAIs continue to spread in healthcare settings. Accordingly, patient engagement in IC was suggested as a means of improving patient safety and reducing the transmission of HAIs (107). Globally, several campaigns have been conducted to include patients in HH to improve HCW compliance (134). In 2004, the National Patient Safety Agency issued a patient safety alert to all acute hospitals in England and Wales, which included involving patients in an HH campaign to reduce the spread of HAIs (107,135,136). In 2006, another campaign was initiated by the same agency "cleanyourhands campaign" that aimed to enhance HCW compliance with HH, emphasizing HH performance "at the right time and in the right place." The campaign key message was to encourage patients to ask their HCWs if they performed HH prior to providing care. Later, in 2009, the WHO launched the "SAVE LIVES: Clean Your Hands campaign", an extension of the "Clean Care is Safer Care WHO Patient Safety Challenge" in 2005, to increase global efforts in encouraging HCW compliance with HH (107,137,138). Afterward, "Stop! Clean Your Hands," campaign was initiated by Canada's Patient Safety Institute, which stated four moments for HH performance among HCWs and highlighted the patients' role in HH (134). Patient empowerment was a vital part of the WHO's HH multimodal strategy (107,139).

Furthermore, the CDC recommends patients' and family members' education on IC after it was shown that they can aid in preventing the spread of HAIs (74). Similarly, patients' and relatives' education on IC measures is mentioned in the Hungarian inpatient and outpatient accreditation standards, where educating patients and their relatives on HAIs and their prevention is highlighted in the IC chapter for inpatient care (Chapter five) (67). Additionally, the handbook of Hungarian healthcare standards mentions educating patients on HH in the IPC chapter (Chapter 15) (66). Likewise, the EU Commission 2009 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 (63).

Additionally, the WHO recommends conducting research on the involvement of patients and their family members in HAI control as a means of reducing the transmission of HAIs and improving patient safety (3). Despite this interest, assessing patient education on IC in hospitals is poorly investigated worldwide.

Abbate et al. (140) conducted a survey in 2008 in Italy including 450 patients to document their level of knowledge, attitudes and behavior and to identify their determinants regarding HAIs. Only 15.1% of patients received information on HAIs from their HCWs. In 2011, Sengupta et al. (141) conducted a study in the USA among 100 caregivers (parents and grandparents) to discover their knowledge, awareness and attitudes about MRSA and to determine the concerns found when recognizing a child with MRSA. The results showed that 18% of the caregivers were not informed about MRSA infections, and 29% of participants were not informed about their child's MRSA status. In 2016, another study was conducted in the USA by Chittick et al. (142) among 249 patients and family members to assess their knowledge of contact isolation, their opinion regarding compliance with contact isolation precautions and whether it affected their process of care. The results revealed that more than 60% of participants said that the rationale of using contact isolation was sufficiently explained to them. Finally, in 2020, Srigley et al. (143) conducted a cross-sectional study in Canada among 268 patients and their caregivers to assess the HH knowledge, attitudes, and practices of inpatients. A total of 55.1% of patients indicated that staff had informed them about the importance of HH while in the hospital. To our knowledge, no such studies have been conducted in Hungary.

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.

Based on what is presented above and since no studies have been conducted in Hungary to assess nurses' awareness of IC or to determine whether patients and their family members are being educated on IC, this necessitated our research. Additionally, there is a research gap on the effect of nurses' IC awareness on patient and family education implementation; thus, this study was also meant to address this research gap. Therefore, we are conducting this research among nurses, patients, and family members in Hungary to address the research questions and objectives below.

1.13 PROBLEM STATEMENT/RESEACH QUESTION

1. What is the level of Hungarian nurses' awareness of IC measures?
2. Are patients and family members educated on IC measures in Hungary?
3. What are the barriers that might prevent nurses from educating their patients and family members on IC measures?
4. What is the effect of nurses' IC awareness on implementing patient and family education?

1.14 RESEARCH OBJECTIVES

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

1.14.1 Detailed objectives

a. Systematically review patient education on IC measures among hospitalized patients.
b. Assess patient and family members' education on IC measures from the patients' and family members' perspectives in Hungary.
c. Assess the level of IC awareness among nurses in Hungary.
d. Assess patient and family members' education on IC measures from the nurses' perspective in Hungary.
e. Explore the reasons that might prevent nurses from educating their patients and family members on IC.
f. Determine the effect of nurses' awareness of IC measures on implementing patient and family education.

1.15 THESIS OUTLINE

The current thesis is composed of seven chapters. Chapter one is an introductory chapter that introduces the concept of IC, including its development, program components, responsibilities, and obligations. Then, the chapter goes narrower to present the background of our research problem, the knowledge gap, the problem statement, and the research objectives. Chapter two presents the first part of the current research, which is a systematic review of patient education on IC. Chapter three displays the second part of this research, which is a substudy assessing patients' and family members' education on IC in Hungary. Chapter four

presents another substudy that determined the level of IC awareness among nurses in Hungary, assessed patients' and family members' education on IC from the nurses' perspectives, explored the reasons that might prevent nurses from educating their patients and family members on IC, and examined the effect of IC awareness among nurses on implementing patient and family education. Chapter five is another substudy that shows the results of the translation and validation of the Hungarian version of the tool used to assess nurses' awareness of IC measures. Chapter six presents the novel findings of our research, including all the substudies, recommendations, and implications for practice and research. Finally, chapter seven shows the list of publications related to the current thesis and other topics.

CHAPTER 2 Substudy 1 - Patient Education on Infection Control: A Systematic Review

2.1 INTRODUCTION

HAIs are considered the most adverse event faced by patients throughout the world (144,145). The CDC estimates that 5 to 10% of patients inside hospitals acquire an HAI (146,147). While studies have shown that approximately 30 to 70% of HAIs can be prevented (145,148,149), the elevated rates of HAIs due to MDROs have led to an increase in morbidity and mortality (150), making HAIs a patient safety concern (145). Several types of invasive devices and interventions are utilized to treat patients and support their recovery. Infections can be associated with the use of these devices, such as catheters or ventilators. HAIs include CLABSIs, CAUTIs, and VAP. Additionally, SSIs may arise at surgery sites. The CDC operates to monitor and avoid these infections since they represent a vital risk to patient safety (4).

To improve the quality of provided care, many suggestions were made to empower the patients by involving them in their process of care (107,151). Patient empowerment has earlier been known as patient involvement, partnership, and patient-centered care. Patient empowerment refers to permitting patients to achieve the information and build the needed skills to make decisions and contribute to their care process by educating and encouraging them to participate in all aspects (12,107). Later, suggestions on engaging the patient in many IC aspects were given (107), after showing that patients, their family members, and visitors can aid in preventing the transmission of HAIs inside hospitals (74,152).

The Joint Commission International accreditation standards for hospitals mentioned patient and family engagement in IC by stating in Prevention and Control of Infection standard 11 (PCI.11); “Patients and families are encouraged to participate in the implementation and use of IPC practices in the hospital” (153). The same standard also requires educating the patients and their families on IPC: “The hospital provides education about IPC to patients and families” (153). In addition, the CDC guideline for isolation precautions clearly mentioned that information about SPs, especially HH, respiratory hygiene/cough etiquette, and other IC practices, could be shared with the patients upon their hospital admission. Further information on isolation precautions can be given when isolation is started. Additional information about the reason for isolation initiation, the use

PPE, the risk to healthcare staff, and other IC-related measures can also be provided (74). Despite this interest, assessing patient education on IC in hospitals is poorly investigated. Moreover, no systematic reviews were performed to examine patient education on IC. Hence, this systematic review addresses this knowledge gap by investigating studies that assessed patient education on IC measures in hospitals, summarizing them, and comparing their results.

2.2 METHODS

This review was prepared and is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (154).

2.2.1 Inclusion and exclusion criteria

To be included, any primary study needed to meet all of the following criteria: 1) a study on human beings of any age and gender; 2) a study on patients admitted to hospitals or discharged patients who were previously hospitalized as inpatients; 3) not focusing on specific diseases (tuberculosis, hepatitis B, HIV, influenza, etc.); 4) conducted inside of hospitals; 5) assessing patients' education on IC measures (irrespective of the instrument used for assessing education), 6) including one or more of the following IC measures: HH, respiratory hygiene/cough etiquette, HAIs and/or HAIs risks including CLABSIs, CAUTIs, VAP, and SSIs, reason for isolation, isolation precautions, and the use of PPE. Qualitative studies were excluded since most of them lacked numerical measurements. Studies assessing the impact of IC patient education without measuring the education were excluded. Studies conducted on the general population and out-service unit patients were excluded.

2.2.2 Search strategy and study selection

A systematic search strategy was developed using Medline via PubMed (www.pubmed.gov) by combining terms for 'hospitalized patients', 'education', and 'infection control'. Then, the Medline strategy was adapted for Embase (www.embase.com) and CINAHL (www.ebscohost.com). Details for the search strategy are supplied in Appendix A.

Electronic searches were carried out from inception until May 6, 2020. However, it should be mentioned that an alert system was set up on the three electronic search databases to get all new studies being published in the same search topic. When this paper was submitted for publication, no additional studies had been recognized that fit our systematic review's

objective. The systematic search was conducted without any restriction on the study type, research design, language of publication, publication date, or publication status. To avoid selection bias, unpublished papers (including theses, conference abstracts, and technical reports) were searched using OpenGrey (www.opengrey.eu), and hand searching was also performed on the reference lists of all the eligible articles. The search strategy was developed by the first and third authors, and the electronic database search was conducted by the first author. The selection of eligible studies was performed by the first and second authors independently, starting by inspecting the titles and abstracts to eliminate irrelevant papers. 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.

2.2.3 Reporting quality assessment and data extraction

We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) tool (155) to assess the reporting quality of each eligible study. A data extraction form was designed based on guidelines (Cochrane Handbook for Systematic Reviews of Intervention) (156). The extracted data included the following: author's name, year of publication, the objective of the study, country, type of study, duration, participants, mean age, sample size, the tool used to assess patient education on IC measures, psychometric properties, and the main results. To avoid selective reporting within studies, the authors were contacted to obtain additional information about missing data. To avoid multiple publication bias and missing outcomes, a careful examination of papers was performed by two reviewers independently. Reporting quality assessment and data extraction were performed by the first and second authors independently.

2.2.4 Data synthesis

A table summarizing the included studies was established. We defined the main results (outcomes) of each study as related to our review objective.

2.3 RESULTS

2.3.1 Study selection and characteristics of the included studies

As a result of database searching, 6714 records were retrieved. Additionally, 26 other records were identified through other sources. Therefore, we had a total of 6740 records.

Duplicates were removed (n= 1154), and irrelevant papers were excluded based on their titles and abstracts (n= 5434). As a result, the 152 full-text studies were examined. After a careful examination, 127 studies were excluded. Thus, 25 studies were eligible for the review. Details of the study selection process are shown in **Figure 1**.

A summary of the study characteristics is presented in **Table 1**. Of the 25 included studies, 19 were cross-sectional (140,143,157–173), three were pre-post intervention studies (174–176), two were quasi-experimental (177,178), and one was an observational cohort study (179). Studies were conducted in high-, upper-middle-, and middle-income countries: the USA (n= 12), Canada (n= 1), Australia (n= 2), the UK (n= 2), Scotland (n= 1), France (n= 2), Italy (n= 1), Singapore (n= 1), China (n= 1), Lebanon (n= 1), and Ghana (n= 1).

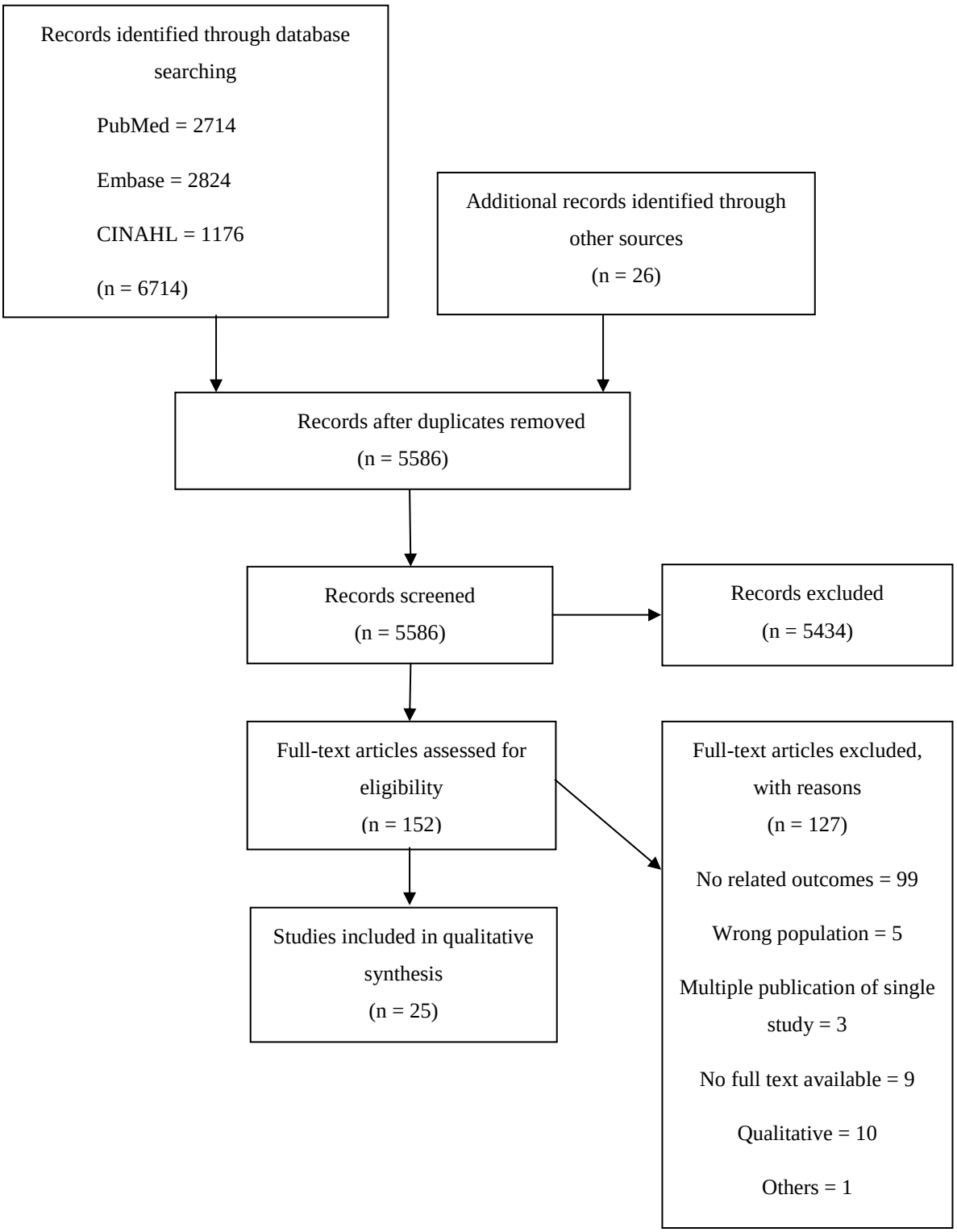

Figure 1 PRISMA flow diagram of the study selection process.

Table 1 Characteristics of the included studies

Author	Objective	Country	Study type	Duration of data collection	Sample size	Mean age (years)	Data collection tool	Psychometric properties	Outcome related to review
Knighton et al. 2020 (166)	To obtain information from patients with recent hospital stays on their perceptions of barriers to and facilitators of patient HH, and their satisfaction or lack of satisfaction with their ability to maintain HH practice during their recent past hospitalization	USA	Cross-sectional	January till April 2018	107 patients	63.5± 14.69	A modified version of a questionnaire by Sunkesula et al. 2015	Reliability: Cronbach's alpha= 0.848	16.8% (18/107) reported never being reminded to clean their hands, 29.9% (32/107) almost never, 28% (30/107) sometimes, 24.3% (26/107) often, and 0.9% (1/107) being reminded very often
Srigley et al. 2020 (143)	To assess the HH knowledge, attitudes, and practices of inpatients, in preparation for implementation of a patient HH improvement program	Canada	Cross-sectional	1 week (Between 2014 and 2015)	268 patients and/or their caregivers	65.2 (survey) and 65.9 (interview)	Questionnaire + interviews	-	55.1% of patients indicated that staff had informed them about the importance of HH while in the hospital
Li Y. et al. 2019 (159)	To investigate inpatient knowledge, attitudes, and practices of HH during hospital stay, and to identify some factors influencing practice compliance, which may contribute	China	Cross-sectional	November till December 2017	310 (242 patients + 68 family members)	47.80± 18.066	Self-designed, structured questionnaire	Reliability: Cronbach's alpha= 0.867	30.6% (95/310) received education on HH from HCWs. (35.6% if calculated out of all sources 267)

	to the design of effective patient HH promotion strategies								
Minejima et al. 2019 (170)	To identify current gaps in patient understanding and attitudes toward UTIs with respect to the disease and its management in a medically underserved population	USA	Cross-sectional	January 2015 till July 2016	120 patients	53± 16	Structured questionnaire	Questions were not validated for reproducibility	28% (33/120) reported receiving information from their healthcare provider about appropriate hygiene measures to prevent a UTI
Hammoud et al. 2017 (168)	To assess nurses' awareness level of IC, and determine the role of this awareness in implementing patient and family education	Lebanon	Cross-sectional	May till June 2016	223 (116 patients + 107 family members) and 217 nurses	31.8% of patients and family members between [26-35]	Developed questionnaire	-	1- 34.5% of patients and family members were educated on HAIs and their risks. 2- 21.1% educated on respiratory hygiene. 3- 29.1% provided with brochures on HH and/or respiratory hygiene. 4- 79.4% of those in isolation (34 participants) were informed about the reason of isolation and 82.4% were educated on the use of PPE
Haverstick et al. 2017 (174)	To determine if increased access to HH products and patient education could improve patients' HH and reduce the transmission of HAIs	USA	Pre-post intervention	4 months (August 2013)	172 patients. (Pre intervention: 16 + post intervention 156) and 33 staff	-	Questionnaires by Burnett et al. 2008	-	Pre intervention: 53% of patients were always encouraged to clean their hands on specific times, the rate decreased to 46% post intervention

Pokrywka et al. 2017 (177)	To assess HH practice in patients, to improve the opportunities for patient HH through staff education and patient assistance, to ask the question if improving patient HH opportunities in the hospital could affect the occurrence of *Clostridium difficile* infection	USA	Quasi-experimental	November 2013 and March 2016	657 patients. Phase one: 388 (97 pre interventi on + 291 post interventi on) phase two: 269 (80 baseline + 189 follow-up)	59.6 pre intervention and 60.8 post intervention	Questionnaire	-	1- Phase one: (Pre intervention): 34% of patients received verbal or written education on HH, (Post intervention): patient education on HH increased to 64% ($p<$ 0.0001). 2- Phase two: (Baseline): 48% of patients received verbal or written education on HH, (Follow-up survey): patient education on HH increased to 53%
Ong et al. 2017 (175)	To improve patients' knowledge on HH	Singapore	Pre-post intervention audit	March 2013 (1 week) and June 2013 (1 week)	54 patients	-	Developed audit tool via JBI-PACES and GRIP	-	1- Pre intervention: 20.4% received education on HH. 2- Post intervention: Patient education on HH showed improvement of 48.1% ($p<$ 0.001)
Guilley-Lerondeau et al. 2017 (179)	To evaluate the satisfaction and the psychological impact (anxiety) of isolation precautions in hospitalized patients in a French acute-care university hospital	France	Observation al cohort	March till July 2012	90 patients (30 isolated and 60 non-isolated)	Median (isolated patients 69) and (non-isolated 64)	Questionnaire : Patient satisfaction (qualitative scale) +Anxiety Spielberger scale	-	40% (12/30) of isolated patients received information about isolation precautions and 36.6% (11/30) about their infectious status
Sunkesula et al. 2015 (176)	To determine patients' opinions on HH and evaluate patient HH practices	USA	Pre-post intervention	February till September 2014	100 patients	-	Questionnaire + direct observation of patient HH performance	-	88% (88/100) of patients disagreed that they received information about the importance of HH

Smyth et al. 2015 (173)	To study the knowledge of HAIs held by patients in Australian hospitals	Australia	Cross-sectional	April 2013 till April 2014	42 patients	56	Questionnaire by Madeo et al. 2008	-	4.8% (2/42) received information about the risks of HAIs from a nurse at hospital
Seale et al. 2015 (157)	To ascertain patients' knowledge of, risk awareness of, and attitudes toward HAIs and common IC strategies, as well as their perceptions of participating in an engagement program aimed at preventing HAIs	Australia	Cross-sectional	May till December 2013	511 patients	65	Questionnaire	-	22.3% (114/511) stated that they had previously received information on HAIs
Ocran & Tagoe 2014 (164)	To assess the knowledge of HCWs and patients on HAIs, sources of knowledge of these infections, sources of these infections, and their attitudes to prevent these infections	Ghana	Cross-sectional	6 months	210 patients and 71 HCWs	55.2% of patients [25-30]	Questionnaire	-	24.8% of patients (52/210) were informed about HAIs by a healthcare officer
Barker et al. 2014 (167)	To examine factors associated with HH practices of hospital patients	USA	Cross-sectional	October 2012 till May 2013	207 patients	Median 63	Developed questionnaire	-	74.2% reported frequent reminders from HCWs to wash their hands
Anderson et al. a 2013 (169)	To examine patients' awareness and understanding of CLABSI risks and consequences	USA	Cross-sectional	July till October 2011	50 patients	46% [50- 64]	Developed questionnaire	Questionnaire was reviewed and improved by physicians, nurses, and infection preventionists	1- 46% (23/50) recalled receiving an informational flyer regarding CLABSI. 2- 76% (38/50) mentioned that the HCW talked to them about risks of infection with the central line

Anderson et al. b 2013 (160)	To examine patients' awareness and understanding of SSI risks and consequences	USA	Cross-sectional	July till October 2011	50 patients	84% ≤ 64	Developed questionnaire	-	1- 84% (42/50) had discussions about SSIs with their HCW. 2- 60% (30/50) recalled receiving an informational flyer regarding SSI. 3- 54% (27/50) learned about SSI in hospital
Ardizzone et al. 2013 (178)	To explore nurses' and patients' perceptions of patient HH and to determine the effectiveness of an educational intervention directed at the nursing staff about patient HH	USA	Quasi-experimental	5 months	71 patients and 42 nurses	-	A modified version of a validated questionnaire by Burnett et al. 2008 + observation of HH performance	Already validated	14% of patients were always encouraged to clean their hands on specific times, 34% often, 15.5% sometimes, 11% rarely, and 25.5% never encouraged
Hari & Rosenzweig 2012 (172)	To determine the exact rates and reasons for postsurgical readmissions for patients who had undergone Pancreaticoduodenectomy and identify what postoperative education was delivered to patients and families	USA	Cross-sectional	January 2006 till December 2008	62 patients	-	Patient medical records	-	95.2% (59/62) received written education on infection (SSI), 93.5% (58/62) verbal, and 6.5% (4/62) received education by demonstration
Madeo et al. 2008 (165)	To determine patients reported knowledge, awareness, attitudes, and beliefs on HAIs	UK	Descriptive survey	4 weeks	110 patients	-	Developed questionnaire	Examined for face validity and suitability	33% received information on HAIs from previous hospitalization

Burnett et al. 2008 (171)	To determine whether or not patients who required assistance with personal hygiene were encouraged and provided with facilities to do so, and to gain an insight into HCWs' perceptions toward patient HH	Scotland	Descriptive survey	January 2007	22 patients and 33 nurses	75 (patients)	Developed questionnaire + observation of HH performance	The patient questionnaire was pretested and piloted to maximize its reliability and validity	5% (1/22) of patients were always encouraged to clean their hands on specific times, 9% (2/22) often, 9% (2/22) sometimes, 22% (5/22) rarely, and 55% (12/22) never encouraged
Abbate et al. 2008 (140)	To document the level of knowledge, attitudes, and behavior, and to identify their determinants regarding HAIs among medical and surgical patients admitted to hospitals in Italy	Italy	Cross-sectional	June till October 2006	450 patients	51	Questionnaire	All items in the original version of the questionnaire were assessed to ensure practicability and validity	15.1% received information on HAIs from healthcare providers
Gasink et al. 2008 (158)	To compare satisfaction with inpatient care between isolated and non-isolated patients, and to assess isolated patients' perceptions and understanding of contact isolation	USA	Cross-sectional	7th August till 25th August 2006	86 patients (43 isolated and 43 non-isolated)	Median 54	CAHPS questionnaire + additional questions to assess perceptions and understanding of isolation	Non-validation of the CAHPS for face to face interviews	46.2% (18 out of 39 isolated patients) reported that the rationale and procedures for isolation were adequately explained to them
Duncan 2007 (163)	To explore patient's feelings about asking healthcare professionals to wash their hands prior to a clinical procedure,	UK	Descriptive survey	-	109 patients	25% [31-45]	Semi-structured questionnaire	-	25.3% (25/99) received information about MRSA and handwashing upon hospital admission, 3.6% (4/109) mentioned staff members as a source of information and 29.3%

	and to explore if MRSA status and access to patient information about IC would influence anxiety about asking								(32/109) mentioned patient information leaflets in hospital
Merle et al. 2005 (161)	To investigate the knowledge and opinions of surgical patients regarding NIs	France	Cross-sectional	-	65 patients	Median 54	Questionnaire	-	1- 80% (52, 95% CI: 68.2-88.9) of patients did not receive information regarding NIs during their hospitalization, while 20% (13 patient) did. 2- 6.2% received information on risk factors for NIs. 3- 10.8% received on IC methods and 6.2% on the organization of IC in the hospital
Miller & Farr 1989 (162)	To determine if patients were aware of the risk of acquiring a NI, satisfied with the current information on NIs provided by the medical community, the level of investment they want hospitals to make in IC, and the extent to which they are willing to pay for increased investment in this area	USA	Mail-based questionnaire survey	October 1986 and February 1987	976 patients	51	Mail-based questionnaire	-	69% (672) of patients said that the risk of acquiring a NI was not explained to them during their hospitalization.

HH, hand hygiene; HCWs, healthcare workers; UTIs, urinary tract infections; IC, infection control; HAIs, healthcare-associated infections; PPE, personal protective equipment; JBI-PACES, Joanna Briggs Institute practical application of clinical evidence system; GRIP, getting research into practice; CLABSIs, central line associated-bloodstream infections; SSIs, surgical site infections; CAHPS, the consumer assessment of healthcare providers and systems; MRSA, methicillin-resistant *Staphylococcus aureus*; NIs, nosocomial infections; CI, confidence interval.

2.3.2 Results of individual studies

Patient education on HAIs was investigated in eight studies. Miller and Farr (162) found that 69% of patients said that the risk of acquiring a NI was not explained to them during their hospitalization in a survey conducted among 976 discharged patients in the USA. Similarly, Hammoud et al. (168) revealed that 34.5% of patients and family members were educated on HAIs and the risk of acquiring an HAI during their hospital stay in a cross-sectional survey among 223 patients and family members and 217 nurses in Lebanon. Likewise, Madeo et al. (165) found that 33% of patients received information on HAIs from previous hospitalization in a survey among 110 patients in the UK. Seale et al. (157) revealed that 22.3% of patients stated that they had previously received information on HAIs in a cross-sectional survey among 511 patients in Australia, and Merle et al. (161) mentioned that 20% of patients received information regarding NIs during their hospitalization and 6.2% received information on risk factors for NIs in a cross-sectional survey among 65 inpatients in France. At the same time, Ocran and Tagoe (164) found that 24.8% of patients were informed about HAIs by a healthcare officer in a cross-sectional survey among 210 patients and 71 HCWs in Ghana, while Abbate et al. (140) revealed that 15.1% of patients received information on HAIs from their healthcare professionals in a cross-sectional survey among 450 patients in Italy, and Smyth et al. (173) showed that 4.8% of patients received information about the risks of HAIs from a nurse at hospital in a cross-sectional survey among 42 patients in the USA.

Education on CLABSIs was investigated in one study by Anderson et al. a (169), who showed that 46% of patients recalled receiving an informational flyer regarding CLABSIs, and 76% mentioned that the HCWs talked to them about risks of infection with the central line in a cross-sectional survey among 50 patients in the USA.

Education on SSIs was investigated in two studies. Anderson et al. b (160) found that 84% of patients had discussions about SSIs with their HCWs, 60% recalled receiving an informational flyer regarding SSIs, and 54% learned about SSIs in hospitals in a cross-sectional survey among 50 surgical patients in the USA. Similarly, Hari and Rosenzweig (172) showed that 95.2% of patients received written education on infection (SSI), 93.5% verbal, and 6.5% received education by demonstration in a cross-sectional survey among 62 surgical patients in the USA.

Education on HH was investigated in 12 studies. Ong et al. (175) showed that 20.4% of patients received education on HH in the pre intervention phase, while in the post intervention

phase, patient education on HH showed an improvement of 48.1% (X^2= 26.517, p< 0.001) in a pre-post intervention audit among 54 patients in Singapore, unlike Haverstick et al. (174), who found that 53% of patients were always encouraged to clean their hands on specific times, but the rate decreased to 46% post intervention in a pre-post intervention study among 172 patients and 33 staff in the USA. Sunkesula et al. (176) showed that 88% of patients disagreed that they received information about HH in the pre intervention phase of a pre-post intervention study among 100 patients in the USA. At the same time, Pokrywka et al. (177) found that 34% of patients received education on HH prior to intervention in phase one and 48% in the baseline survey of phase two in a quasi-experimental study among 388 patients in phase one (97 pre intervention and 291 post intervention) and 269 patients in phase two (80 baselines and 189 follow-ups) in the USA, while the percentage of HH education increased to 64% (p< 0.0001) post intervention in phase one and to 53% in the follow-up survey of phase two. Barker et al. (167) showed that 74.2% of patients reported frequent reminders from HCWs to wash their hands in a cross-sectional survey among 207 patients in the USA, while Srigley et al. (143) revealed that 55.1% of patients indicated that staff had informed them about the importance of HH while in the hospital in a cross-sectional survey among 268 patients and/or caregivers in Canada. Li Y. et al. (159) found that 30.6% of patients and family members received education on HH from HCWs in a cross-sectional survey among 310 participants (242 patients and 68 family members) in China. Similarly, Hammoud et al. (168) showed that 29.1% of patients and family members were provided with brochures on HH and/or respiratory hygiene. Duncan (163) revealed that only 3.6% of patients received information about handwashing and MRSA from their staff members upon hospital admission, and 29.3% of patients mentioned patient information leaflets in the hospital as a source of their information in a survey among 109 inpatients in the UK. Similarly, Burnett et al. (171) showed that only 5% of patients were always encouraged to clean their hands on specific times in a cross-sectional survey among 22 patients and 33 nurses in Scotland, and Knighton et al. (166) revealed that 0.9% of patients reported being reminded very often to clean their hands in a cross-sectional survey among 107 discharged patients in the USA, while Ardizzone et al. (178) found that 14% of patients were always encouraged to clean their hands on specific times in a quasi-experimental study among 71 patients and 42 nurses in the USA.

Education on isolation rationale, precautions, and use of PPE was investigated in three studies. Gasink et al. (158) reported that 46.2% of isolated patients mentioned that the rationale and procedures for isolation were adequately explained to them in a cross-sectional survey

among 86 patients (43 isolated and 43 non-isolated) in the USA. Similarly, Guilley-Lerondeau et al. (179) showed that 40% of isolated patients received information about isolation precautions and 36.6% about their infectious status in an observational prospective cohort study among 90 patients, including 30 isolated and 60 non-isolated patients in France. At the same time, Hammoud et al. (168) mentioned in their study that 79.4% of isolated participants were informed about the reason for placing them in isolation, and 82.4% were educated on the use of PPE.

Education on respiratory hygiene/cough etiquette was investigated in one study only by Hammoud et al. (168), who showed that 21.1% of patients and family members were educated on this measure.

Patient education on other IC measures was investigated; Minejima et al. (170) showed that 28% of patients reported receiving information from their healthcare provider about appropriate hygiene measures to prevent UTIs in a cross-sectional survey among 120 patients in the USA, and Merle et al. (161) reported that 10.8% of patients received information on IC methods and 6.2% on the organization of IC in the hospital.

Concerning the data collection tools used in the included studies, 23 studies employed questionnaires (structured and semi-structured), while one of the three pre-post intervention studies by Ong et al. (175) involved a developed audit tool, and one study by Hari and Rosenzweig (172) used patient medical records. Regarding the validity and reliability of the instruments, Li Y. et al. and Knighton et al. (159,166) mentioned the Cronbach's alpha values of the reliability of the questionnaire, while Abbate et al., Madeo et al., Anderson et al. a, and Burnett et al. (140,165,169,171) indicated that the questionnaires were assessed for validity, but values were not reported. Gasink et al. and Minejima et al. (158,170) stated that no validation was done; Ardizzone et al. (178) stated that the questionnaire was already validated, and no process of validity and reliability was reported in any of the remaining studies.

2.3.3 Reporting quality assessment

The STROBE checklist (155) defines five headings, title and abstract, introduction, methods, the results, and discussion, with several items below each heading to indicate whether this particular item was well reported in each study. First, the abstract was well reported in all eligible studies, except for Seale et al., Gasink et al., Barker et al., Smyth et al., and Sunkesula et al. (157,158,167,173,176), where the abstracts were very brief and lacked numerical values

of key results. Second, the introduction was properly described in all eligible studies, except for Seale et al. and Merle et al. (157,161), where the scientific background was explained very briefly. Third, in the methods section; study design, setting, and participants were well reported in all eligible studies but, Merle et al., Duncan, Hammoud et al., and Ardizzone et al. (161,163,168,178) did not mention the dates and period of data collection. The variables were reported in the methods section of all studies, except for Anderson et al. b, Miller and Farr, and Smyth et al. (160,162,173). Efforts to address the potential risk of bias were described by Gasink et al., Duncan, Madeo et al., Ong et al., and Sunkesula et al. (158,163,165,175,176). Only Gasink et al., Li Y. et al., Ong et al., and Ardizzone et al. (158,159,175,178) described how the study size was arrived at. In the statistical methods subsection, only Ong et al. (175) explained how missing data were addressed. Fourth, the results section; only Seale et al., Duncan, Madeo et al., Knighton et al., Burnett et al., Hari and Rosenzweig, Ardizzone et al., and Guilley-Lerondeau et al. (157,163,165,166,171,172,178,179) gave the reasons for nonparticipation. The characteristics of study participants were well reported in all eligible studies, except for Hammoud et al., Haverstick et al., Ong et al., Sunkesula et al., and Pokrywka et al. (168,174–177). None of the studies indicated the number of participants with missing data for each variable of interest, except for Gasink et al. and Smyth et al. (158,173). Outcome data were well reported in all studies. In the main results subsection, only Abbate et al., Seale et al., Li Y. et al., Barker et al., and Minejima et al. (140,157,159,167,170) reported the unadjusted and adjusted estimates and their precision. None of the studies reported any other analysis performed. Fifth, the discussion section; summary of key results and overall interpretation of results were well reported in all eligible studies. Study limitations were reported by all except Duncan, Ocran and Tagoe, Hammoud et al., Smyth et al., and Ong et al. (163,164,168,173,175). Srigley et al., Seale et al., Gasink et al., Li Y. et al., Anderson et al. b, Miller and Farr, Knighton et al., Barker et al., Anderson et al. a, Minejima et al., Burnett et al., and Haverstick et al. (143,157–160,162,166,167,169–171,174) discussed the generalizability of the study results. Finally, the source of funding was reported by Srigley et al., Seale et al., Li Y. et al., Ocran and Tagoe, Knighton et al., Barker et al., Minejima et al., Burnett et al., Haverstick et al., Ong et al., Sunkesula et al., Ardizzone et al., and Guilley-Lerondeau et al. (143,157,159,164,166,167,170,171,174–176,178,179).

2.4 DISCUSSION

2.4.1 Summary of main results

The present paper is the first systematic review that identifies the studies that assess hospitalized patients' education on IC measures. Each of the 25 included studies had one or more outcomes that matched our review's outcomes. Education on HAIs was investigated in eight studies, education on CLABSIs in one, education on SSIs in two, education on HH in 12, education on isolation rationale, precautions, and use of PPE in three, education on respiratory hygiene in one, and education on other IC measures in two studies.

2.4.2 Overall completeness and applicability of evidence

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 (169) and in the two studies that assessed education on SSIs (160,172). It is important to mention that Hari and Rosenzweig (172) stated that "postdischarge education was inconsistent and no evidence of learning was shown". Additionally, we should highlight that the sample size included in these three studies was small (50 patients Anderson et al. b, 50 Anderson et al. a, and 62 Hari and Rosenzweig) (160,169,172). This better level of education 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 the study by Barker et al. (167), although HH is suggested to be the most effective approach to prevent the transmission of HAIs (180–183). At the same time, asking patients to remind their healthcare professionals to perform HH is considered one of the pioneering strategies to promote patient empowerment (183–188). When educating on isolation rationale, precautions, and use of PPE, we recognized a high level of education by only one study (168), but it is notable here that the sample of isolated participants was small in the three studies that assessed education on these measures (39 participant Gasink et al., 34 Hammoud et al., and 30 Guilley-Lerondeau et al. (158,168,179). We think these results may be biased due to the small sample size. Finally, when educating on other IC measures, a low level of education was also recognized. Given the low percentage of education on IC measures in most of the studies included in this review, we believe that patient education on IC is not being adequately done inside hospitals, although it is recommended by the CDC, as mentioned earlier (74). On the other hand, only two studies were found to assess patient education on more than one IC measure (Merle et al. and Hammoud et al.) (161,168), 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, especially, after the late suggestions on engaging the patients in many IC aspects as a way to prevent the transmission of HAIs (107) and after the global discussion of empowering patients to maintain their safety (123,189–193).

As stated before, only a few studies reported assessing the validity and reliability of the questionnaires used. The validity and reliability of the questionnaire are essential points to be mentioned since the questionnaire should be able to accurately measure what it is intended to measure (194,195). In addition, the rise in diverse populations internationally and the necessity for cross-cultural and multinational research show a remarkable requirement for researchers to have access to valid and reliable instruments; hence, this would improve the validity and generalizability of cross-cultural health research (196–198).

2.4.3 Reporting quality assessment

In general, the abstracts and introductions were well reported in all studies, so readers can have an informative summary of each study to realize the study's background and to judge its impact on the existing knowledge (155). However, several gaps were found in reporting the methods, the results, and discussion sections. The methods section should include all details that explain what was planned and how implementation was done to allow the readers to understand all the study's characteristics, and to be able to criticize whether the mentioned method was able to deliver the results reliably and validly. As for the results section, it should reflect a clear idea about what was established in the study, starting with the participant's enrollment, giving characteristics of the study participants, reporting the main results, and finally the secondary analysis. Concerning the discussion part, documenting and arguing the limitation of research is a vital point in scientific writing. On the other hand, reporting the external validity and presenting information about the applicability of the study results in other circumstances is essential. Finally, the source of funding and the role of funders must be stated to avoid any doubt about the influence of the funders on the research conclusion (155).

2.4.4 Strengths and limitations

Our review has some limitations: first, for some studies, few data were not available (mean age and duration of data collection) even after contacting the authors (161,163,165,172,174–176,178); second, studies that assessed the general population were

excluded from this review, and only studies on hospitalized patients were included; third, studies that assessed patient education on specific diseases were excluded (tuberculosis, hepatitis B, HIV, etc.), these studies may include outcomes related to education on some IC measures. Finally, qualitative studies were also excluded. On the other hand, we believe that this review has several strengths. First, it is the first systematic review that identifies the studies that assess hospitalized patients' education on IC. Second, the search was conducted without any restrictions. Third, the 25 studies included in this review have an international scope; they were conducted in America, Australia, Europe, Asia, and Africa and in high-, upper-middle-, and middle-income countries.

2.5 CONCLUSION

In conclusion, the present systematic review reveals a low percentage of patient education on IC measures. Our results show that only two studies assessed patient education on more than one IC measure. 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. Moreover, future studies can assess the IC education of family members as well (199).

The previous chapter (substudy) determines a low percentage of patient education on almost all IC measures among different countries. The systematic review was conducted to investigate all the available tools for measuring patient education on IC. The findings reveal only two studies that assessed patient education on several IC measures, while all the others assessed education on only one or two measures. The following substudy introduces the chosen measurement tool that was used to assess patient and family education on IC measures in Hungary and presents the findings.

CHAPTER 3 Substudy 2 - Assessing Patient and Family Education on Infection Control in Hungary: A Cross-sectional Study

3.1 INTRODUCTION

HAIs are among the most common adverse events in healthcare settings worldwide (200). Many HAIs are caused by serious MDROs resulting from the overuse of numerous antimicrobial agents (17). It is estimated that 1.4 million people are affected by HAIs globally at any given time (201), increasing mortality rates and leading to significant financial losses for healthcare systems (3). In the USA, a point prevalence survey was conducted among hospitals in 2018 and reported that 3.2% of patients had at least one HAI (202). On the other hand, the prevalence of HAIs across European countries ranges from 3.5 to 10% (203). In Hungary, the incidence of MDR HAIs was 29.35/100000 patient days in 2017 (32).

During recent decades, the healthcare system has shifted toward providing patient-centered care to improve patient safety (107,151). Patient-centered care stresses the empowerment and involvement of patients in their healthcare process, focusing on health rather than on the disease and on health education and prevention rather than on the treatment (12). Patient empowerment starts with educating patients about their health status so they can actively participate in their treatment decisions (12,107). Several studies have shown that patients who are empowered and engaged in decision-making about their healthcare management have better outcomes than those who are not involved (12). Stenberg et al. (204) conducted a systematic review to provide a comprehensive summary of the health economic impact of patient education for people living with chronic illness. The review concluded that patient education had positive health economic impacts, such as decreased hospital admissions, hospitalization (length of stay and readmission), visits to emergency departments or general practitioners, and loss of production. An increase in quality-adjusted life years was also perceived.

Despite this progress in patient safety, HAIs continue to spread in hospitalized patients (107). The WHO suggested several solutions to prevent HAIs, such as implementing proper IC measures (HH, SP, 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 (3). At the same time, several studies have shown that patients and family members might help prevent the transmission of HAIs. Accordingly, more emphasis was placed on empowering the patients and family members and engaging them in IC practices (74,177,205,206). In addition, the CDC recommended educating patients on several IC measures (74). According to the CDC guideline for isolation precautions, patients can be provided with information on HH and respiratory hygiene/cough etiquette upon their hospital admission, and information on isolation precautions, the reason for isolation, and the use of PPE when isolation is initiated (74).

A recent systematic review (substudy one of this research) was conducted to examine patient education on IC. The review involved 25 studies that assessed patient education on different IC measures, including HAIs, CLABSIs, SSIs, HH, isolation rationale, isolation precautions, the use of PPE, and respiratory hygiene. It was notable that only two studies assessed patient education on several IC measures, while all the other studies examined education on only one or two measures. A low percentage of IC education among hospitalized patients was revealed, which highlights the need for further emphasis on patient involvement in IC (199).

To date, research examining patient education on IC has mainly focused on HH (143,159,166,174–177) and HAIs (157,164,165), although the IC program is wide and includes diverse measures and processes throughout hospitals. Thus, education on other IC measures beyond HH and HAIs should be explored. Additionally, to our knowledge, no previous study has examined patients' and family members' education on IC in Hungary; therefore, we are conducting this study among hospitalized patients and family members to assess their education on IC measures in Hungary.

3.2 METHODS

3.2.1 Study design, setting and inclusion criteria

This study used a multisite, cross-sectional design. Considering the inability to survey all hospitals in Hungary, hospitals in the Southern Transdanubian region (excluding specialized clinics) were invited to take part in our study. The Southern Transdanubian region of Hungary includes three counties: Baranya, Somogy, and Tolna. Approval was obtained from a total of seven hospitals.

Inclusion criteria for participation in this study included patients who were admitted to inpatient units (medicine, surgery, critical care units, Obstetrics-Gynecology (OB-GYN), hematology-oncology, and pediatrics), admitted for at least 24 hours, conscious, and willing to complete the questionnaire. Family members caring for/staying with the patients and willing to complete the questionnaire were also included. However, visitors were excluded from the study.

3.2.2 Data collection and sample

After obtaining each hospital's approval, hard copies of the questionnaires were handed over to the top management. The head nurse of each unit distributed the questionnaires to a convenience sample of patients and family members who were eligible and present during the period of data collection. The questionnaires were distributed during patients' hospitalization to maximize participation and minimize recall bias. The head nurse collected the completed questionnaires later during the day. Finally, the questionnaires were collected by the researcher three months later. Data collection was initiated in February 2020 and completed in June 2021.

The required sample size was calculated using the Thompson equation (207).

$$n = \frac{N \times p(1-p)}{[N-1 \times (d^2 \div z^2)] + p(1-p)}$$

Considering the total number of operating hospital beds in Hungary as the population size (N= 68112 beds) (208) and taking 0.5 estimated variability in population (p), 0.05 margin of error (d), and a z score of 1.96 (z), the required sample size was 382 participants.

3.2.3 The questionnaire

According to a recent systematic review (substudy one) on patient education on IC (199), only two studies examined patient education on several IC measures. The first was a study by Merle et al. (161) that assessed patient education on HAIs, risk factors for HAIs, IC methods, and the organization of IC in the hospital. The second was a study by Hammoud et al. (168) that 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 (74). Therefore, in this study, we used a modified version of the questionnaire developed by the latter (168). 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 self-administered questionnaire consisted of two parts; the demographics

part assessed the patients' and family members' gender, age, educational degree, and admission status in addition to county, hospital type, and nursing unit. The second part involved nine close-ended questions (instead of eight in the original questionnaire) concerning patients' and family members' education provided by nurses 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. Responses to each question were coded and scored as Yes (1) or No (0).

3.2.4 Translation and validation of the questionnaire

It was impossible to distribute the questionnaires in English (the original language of the questionnaire) since most of the patients did not speak English, given that the official language in Hungary is Hungarian. Therefore, translation and validation guidelines (198) were followed to translate the questionnaire. First, translation from English into Hungarian was performed by two Ph.D. candidates, separately. Second, proofreading and comparison of the two translated versions were performed by a committee that resulted in a single Hungarian questionnaire. Third, blind back-translation into English was performed by two Ph.D. candidates once again separately. Fourth, a comparison process was conducted by comparing the two back-translated questionnaires and then comparing them against the original English questionnaire. In this comparison, we examined similarities of the questionnaire questions, their wording, sentence structure, meaning, and relevance. This comparison was performed by a Hungarian associate professor of linguistics and a Hungarian bilingual medical doctor who are knowledgeable about health terminology and IC. As a result, a final Hungarian version of the questionnaire was produced. Content validity was assessed by a panel of four expert members: an IC expert, a physician, and two nurses. All members agreed on the questions; thus, 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. Based on this pilot study, few words were modified as per the participants' comments. Kuder-Richardson 20 coefficient was equal to 0.814, which is similar to the original questionnaire (0.877), showing a very good reliability coefficient.

3.2.5 Data analysis

Data curation and analysis were performed via Statistical Package for the Social Sciences (SPSS) version 20. First, descriptive statistics were utilized. Frequencies and percentages were used for categorical variables, while the mean and Standard Deviation (SD) were used for the only continuous variable in our dataset (age). Second, variance analysis was performed. Since the outcome variable (IC education) is categorical, the chi-square (X^2) test or Fisher's exact test was used to compare the difference in IC education across demographics. Finally, a logistic regression analysis was performed to identify independent predictors of patient and family education for each IC measure. All demographic variables were introduced in the logistic regression. The significance level was set at $p< 0.05$. For missing data management, incomplete questionnaires were disregarded.

3.2.6 Ethical considerations

The study received ethical approval from the Regional Research Ethics Committee of the Medical Center, Pécs, Hungary (Record number: 7862 - PTE 2019). Before administering the questionnaires, participants were informed that their participation was voluntary and anonymous. Written informed consent was signed by all participants. No complaints were reported or raised.

3.3 RESULTS

3.3.1 Demographic characteristics

Of the seven included hospitals, three were located in Baranya County, three in Tolna, and one in Somogy. One of the hospitals was a university hospital, two were county hospitals, and four were city hospitals. A total of 418 participants responded out of 760 participants invited, with a 55% response rate. After checking incomplete questionnaires, six were discarded, so the final number of participants included was 412.

Of the 412 participants, 89.6% were patients, and 59.2% were females. Ages were between 18 and 90 years, with a mean age (± SD) of 52.67 ± 17.442 years. A total of 57.3% of participants had a secondary school degree, and 18.7% had their first hospital admission. The complete demographics of the respondents are shown in **Table 2**.

Table 2 Demographic characteristics of participants (N= 412)

Demographics	Number of respondents n (%)
Status	
Patient	369 (89.6)
Family member	43 (10.4)
Gender	
Female	244 (59.2)
Male	168 (40.8)
Age	
[18-27] years	36 (8.7)
[28-37] years	70 (17.0)
[38-47] years	50 (12.1)
[48-57] years	74 (18.0)
[58-67] years	77 (18.7)
[68-77] years	83 (20.1)
>77 years	22 (5.3)
County	
Baranya	142 (34.5)
Tolna	125 (30.3)
Somogy	145 (35.2)
Hospital type	
City	135 (32.8)
County	211 (51.2)
University	66 (16.0)
Department	
Medicine	79 (19.2)
Surgery	128 (31.1)
Critical care units	23 (5.6)
Obstetrics-Gynecology	72 (17.5)
Hematology-Oncology	94 (22.8)
Pediatrics	16 (3.9)
Educational degree	
Elementary school	109 (26.5)
Secondary school	236 (57.3)
University degree	67 (16.3)
First hospital admission	
No	335 (81.3)
Yes	77 (18.7)

3.3.2 IC *education of patients and family members*

The highest percentage of education was on respiratory hygiene/cough etiquette with 89.8%, while the lowest was on receiving brochures on hand hygiene and/or respiratory hygiene with 75.7%. The results of all IC education questions are displayed in **Table 3**.

Table 3 Participants' education on IC measures (N= 412)

Infection control education (provided by nurses)	Number of respondents n (%)
Educated on healthcare-associated infections	Yes 340 (82.5) No 72 (17.5)
Educated on the risks of acquiring an healthcare-associated infection	Yes 326 (79.1) No 86 (20.9)
Educated on hand hygiene	Yes 338 (82.0) No 74 (18.0)
Educated on respiratory hygiene/cough etiquette	Yes 370 (89.8) No 42 (10.2)
Provided with brochures on hand hygiene and/or respiratory hygiene	Yes 312 (75.7) No 100 (24.3)
I am in isolation right now	Yes 84 (20.4) No 328 (79.6)
Educated on the reason for isolation†	Yes 68 (81.0) No 16 (19.0)
Educated on the use of personal protective equipment†	Yes 67 (79.8) No 17 (20.2)
Time of education	
Educated upon admission	128 (31.1)
Educated upon admission and during the stay	258 (62.6)
Educated upon discharge (previous admission)	48 (11.7)
No education was done	11 (2.7)

†Percentages were calculated from a total of 84 participants who were in isolation.

3.3.3 Variance analysis (patient and family education on IC across demographics)

Table 4 presents the results of variance in IC patient and family education across participants' demographics. Only significant results are displayed in this table. The percentage of IC education did not vary across participants' status (patient or family member), gender, age, and educational degrees; however, it varied across different counties. 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).

The results showed that IC education differed across hospital departments. For instance, participants from pediatrics and hematology-oncology departments had the highest percentages of education on HAIs (p= 0.001) and the highest percentage of receiving fliers on HH and/or respiratory hygiene (p= 0.019). Additionally, participants from the surgery, hematology-oncology, and pediatrics departments had the highest percentages of education on respiratory hygiene (p< 0.001).

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).

3.3.4 Logistic regression analysis

The logistic regression analysis presented in **Table 5** 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 brochures 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).

Table 4 Patients' and family members' education on IC across demographics (N= 412)

	Education on HAIs		
	Yes, n (%)	**No, n (%)**	***P*-value**
County			
Baranya	108 (76.1)	34 (23.9)	0.001
Tolna	99 (79.2)	26 (20.8)	
Somogy	133 (91.7)	12 (8.3)	
Ward/Unit			
Medicine	67 (84.8)	12 (15.2)	0.001
Surgery	97 (75.8)	31 (24.2)	
Critical care units	21 (91.3)	2 (8.7)	
Obstetrics-Gynecology	52 (72.2)	20 (27.8)	
Hematology-Oncology	87 (92.6)	7 (7.4)	
Pediatrics	16 (100)	0 (0)	
Admission			
Not first admission	270 (80.6)	65 (19.4)	0.032
First admission	70 (90.9)	7 (9.1)	

	Education on hand hygiene		
	Yes, n (%)	**No, n (%)**	***P*-value**
County			
Baranya	106 (74.6)	36 (25.4)	0.018
Tolna	108 (86.4)	17 (13.6)	
Somogy	124 (85.5)	21 (14.5)	

Receiving brochures on hand hygiene and/or respiratory hygiene			
	Yes, n (%)	**No, n (%)**	***P*-value**
County			
Baranya	102 (71.8)	40 (28.2)	<0.001
Tolna	84 (67.2)	41 (32.8)	

	Education on the risks of HAIs		
	Yes, n (%)	**No, n (%)**	***P*-value**
County			
Baranya	99 (69.7)	43 (30.3)	<0.001
Tolna	94 (75.2)	31 (24.8)	
Somogy	133 (91.7)	12 (8.3)	

	Education on respiratory hygiene		
	Yes, n (%)	**No, n (%)**	***P*-value**
County			
Baranya	109 (76.8)	33 (23.2)	<0.001
Tolna	122 (97.6)	3 (2.4)	
Somogy	139 (95.9)	6 (4.1)	
Type of Hospital			
City hospital	116 (85.9)	19 (14.1)	<0.001
County hospital	203 (96.2)	8 (3.8)	
University hospital	51 (77.3)	15 (22.7)	
Ward/Unit			
Medicine	65 (82.3)	14 (17.7)	<0.001
Surgery	124 (96.9)	4 (3.1)	
Critical care units	18 (78.3)	5 (21.7)	
Obstetrics-Gynecology	59 (81.9)	13 (18.1)	
Hematology-Oncology	89 (94.7)	5 (5.3)	
Pediatrics	15 (93.8)	1 (6.2)	

Education on the use of PPE			
	Yes, n (%)	**No, n (%)**	***P*-value**
County			
Baranya	19 (79.2)	5 (20.8)	0.012
Tolna	31 (93.9)	2 (6.1)	

Somogy	126 (86.9)	19 (13.1)		Somogy	17 (63)	10 (37)
Ward/Unit						
Medicine	62 (78.5)	17 (21.5)	0.019			
Surgery	96 (75)	32 (25)				
Critical care units	17 (73.9)	6 (26.1)				
Obstetrics-Gynecology	44 (61.1)	28 (38.9)				
Hematology-Oncology	79 (84)	15 (16)				
Pediatrics	14 (87.5)	2 (12.5)				

The chi-square (X^2) test was used for the comparison. HAIs, healthcare-associated infections; PPE, personal protective equipment

Table 5 Logistic regression analysis of factors associated with IC education of patients and family members (N= 412)

	Education on HAIs		Education on the risks of HAIs		Education on hand hygiene		Education on respiratory hygiene	
Predictors	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Status-Family member	1.343	0.545-3.313	0.996	0.458-2.165	0.692	0.325-1.476	0.667	0.263-1.687
Gender-Male	0.956	0.571-1.602	0.890	0.550-1.439	0.826	0.497-1.372	1.133	0.588-2.184
Age	1.000	0.985-1.014	1.003	0.990-1.017	1.013	0.998-1.027	1.008	0.989-1.026
Baranya County	Reference							
Tolna County	1.199	0.672-2.139	1.317	0.767-2.263	2.158	1.142-4.075 *	12.312	3.672-41.280 ***
Somogy County	3.489	1.723-7.064 **	4.814	2.413-9.605 ***	2.005	1.103-3.644 *	7.014	2.837-17.342 ***
City hospital	Reference							
County hospital	0.946	0.529-1.692	1.449	0.846-2.482	1.717	0.973-3.029	4.156	1.764-9.792 **
University hospital	0.723	0.343-1.525	0.737	0.378-1.437	0.855	0.426-1.716	0.557	0.262-1.182
Medicine	Reference							
Surgery	0.560	0.269-1.169	0.936	0.475-1.843	1.294	0.629-2.661	6.677	2.112-21.108 **
Critical care units	1.881	0.389-9.086	0.987	0.320-3.046	1.206	0.360-4.045	0.775	0.246-2.441
Obstetrics-Gynecology	0.466	0.209-1.039	0.666	0.318-1.394	0.708	0.332-1.513	0.978	0.425-2.249
Hematology-Oncology	2.226	0.831-5.961	1.874	0.834-4.209	2.133	0.907-5.016	3.834	1.315-11.177 *
Pediatrics	289338781.7	0.000	1.919	0.397-9.279	0.762	0.217-2.680	3.231	0.394-26.515
Elementary school degree	Reference							
Secondary school degree	1.768	0.994-3.144	1.539	0.901-2.626	0.975	0.537-1.771	2.216	1.074-4.574 *
University degree	1.236	0.583-2.623	1.661	0.781-3.536	0.877	0.401-1.917	1.109	0.460-2.673
First hospital admission	2.407	1.057-5.481 *	1.731	0.870-3.444	1.390	0.694-2.784	1.788	0.679-4.710

	Distributing brochures on hand hygiene and/or respiratory hygiene		Education on the reason for isolation		Education on the use of PPE	
Predictors	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Status-Family member	2.108	0.862-5.153	453466628.6	0.000	2.807	0.334-23.600
Gender-Male	1.103	0.696-1.748	1.843	0.578-5.879	0.600	0.206-1.750
Age	0.998	0.986-1.011	0.994	0.963-1.027	1.011	0.980-1.042
Baranya County	Reference					
Tolna County	0.803	0.476-1.355	0.822	0.232-2.918	4.079	0.719-23.156

Somogy County	2.601	1.420-4.764 **	2.105	0.446-9.946	0.447	0.127-1.573
City hospital	Reference					
County hospital	0.989	0.599-1.634	0.776	0.240-2.513	0.230	0.058-0.911 *
University hospital	1.100	0.548-2.208	0.931	0.159-5.446	0.250	0.042-1.479
Medicine	Reference					
Surgery	0.823	0.421-1.606	1.377	0.291-6.519	4.737	0.904-24.809
Critical care units	0.777	0.265-2.275	0.217	0.012-4.094	765224935.7	0.000
Obstetrics-Gynecology	0.431	0.211-0.882 *	0.326	0.043-2.492	0.316	0.045-2.235
Hematology-Oncology	1.444	0.669-3.118	0.696	0.173-2.805	4.500	0.857-23.641
Pediatrics	1.919	0.397-9.279	351190187.9	0.000	2.368	0.240-23.361
Elementary school degree	Reference					
Secondary school degree	1.730	1.036-2.890 *	2.850	0.888-9.149	0.480	0.137-1.687
University degree	1.333	0.673-2.641	4.500	0.498-40.654	0.720	0.112-4.628
First hospital admission	1.727	0.907-3.290	1.226	0.309-4.875	0.400	0.124-1.295

*p< 0.05, **p< 0.01, ***p< 0.001. OR, odds ratio; CI, confidence interval; HAIs, healthcare-associated infections; PPE, personal protective equipment.

3.4 DISCUSSION

This study aimed to assess patients' and family members' education on IC measures in Hungary. The results show a high percentage of IC education compared to the recent systematic review results (substudy one) on patient education on IC (199).

The highest percentage of education was on respiratory hygiene, which is much higher than the results of Hammoud et al. (168). Education on HAIs and the risks of HAIs are also high compared to the literature. For instance, these findings are much higher than the findings of Seale et al. (157), Ocran and Tagoe (164), and Madeo et al. (165) for HAIs education and the findings of Smyth et al. (173), Merle et al. (161), and Hammoud et al. (168) for education on the risks of HAIs. Additionally, our results showed higher HH education than those of Li Y. et al. (159), Srigley et al. (143), and Ong et al. (175). The lowest percentage of education was on receiving fliers on HH and/or respiratory hygiene; however, it is still much better than the results of Hammoud et al. (168). Finally, 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. (179); however, our results are similar to those of a previous study by Hammoud et al. (168).

The high level of IC education among patients and family members in our study could be explained by three main reasons. First, our research was conducted during the Coronavirus Disease (COVID-19) pandemic. As COVID-19 has been shown to have higher fatalities than the previous two coronavirus epidemics (SARS and Middle East respiratory syndrome), patient education becomes critical so that patients may aid in combating the virus (209). Consequently, strict regulations were applied in Hungarian hospitals to fight against the virus and to prevent its transmission. Perhaps this was reflected in having the highest percentage of education on respiratory hygiene, followed by HAIs and HH with almost the same percentages, as HH (210–212) and respiratory hygiene are the key recommended IC measures to fight against COVID-19 (213,214). Our results are similar to those of a recent study (substudy three) (215) that assessed IC patient and family education from the nurses' perspective in Hungary, where HH and respiratory hygiene had the highest percentages of education as stated by nurses. This similarity in the findings of the two substudies of the current research is promising and reflects the reliability of our findings. It would be interesting if future researchers conducted a study including both perspectives (that of patients and nurses) and compared them. 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 (63), where all the healthcare

institutions of member states are required to engage and empower their patients by involving them in the patient safety process and informing them about safety measures. Additionally, all healthcare institutions are required to provide their patients with information on the risks of HAIs and the required IC measures to prevent them. Furthermore, 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 (64) does not mention or state patient education on IC, it clearly states that healthcare institutions in Hungary should conform to the EU Council recommendation on patient safety, including the prevention and control of HAIs. This may explain the high percentage of education on all IC measures. Finally, it should be highlighted that providing patients with information on HH is mentioned in the handbook of Hungarian healthcare standards (66). Moreover, educating patients and their family members on preventing infection transmission and providing more attention to high-risk patients are mentioned in the Hungarian inpatient and outpatient accreditation standards (67).

The percentage of education was significantly the highest among pediatrics and hematology-oncology departments when educating on HAIs and receiving fliers on HH and/or respiratory hygiene and the highest among surgery, hematology-oncology, and pediatrics when educating on respiratory hygiene. This could be because patients in these units are usually given more attention due to their conditions. Patients at hematology-oncology are more susceptible to acquiring HAIs due to neutropenia, while surgery patients are at risk of acquiring postoperative SSIs. Education in the pediatrics unit reflects the attention given to family members, mostly parents, to protect their children from HAIs. On the other hand, the results also showed that participants who had their first hospital admission were more educated on HAIs than their counterparts. This might show that HCWs are being more cautious with patients who are having their first admission due to their minimal experience in hospitalization and HAIs compared to patients who have been admitted more than once.

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 counties where participants are less likely to be educated on certain IC measures.

3.4.1 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 in all hospitals 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, to make the questionnaire understandable by participants of different ages and educational backgrounds, 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 response rate was considerably low. Despite this limitation, we consider that there is a well-adjusted representation of patients from different types of hospitals, which suggests that the findings can be generalized. Fifth, 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 include a higher number of family members or to conduct a separate study to assess family members' or caregivers' education on IC measures. Finally, our study took place during the COVID-19 pandemic, where strict regulations were applied inside Hungarian hospitals, 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 COVID-19 pandemic.

3.4.2 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 and through effective actions intended to involve and engage the patients in IC (203). Previous studies have shown that patients are more willing to be engaged in hygiene discussions with their HCWs if they receive motivation or encouragement from them, mainly nurses and doctors (183). The encouragement of patients' active engagement will improve the possibility of knowledge retention and positive behavior change over time (216). 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 patients' and family members' 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. However, it is critical to adhere to patient preferences, especially after the recent findings of Bányai et al. (217), who investigated individuals' preferences regarding communication between patients and HCWs in Hungary, Slovakia, the Czech Republic, and Poland. In their study, they found that respondents preferred to receive more information from their HCWs than to be too engaged in decision-making about their health status.

3.5 CONCLUSION

In summary, the present study reveals a high percentage of patients' and family members' 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.

The previous two chapters (substudies) presented the patient and family education part of our research as a systematic review and then more specifically in Hungary through a cross-sectional study. The upcoming two chapters address the nurses' part of our research, more specifically nurses' awareness of IC measures in Hungary and its effect on implementing patient and family education. Since few systematic reviews on nurses' knowledge and awareness of IC have already been conducted (88,195,218), it was not applicable to conduct an additional systematic review addressing the same topic. Therefore, in addition to reviewing the results of the previously conducted reviews, a thorough literature review was performed to find studies that assessed HCWs' or nurses' awareness or knowledge of IC measures or practices. Sufficient research was conducted internationally and in Europe, as listed in the first chapter (Introduction) of the current thesis. After a thorough review and discussion of the findings, the ICSQ by Tavolacci et al. (97) was selected for use in the current research. The ICSQ was selected for two reasons. First, it was developed based on SP and not UP, similar to other developed questionnaires (92). Second, the questionnaire was originally developed in France and then used in several studies in Italy and in other countries outside Europe. Thus, taking into consideration cultural differences, the authors thought that using a European-origin questionnaire would be better. However, few modifications were needed to adapt to the Hungarian situation. Thus, the coming chapter presents a substudy that used the ICSQ to assess nurses' awareness of IC measures. Additionally, the substudy determined whether nurses educate their patients and family members on IC (from the nurses' perspective) and examined the effect of nurses' IC awareness on implementing patient and family education.

CHAPTER 4 Substudy 3 - Examining the Effect of Infection Prevention and Control Awareness among Nurses on Patient and Family Education: A Cross-sectional Study

4.1 INTRODUCTION

HAIs are major health issues recognized globally (88,219), as they negatively affect the quality of patient care (220). HAIs lead to increased morbidity and mortality (221) and are associated with elevated treatment costs (15,16). The ECDC estimates that 3.1-4.6 million patients acquire an HAI annually in acute care hospitals in European countries (33), while the 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 USA each year (3). The high prevalence of HAIs due to MDROs has continued to spread widely in healthcare settings (17), making HAIs a patient safety concern (145,199). In 2017, the overall incidence of MDR HAIs in Hungary was 29.35/100000 patient days (32).

Since HAIs are avoidable (15,221,222), preventing HAIs remains a main concern for healthcare settings (223,224) and is one of the highest priorities of modern medicine (225). IPC is one of the most effective interventions to prevent HAIs (17,226), which might result in a 70% reduction of this infection (227). The poor adherence of HCWs to IPC guidelines is the major cause of a high rate of HAIs (222). Attaining and preserving high levels of compliance with IPC are essential. Some studies have explored the barriers and opportunities to enhance compliance (5). 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 (5,17,226,228–230). Efforts should be continued to improve HCWs' knowledge to enhance compliance with IPC (17). 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 (17,231).

The CDC recommends assessing HCWs' knowledge and compliance with IPC practices periodically to control and avoid the transmission of HAIs (74). Several studies have assessed the level of HCWs, focusing on nurses' knowledge and awareness of IPC both in and outside Europe. Tavolacci et al. (97) conducted a study in France among 350 healthcare students using the ICSQ. An acceptable knowledge score was achieved in the overall IPC (21.5

of 30); however, the scores varied between IPC areas where SP and HH scores were acceptable, while HAIs' scores were not. In another study, D'Alessandro et al. (99) surveyed 1461 nursing and medical students using the ICSQ in Italy. Acceptable knowledge scores were achieved in overall IPC (18.1 of 25) and SP only.

Although HAI prevention approaches are mainly concentrated 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 (222,232,233). 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 (232). Furthermore, the CDC recommends patients' and family members' education on IPC 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 (74). Involving patients in IPC is challenging, given the diversity of hospitalized patients and their abilities to be involved (222). A recent systematic review (substudy one) on patient education on IPC measures revealed a low percentage of IPC education among hospitalized patients (199). Lack of knowledge and poor communication by HCWs have been reported as the prime obstacles to patient engagement (233). 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 study was also meant to address this gap by investigating the effect of nurses' awareness of IPC measures on implementing IPC patient and family education.

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 (168).

To our knowledge, no studies have been conducted in Hungary to assess nurses' awareness of IPC; additionally, none has been done to determine whether nurses are educating their patients and family members on IPC, which justifies the necessity for our study. Thus, 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.

4.2 METHODS

4.2.1 Study design, setting and sample

This study used a cross-sectional, multisite design. Because it was infeasible to reach all hospitals in Hungary, all hospitals located in the three counties (Baranya, Somogy, and Tolna) of the Southern Transdanubian region were invited to participate as research sites in this study. Specialized clinics were excluded. The approval was granted from seven hospitals: one was a university hospital, two were county hospitals, and another four were city hospitals. Regarding the geographical location, three hospitals were located in Baranya County, three in Tolna, and one in Somogy.

Concerning the inclusion and exclusion criteria for the participants, all nurses of the inpatient units were eligible to participate. Nurses working in the outpatient units were excluded since one of the study objectives was to assess hospitalized patients' and family members' education on IPC measures (from the nurses' perspective), particularly applicable to inpatient units such as isolation initiation and the use of PPE. Therefore, nurses working in internal medicine, infectious diseases, surgery, ICU, Cardiac Intensive Care Unit (CICU), Neonatal Intensive Care Unit (NICU), Pediatric Intensive Care Unit (PICU), OB-GYN, hematology, oncology, and pediatrics were invited to voluntarily participate. Printed questionnaires were handed over to the top management of each hospital after granting the hospital's approval. The nursing manager of each unit distributed the questionnaires to a convenience sample of nurses who were present (on duty) during the period of data collection. The questionnaires were returned to the nursing manager after completion. Three months later, the completed questionnaires were collected. Data collection started in February 2020 and ended in 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 was determined using the Thompson sample size equation (207). Taking a 0.5 estimated variability in the population, 0.05 margin of error, 1.96 z score (at 95% CI), and population size of 46125 nurses (234) representing the total number of nurses

employed in the Hungarian health system, the needed sample size was 381 nurses. The researchers expected a low response rate due to the COVID-19 situation and the extreme nursing work overload; thus, 810 questionnaires were distributed to reach the required sample size.

4.2.2 Data collection tool

The study used a modified version of the ICSQ developed by Tavolacci et al. (97). Approval for using the questionnaire was obtained from Cambridge University Press. The first part of the questionnaire focused on demographics (gender, age, hospital type, department, educational degrees, years of service, and training attended in IPC), 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, question 1A, 1B, and 1C), HH (eight questions, question 3A, 3B, 3C, and 3D, and question 6A, 6B, 6C, and 6D), and SPs (12 questions, question 2A, 2B, 2C, and 2D, question 4A, 4B, 4C, and 4D, and question 5A, 5B, 5C, and 5D). 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. (97). 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 (categorical) 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 (patient and family education part) (74). 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 (IPC expert and a physician), content validity was assessed by a panel of four expert members: an IPC expert, a physician, and two nurses. All members accepted the proposed questions.

Translation (English to Hungarian) and back-translation (Hungarian to English) were performed as per the translation and validation guidelines (198). The details of the translation process are presented in the next chapter (substudy four). 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 (97) and a Cronbach's alpha of 0.704 (patients and family education part), both showing good reliability coefficients.

4.2.3 Data analysis

The collected data were analyzed using SPSS version 20. 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 (χ^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 (HAIs, HH, and SPs). The following variables were introduced in the logistic regression: gender, age, hospital type, nursing unit, educational degrees, and years of service. The significance level was set at $p< 0.05$. To manage missing data, partially completed questionnaires were disregarded.

4.2.4 Ethical considerations

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. All nurses were informed that participation was optional and were assured of the confidentiality and anonymity of the data.

4.3 RESULTS

4.3.1 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. The mean (±SD) age 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. **Table 6** presents the detailed demographics of the participants.

Table 6 Demographic characteristics of nurses (N= 566)

Demographics	Number of participants n (%)
Gender	
Female	519 (91.7)
Male	47 (8.3)
Hospital type	
University	90 (15.9)
County	308 (54.4)
City	168 (29.7)
Department	
Medicine	120 (21.2)
Infectious diseases	78 (13.8)
Surgery	104 (18.4)
ICU	37 (6.5)
CICU	24 (4.2)
NICU-PICU	20 (3.5)
OB-GYN	70 (12.4)
Hematology	21 (3.7)
Oncology	40 (7.1)
Pediatrics	52 (9.2)
Educational degree	
University nursing degree	94 (16.6)
Vocational nursing training (OKJ)	367 (64.8)
Secondary school	105 (18.6)
Years of service at the hospital	
<1 year	29 (5.1)
[1-5] years	104 (18.4)
[6-10] years	92 (16.3)
>10 years	341 (60.2)
Infection prevention and control attended training subject	
Hand hygiene	493 (87.1)
Use of personal protective equipment	466 (82.3)
Healthcare-associated infections	308 (54.4)
Standard precautions	267 (47.2)
Isolation precautions	250 (44.2)
Managing hospital blood/body fluid spills	220 (38.9)

ICU, intensive care unit; CICU, cardiac intensive care unit; NICU-PICU, neonatal intensive care unit-pediatric intensive care unit; OB-GYN, obstetrics-gynecology.

4.3.2 IPC awareness

The results of the 23 IPC questions (ICSQ) are shown in **Table 7**.

Table 7 The ICSQ including the 23 IPC awareness questions and the responses of nurses who gave correct answers (N= 566)

Question	Correct answer	Nurses with correct answers n (%)
1. Healthcare-associated infections		
A. The environment (air, water, inert surfaces) is the major source of bacteria responsible for nosocomial infection.	False	244 (43.1)
B. Advanced age or very young age increases the risk of nosocomial infection.	True	278 (49.1)
C. Invasive procedures increase the risk of nosocomial infection.	True	549 (97.0)
2. Standard precautions		
A. Include the recommendations to protect only the patients.	False	542 (95.8)
B. Include the recommendations to protect the patients and the healthcare workers.	True	547 (96.6)
C. Apply for all patients.	True	431 (76.1)
D. Apply for only healthcare workers who have contact with body fluids.	False	519 (91.7)
3. When is hand hygiene recommended?		
A. Before or after a contact with (care of) a patient.	False	416 (73.5)
B. Before and after a contact with (care of) a patient.	True	556 (98.2)
C. Between patient contacts.	True	501 (88.5)
D. After the removal of gloves.	True	490 (86.6)
4. The standard precautions recommend use of gloves:		
A. For each procedure.	False	95 (16.8)
B. When there is a risk of contact with the blood or body fluid.	True	519 (91.7)
C. When there is a risk of a cut.	True	443 (78.3)
D. When healthcare workers have a cutaneous lesion.	True	517 (91.3)
5. When there is a risk of splashes or spray of blood and body fluids, the healthcare workers must wear:		
A. Only mask.	False	520 (91.9)
B. Only eye protection.	False	525 (92.8)
C. Only a gown.	False	518 (91.5)
D. Mask, goggles, and gowns.	True	545 (96.3)
6. What are the indications for the use of alcohol-based hand rub (on unsoiled hands)?		
A. Instead of a traditional handwashing (30 seconds).	True	226 (39.9)
B. Instead of an antiseptic handwashing (30 seconds).	True	229 (40.5)
C. Instead of surgical handwashing (3 minutes).	True	48 (8.5)
D. A traditional handwashing must be done before handwashing with alcohol-based hand rub.	False	190 (33.6)

The mean scores of the overall awareness and the three IPC areas, in addition to the frequencies and percentages of respondents with high and low awareness of each area, are presented in **Table 8**.

Table 8 IPC awareness results of nurses (N= 566)

Infection prevention and control area	Mean ± standard deviation	Participants with acceptable/high awareness n (%)	Participants with nonacceptable/low awareness n (%)
Overall awareness	16.69 ± 2.504	349 (61.7)	217 (38.3)
Healthcare-associated infections	1.89 ± 0.722	110 (19.4)	456 (80.6)
Hand hygiene	4.69 ± 1.403	168 (29.7)	398 (70.3)
Standard precautions	10.11 ± 1.509	472 (83.4)	94 (16.6)

The mean scores are the average awareness scores of the 566 nurses in each IPC area.

Acceptable/high awareness of each area was set at a score ≥ 70%.

4.3.3 Patients' and family members' 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 results of education on different IPC measures are presented in **Table 9**.

Table 9 Patients' and family members' education on IPC (N= 566)

Infection prevention and control education	Number of participants n (%)
I educate my patients and their family members on infection prevention and control measures	431 (76.1)
I educate my patients and their family members on:	
Hand hygiene	407 (71.9)
Respiratory hygiene/cough etiquette	324 (57.2)
The reason for isolation	209 (36.9)
The use of personal protective equipment	247 (43.6)
The risks of acquiring healthcare-associated infections	236 (41.7)
Barriers to educating patients and family members on infection prevention and control:	
Work overload/nursing shortage	381 (67.3)
No enough time	354 (62.5)
Stress	98 (17.3)
Demotivation	33 (5.8)
I believe it is not important to educate patients and family members on infection prevention and control measures	11 (1.9)
Other barriers	106 (18.7)

4.3.4 Variance analysis (IPC awareness score)

The Shapiro-Wilk test results showed that the data (IPC awareness score) were not normally distributed, so nonparametric tests were used to assess the variance across demographics, as shown in **Table 10**. The overall mean awareness did not significantly differ across gender, age, and hospital type. However, it differed across nursing units (p= 0.029), where 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).

Table 10 Nurses' IPC total awareness score across demographic characteristics (N= 566)

Demographics	Mean rank	*P*-value
Gender†		
Female	285.13	0.425
Male	265.46	
Age‡		
[20-29] years	275.32	0.808
[30-39] years	273.45	
[40-49] years	289.33	
≥ 50 years	286.36	
Hospital type‡		
University	289.83	0.339
County	274.56	
City	296.50	
Department‡		
Medicine	304.71	**0.029**
Infectious diseases	255.58	
Surgery	276.03	
ICU	338.04	
CICU	292.04	
NICU-PICU	315.28	
OB-GYN	252.82	
Hematology	238.45	
Oncology	249.23	
Pediatrics	322.26	
Educational degree‡		
University nursing degree	364.36	**<0.001**
Vocational nursing training (OKJ)	280.62	
Secondary school	258.01	

Years of service at the hospital‡		
<1 year	241.50	**0.026**
[1-5] years	251.77	
[6-10] years	275.40	
>10 years	298.94	

†Mann-Whitney U test and ‡Kruskal-Wallis test were used for the comparison.

ICU, intensive care unit; CICU, cardiac intensive care unit; NICU-PICU, neonatal intensive care unit-pediatric intensive care unit; OB-GYN, obstetrics-gynecology.

4.3.5 Logistic regression analysis

Table 11 presents the results of 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.

Table 11 Logistic regression analysis of factors associated with high awareness of each IPC area (N= 566)

	Infection prevention and control total awareness		Healthcare-associated infections		Hand hygiene		Standard precautions	
Predictors	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Gender-female	0.751	0.412-1.371	1.132	0.545-2.354	1.006	0.523-1.932	0.343	0.179-0.656
Age	0.997	0.980-1.014	1.014	0.993-1.035	1.008	0.991-1.026	1.001	0.979-1.023
University hospital	Reference							
County hospital	0.871	0.536-1.415	0.657	0.374-1.154	1.270	0.727-2.218	1.083	0.575-2.042
City hospital	1.016	0.597-1.728	0.784	0.426-1.444	2.265	1.261-4.067 **	0.884	0.449-1.741
<1 year	Reference							
[1-5] years	1.224	0.536-2.793	1.053	0.321-3.458	0.779	0.317-1.918	1.704	0.656-4.425
[6-10] year	1.520	0.655-3.525	1.028	0.307-3.441	0.829	0.333-2.062	1.681	0.637-4.432
>10 years	1.654	0.773-3.541	1.854	0.626-5.487	1.016	0.448-2.305	2.217	0.931-5.281
University nursing degree	Reference							
Vocational nursing training (OKJ)	0.281	0.156-0.507 ***	0.661	0.393-1.110	0.543	0.339-0.868 *	0.271	0.106-0.695 **
Secondary school	0.179	0.092-0.351 ***	0.275	0.125-0.608 **	0.488	0.268-0.889 *	0.171	0.063-0.466 **
Medicine	Reference							
Infectious diseases	0.534	0.297-0.959 *	0.545	0.260-1.144	0.697	0.378-1.284	0.633	0.304-1.320
Surgery	0.740	0.428-1.280	0.429	0.210-0.874 *	1.000	0.581-1.720	0.658	0.331-1.308
ICU	1.003	0.457-2.204	1.826	0.835-3.993	1.014	0.474-2.170	0.756	0.289-1.982
CICU	0.802	0.323-1.994	1.000	0.363-2.751	0.833	0.330-2.103	0.882	0.270-2.885
NICU-PICU	0.894	0.331-2.419	2.000	0.747-5.358	0.714	0.256-1.991	1.588	0.339-7.441
OB-GYN	0.642	0.349-1.179	0.500	0.228-1.098	0.215	0.094-0.490 ***	0.947	0.419-2.140
Hematology	0.438	0.171-1.118	0.316	0.069-1.436	0.278	0.077-0.996 *	3.529	0.445-27.968
Oncology	0.588	0.283-1.222	0.158	0.036-0.694 *	0.354	0.144-0.866 *	0.706	0.281-1.776
Pediatrics	1.444	0.693-3.012	1.000	0.472-2.120	0.676	0.334-1.367	2.118	0.680-6.598

*p< 0.05, **p< 0.01, ***p< 0.001. OR, odds ratio; CI, confidence interval; ICU, intensive care unit; CICU, cardiac intensive care unit; NICU-PICU, neonatal intensive care unit-pediatric intensive care unit; OB-GYN, obstetrics-gynecology. High awareness of each area was set at a score ≥ 70%.

4.3.6 Variance analysis (patient and family education on IPC)

Table 12 shows the results of variance in IPC patient and family education across nurses' demographics. Only significant differences in patient education across the independent variables (demographics) are presented in this table. 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, NICU-PICU, and oncology departments (p< 0.001).

Table 12 Patients' and family members' education on IPC among nurses' demographic characteristics (N= 566)

Demographics	I educate my patients and their family members on **Yes** n (%)	**No** n (%)	*P*-value
	Hand hygiene		
Hospital type			
University hospital	61 (67.8)	29 (32.2)	**<0.001**
County hospital	244 (79.2)	64 (20.8)	
City hospital	102 (60.7)	66 (39.3)	
	Respiratory hygiene/cough etiquette		
Hospital type			
University hospital	52 (57.8)	38 (42.2)	**0.002**
County hospital	194 (63.0)	114 (37.0)	
City hospital	78 (46.4)	90 (53.6)	
	The reason for isolation		
Hospital type			
University hospital	46 (51.1)	44 (48.9)	**0.003**
County hospital	113 (36.7)	195 (63.3)	
City hospital	50 (29.8)	118 (70.2)	
Educational degree			
University degree	46 (48.9)	48 (51.1)	**0.029**
Vocational training (OKJ)	128 (34.9)	239 (65.1)	
Secondary school	35 (33.3)	70 (66.7)	

Years of service			
<1 year	7 (24.1)	22 (75.9)	**0.033**
[1-5] years	29 (27.9)	75 (72.1)	
[6-10] years	32 (34.8)	60 (65.2)	
>10 years	141 (41.3)	200 (58.7)	
	The use of personal protective equipment		
Hospital type			
University hospital	46 (51.1)	44 (48.9)	**0.001**
County hospital	147 (47.7)	161 (52.3)	
City hospital	54 (32.1)	114 (67.9)	
	The risks of acquiring healthcare-associated infections		
Hospital type			
University hospital	36 (40)	54 (60)	**<0.001**
County hospital	152 (49.4)	156 (50.6)	
City hospital	48 (28.6)	120 (71.4)	
Department			
Medicine	45 (37.5)	75 (62.5)	**<0.001**
Infectious	25 (32.1)	53 (67.9)	
Surgery	42 (40.4)	62 (59.6)	
ICU	4 (10.8)	33 (89.2)	
CICU	6 (25)	18 (75)	
NICU-PICU	13 (65)	7 (35)	
OB-GYN	33 (47.1)	37 (52.9)	
Hematology	16 (76.2)	5 (23.8)	
Oncology	23 (57.5)	17 (42.5)	
Pediatrics	29 (55.8)	23 (44.2)	

The chi-square (X^2) test was used for the comparison. ICU, intensive care unit; CICU, cardiac intensive care unit; NICU-PICU, neonatal intensive care unit-pediatric intensive care unit; OB-GYN, obstetrics-gynecology.

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 (p= 0.001) and the reason for isolation (p= 0.019), as shown in **Table 13**.

Table 13 Patients' and family members' education on IPC among different awareness groups of nurses (N= 566)

Nurses' infection prevention and control overall awareness	I educate my patients and their family members on **Yes** n (%)	 **No** n (%)	*P*-value
	Infection prevention and control measures		
High awareness	275 (78.8)	74 (21.2)	0.061
Low awareness	156 (71.9)	61 (28.1)	
Total	431	135	
	Hand hygiene		
High awareness	257 (73.6)	92 (26.4)	0.245
Low awareness	150 (69.1)	67 (30.9)	
Total	407	159	
	Respiratory hygiene/cough etiquette		
High awareness	219 (62.8)	130 (37.2)	**0.001**
Low awareness	105 (48.4)	112 (51.6)	
Total	324	242	
	The reason for isolation		
High awareness	142 (40.7)	207 (59.3)	**0.019**
Low awareness	67 (30.9)	150 (69.1)	
Total	209	357	
	The use of personal protective equipment		
High awareness	161 (46.1)	188 (53.9)	0.129
Low awareness	86 (39.6)	131 (60.4)	
Total	247	319	
	The risks of acquiring healthcare-associated infections		
High awareness	149 (42.7)	200 (57.3)	0.542
Low awareness	87 (40.1)	130 (59.9)	
Total	236	330	

The chi-square (X^2) test was used for the comparison.

4.4 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. (99) and Tavolacci et al. (97). Nevertheless, awareness varied across the IPC areas where the SPs score was only acceptable, which is similar to the findings by Brosio et al. (98) and D'Alessandro et al. (99). We believe that the high scores of the total IPC and SP 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 (235,236). Similarly, other studies have revealed that HCWs involved in caring for patients during epidemics (SARS coronavirus 2 and EVD) faced increased distress related to fear of being infected and spreading the disease (235,237,238). 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 (239). IPC practices have been recommended by the CDC for many years as a means of preventing disease outbreaks and ensuring HCW safety (210). Since SPs are considered the main strategy to ensure the safety of HCWs (74), 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 SP scores, our results show scores that fail to meet the expectations since the HAI and HH awareness scores were not acceptable. The results showed that nurses were not aware that the environment is not the major source of bacteria responsible for HAIs and that advanced age or very young age increases the risk of HAIs (Questions 1A and 1B). Moreover, the results revealed that nurses were not aware of the indications for the use of Alcohol-based Hand Rub (ABHR) on unsoiled hands instead of traditional handwashing (Questions 6A, 6B, 6C, and 6D). 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 (64) that determines IPC practices in healthcare institutions in Hungary and the handbook of Hungarian healthcare standards (66), acceptable scores were not achieved in HAIs and HH. Given the importance of HAIs as a major threat to patient safety (145,220) 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 (15), nurses' knowledge of HAIs and HH should still be improved.

The results showed that nurses working in the ICU had the highest mean rank of 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 (17). 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 (17). 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. (240). This finding can be explained by IPC practices not being emphasized similarly in the core curriculum in vocational training institutions and university curricula (210,240).

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. (168), while the lowest was on the reason for isolation (36.9%), unlike the results of Hammoud et al. (168), 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 (241,242). Nevertheless, our findings could not be considered promising since the education on other IPC measures; the reason for isolation, the use of PPE, and HAIs and their risks were all below 50%, although educating patients and family members on the prevention of infections, with giving high attention to high-risk patients, was mentioned in the Hungarian inpatient and outpatient accreditation standards (67). 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 (221). 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 (222). However, this involvement is sometimes ineffective unless patients are encouraged to do these tasks (203). Seale et al. (243) showed that patients often felt intimidated, shy, or embarrassed about being engaged with HCWs in various hygiene measures. 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' engagement in and 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.

4.4.1 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. Additionally, studies assessing IPC education from the patients' and family members' perspectives are encouraged. 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.

4.4.2 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.

4.5 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 members' 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 as a way to maintain patient safety (215).

In the previous chapter (substudy three), we used the ICSQ to assess nurses' awareness of IPC measures. However, due to the slow data collection process as a result of the restrictions applied in Hungarian hospitals during the COVID-19 pandemic, we were unable to validate the tool used through factor analysis prior to publishing the previous substudy, since a larger sample size was preferred for conducting factor analysis. Thus, the validation process was left until the end after the data collection was finished. Hence, the coming chapter presents the results of assessing the validity and reliability of the tool used through factor analysis.

CHAPTER 5 Substudy 4 - Translation and Validation of the Hungarian Version of the Infection Control Standardized Questionnaire: A Cross-sectional Study

5.1 INTRODUCTION

IPC is one of the most cost-effective interventions to prevent the transmission of HAIs (226) and disease outbreaks and to ensure the safety of HCWs (96). The proper implementation of IPC measures may result in a 70% reduction in HAIs (227). IPC practices have been present in different forms for decades. UPs were first introduced by the CDC in the early 1980s after the identification of acquired immunodeficiency syndrome as a means of ensuring HCW safety. In 1996, UPs were replaced by SPs after being revised. Later, IPC guidelines were updated several times as a result of several disease outbreaks (244). For instance, respiratory hygiene/cough etiquette was added after the emergence of the SARS epidemic in 2003. Furthermore, safe injection practices were included after the continued outbreaks of hepatitis B and C (244). Afterward, the guidelines were further updated after the 2014 EVD outbreak in West Africa (73).

Implementing IPC measures is a mandatory requirement in all healthcare institutions, yet despite policies and procedures to impose their practice, HCWs' compliance with IPC remains substandard (244). Poor knowledge of IPC is the main reason for the low adherence of HCWs to IPC practices. Other common reasons are organizational barriers, insufficient supplies, time limits, poor experience, inadequate training, and poor self-efficacy (5,17,229,230,244). Attempts should be continued to enhance the knowledge of HCWs on IPC to ensure higher compliance with IPC practices. Efforts should focus on nurses, who play a vital role in controlling and preventing the transmission of HAIs (17), which have detrimental effects on patient safety (199).

A recent systematic review on nurses' knowledge and practice of IPC measures reported a lack of investigation of the validity and reliability in most of the included studies (218). Given this premise, a valid and reliable tool is required to assess nurses' knowledge about IPC measures. The ICSQ is an instrument that was developed by Tavolacci et al. (97) to measure IPC knowledge among HCWs, including nurses. The ICSQ assesses knowledge about SPs, including their indications, and the use of PPE (gloves, masks, gowns), as well as

knowledge about HH and ABHR indications and HAIs. Unlike other instruments that were used in former related studies that utilized the concept of UPs in measuring knowledge about the present IPC practices (92,96), the ICSQ is more specific in assessing the knowledge of HCWs about SPs and other IPC practices (97). Additionally, the ICSQ has been used in several studies, including developed (98,99,101,105) and developing countries (103,104,106), given its international applicability because of its original English language form and its global relevance. However, to our knowledge, neither study provided any psychometric properties beyond Cronbach's alpha.

To our knowledge, no studies have been conducted to assess IPC knowledge or awareness among nurses in Hungary, aside from our two published studies as a part of this Ph.D. research (210,215). It is important, therefore, to establish a validated Hungarian version of the ICSQ (ICSQ-H) to facilitate a more comprehensive and precise measurement of knowledge about IPC among nurses in Hungary, given that Hungarian is the official language in Hungary. Furthermore, this tool may act as a basis for planning and performing interventions to enhance IPC knowledge. It will also ease more research concerning IPC knowledge to be conducted in Hungary, especially because, to our knowledge, there are no validated Hungarian tools to assess HCWs' knowledge about IPC practices. Thus, the aim of this study was to assess the validity and reliability of the ICSQ-H in Hungarian nurses.

5.2 METHODS

5.2.1 Study design and setting

This was a cross-sectional, multisite study. Seven hospitals from three counties of the Southern Transdanubian region (Baranya, Somogy, and Tolna) of Hungary were included in this study.

5.2.2 The questionnaire

The study used the ICSQ developed by Tavolacci et al. (97). Approval for using the questionnaire was granted by Cambridge University Press. The questionnaire included two parts. The first part was meant to collect demographic information of the study participants, including age, gender, hospital, county, nursing department, educational degree, and years of experience. The second part involved 25 true/false questions regarding nurses' awareness of three IPC topics: HAIs (five questions), HH (eight questions), and SPs (12 questions). The response to each question was coded and counted as not aware (0) and aware (1), where a

maximum score of 25 was achievable for those who answered 25 correct questions. Additionally, an acceptable awareness score was set at 70% for each IPC topic as well as the total IPC awareness as per the original questionnaire (97).

5.2.3 Translation

The translation of the ICSQ was performed following the recommended guidelines of translation, adaptation and validation of instruments for use in cross-cultural healthcare research (198). The ICSQ was independently translated by two bilingual Hungarian nationals. Both were Ph.D. candidates in the health sciences and experts in the healthcare domain. The two Hungarian translated versions were reviewed and combined to produce a single version. This step was performed by a committee approach. Then, the synthesized Hungarian version was independently back-translated to English by two other bilingual Ph.D. candidates. Afterward, the two back-translated English versions were assessed by two individuals who synthesized them to produce a single back-translated Hungarian version. The first was a physician, while the second was a linguistic associate professor. Both had good knowledge of health terminology and IPC. First, the two back-translated versions were compared, and then they were compared against the original English version. This comparison was meant to assess similarities of the instrument questions, their wording, structure, meaning, and appropriateness.

5.2.4 Content validity

The original ICSQ and the ICSQ-H were presented to a panel expert consisting of four members. The panel included an IPC specialist, a physician, and two nurses. The panel assessed the content validity of the ICSQ-H. Content validity was established by calculating the Item Content Validity Index (I-CVI) and Scale Content Validity Index (S-CVI/Ave) (245). As per Davis (246), a 4-point scale was used to rate the relevance of each item as follows: 1= not relevant, 2= somewhat relevant, 3= quite relevant, and 4= highly relevant. Then, for each item, the I-CVI was calculated as the number of experts giving a rating of either three or four divided by the total number of experts. The S-CVI/Ave was calculated as the average of I-CVIs by summing them and dividing by the number of items (245). An I-CVI= 1 for a panel with ≤ 5 members (247) and an S-CVI/Ave$\geq$ 0.90 were acceptable (245). 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.

5.2.5 Sample size

In general, it is recommended to use a minimum of 10 participants per item of the instrument scale in the case of Exploratory Factor Analysis (EFA), which is equivalent to 250 participants in our case. However, in the case of EFA and Confirmatory Factor Analysis (CFA), the recommendation is approximately 300-500 participants (198). Based on this, we decided to include at least 500 nurses. Therefore, 810 questionnaires were distributed since we expected a low response rate due to the COVID-19 pandemic.

5.2.6 Participants and data collection

Inclusion criteria for participation in this study included nurses who were working in inpatient units, including internal medicine, infectious diseases, surgery, critical care units, OB-GYN, hematology, oncology, and pediatrics, and who were willing to complete the questionnaire. To reduce nonresponse bias, hard copies of the questionnaires were distributed instead of online questionnaires. The head nurse of each unit administered the questionnaires to a convenience sample of nurses who were on schedule throughout the data collection period. Three months later, the completed questionnaires were collected by the researcher. Data collection was initiated in February 2020 and completed in May 2021.

5.2.7 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 (248), 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) (249). 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 (250). The rotated component matrix, scree plot, and parallel analysis were used to confirm the accurate number of factors to be retained (249).

In step two, a confirmative approach was adopted to validate the factor structure using the Analysis of Moment Structures (AMOS) program 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 (χ^2/df ratio < 3) with an insignificant *p*-value (> 0.05) (251).

Convergent and discriminant validities were evaluated using the Fornell and Larcker criterion (252). 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 (253). Additionally, discriminant validity was met when the square root of the AVE had a greater value than the correlations with other latent constructs (252,254).

The interitem correlations and the corrected item-total correlations were calculated. The interitem correlation shows the degree to which the items of the scales were related within the scales. A correlation between 0.2 and 0.85 was considered to indicate good consistency (255). Correlations above 0.85 were considered redundant. Corrected item-total correlations are correlations between the scores from that question and the average scores of the other questions. A value ≥ 0.3 was considered acceptable (255). Additionally, the internal consistency was evaluated by calculating Cronbach's alpha. A value > 0.6 was considered sufficient (256).

5.2.8 Ethical considerations

This study was approved by the Regional Research Ethics Committee of the Medical Center, Pécs, Hungary (Record number: 7862 - PTE 2019). Before distributing the questionnaires, nurses were informed that their participation was voluntary and anonymous. All nurses signed written, informed consent forms.

5.3 RESULTS

5.3.1 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. Out of all nurses, 91% were females, and 16.8% had a university nursing degree. The detailed demographics of the participants of both the PCA and CFA samples are shown in **Table 14**.

Table 14 Demographic characteristics of nurses

Demographic	Total sample N= 591 n (%)	PCA sample N= 355 n (%)	CFA sample N= 236 n (%)
Gender			
Female	538 (91)	335 (94.4)	203 (86)
Male	53 (9)	20 (5.6)	33 (14)
Hospital type			
University	90 (15.2)	52 (14.6)	38 (16.1)
County	308 (52.1)	183 (51.5)	125 (53)
City	193 (32.7)	120 (33.8)	73 (30.9)
County			
Baranya	209 (35.4)	118 (33.2)	91 (38.6)
Tolna	204 (34.5)	144 (40.6)	60 (25.4)
Somogy	178 (30.1)	93 (26.2)	85 (36.0)
Department			
Medicine	137 (23.2)	86 (24.2)	51 (21.6)
Infectious diseases	78 (13.2)	40 (11.3)	38 (16.1)
Surgery	104 (17.6)	60 (16.9)	44 (18.6)
Critical care units	89 (15.1)	51 (14.4)	38 (16.1)
Obstetrics-Gynecology	70 (11.8)	39 (11)	31 (13.1)
Hematology-Oncology	61 (10.3)	39 (11)	22 (9.3)
Pediatrics	52 (8.8)	40 (11.3)	12 (5.1)
Educational degrees			
University nursing degree	99 (16.8)	70 (19.7)	29 (12.3)
Vocational nursing training (OKJ)	383 (64.8)	226 (63.7)	157 (66.5)
Secondary school	109 (18.4)	59 (16.6)	50 (21.2)
Age	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
	41.93 ± 10.262	46.63 ± 7.425	34.86 ± 9.893

PCA, principal component analysis; CFA, confirmatory factor analysis; SD, standard deviation.

5.3.2 Content validity

After calculating the I-CVIs for each item in the ICSQ (25 items), 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. **Table 15** presents the detailed calculations of the I-CVI and S-CVI/Ave.

Table 15 Computation of the I-CVI and S-CVI/Ave with four expert raters

Items	**Expert 1** Infection prevention and control specialist	**Expert 2** Physician	**Expert 3** Nurse	**Expert 4** Nurse	Number in agreement of relevance	I-CVI
Q 1A	X	X	X	X	4	1
Q 1B	X	X	X	X	4	1
Q 1C	X	X	X	X	4	1
Q 1D	-	-	X	-	1	0.25*
Q 1E	-	-	X	-	1	0.25*
Q 2A	X	X	X	X	4	1
Q 2B	X	X	X	X	4	1
Q 2C	X	X	X	X	4	1
Q 2D	X	X	X	X	4	1
Q 3A	X	X	X	X	4	1
Q 3B	X	X	X	X	4	1
Q 3C	X	X	X	X	4	1
Q 3D	X	X	X	X	4	1
Q 4A	X	X	X	X	4	1
Q 4B	X	X	X	X	4	1
Q 4C	X	X	X	X	4	1
Q 4D	X	X	X	X	4	1
Q 5A	X	X	X	X	4	1
Q 5B	X	X	X	X	4	1
Q 5C	X	X	X	X	4	1
Q 5D	X	X	X	X	4	1
Q 6A	X	X	X	X	4	1
Q 6B	X	X	X	X	4	1
Q 6C	X	X	X	X	4	1
Q 6D	X	X	X	X	4	1
S-CVI/Ave (after deleting Q 1D and 1E)						1

I-CVI, item content validity index; S-CVI/Ave, scale content validity index average.

- Ratings of 1= not relevant, 2= somewhat relevant. X Ratings of 3= quite relevant, 4= highly relevant. *I-CVI< 1 (item was deleted).

5.3.3 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 (χ^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). Q 3C was removed from construct one due to low interitem correlation. Additionally, construct four included two items; Q 2A and Q 2D were removed due to low interitem correlation, corrected item-total correlation, and construct alpha. Furthermore, Q 3A was removed from component five, and Q 1A and Q 4A were removed from component six due to low interitem correlation, corrected item-total correlation, and alpha construct. Finally, Q 3B was removed from construct two due to low interitem correlation.

Therefore, 11 items were deleted from the ICSQ. The remaining 12 items loaded on the following five constructs: use of gloves (GLVS), use of PPE, ABHR indications on unsoiled hands, SPs, and HAIs, which are presented in **Table 16**.

Table 16 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. We evaluated the goodness of fit model by means of fit indices using AMOS software. 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: χ^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 five-factor model showed a poor model fit (χ^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 (χ^2/df= 1.183; p= 0.231, GFI= 0.972, CFI= 0.994, TLI= 0.990, RMSEA= 0.028, SRMR= 0.0315). The standardized factor loadings of the items ranged from 0.46 to 0.97. The final four-factor model with the item loadings is shown in **Figure 2**.

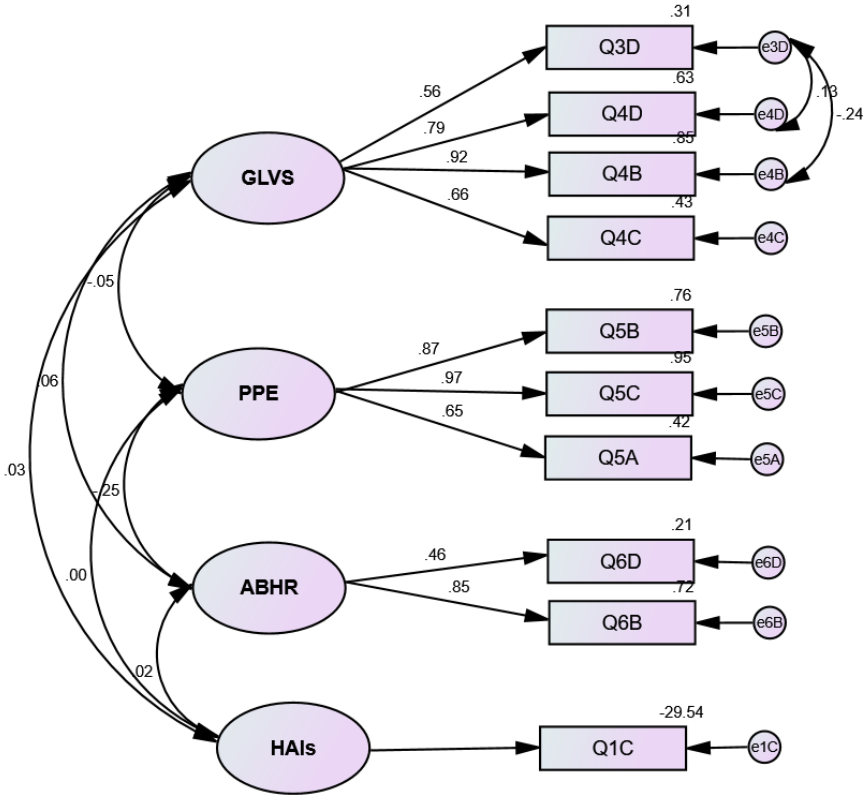

Figure 2 CFA of the four-factor model of the ICSQ-H.

GLVS, use of gloves; PPE, use of personal protective equipment; ABHR, alcohol-based hand rub indications on unsoiled hands; HAIs, healthcare-associated infections.

5.3.4 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, as shown in **Table 17**. Additionally, weak correlations (r< 0.3) were found between the four constructs.

Table 17 Convergent and discriminant validities of the four-construct ICSQ-H

Construct	**AVE**	GLVS	PPE	ABHR	HAIs
GLVS	0.555	**0.745**			
PPE	0.712	0.005	**0.844**		
ABHR	0.467	0.037	-0.181**	**0.683**	
HAIs	-	0.073	-0.024	0.141*	-

AVE, average variance extracted; GLVS, use of gloves; PPE, use of personal protective equipment; ABHR, alcohol-based hand rub indications on unsoiled hands; HAIs, healthcare-associated infections.

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed).

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

As shown in **Table 18**, 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.

Table 18 Interitem correlation, corrected item-total correlation, and internal consistency of constructs

Construct	Interitem correlation	Corrected item-total correlation	Nb of items	Cronbach's alpha
GLVS	0.309-0.756	0.479-0.722	4	0.780
PPE	0.681-0.844	0.721-0.845	3	0.897
ABHR	0.360	0.360	2	0.529
HAIs	-	-	1	-

GLVS, use of gloves; PPE, use of personal protective equipment; ABHR, alcohol-based hand rub indications on unsoiled hands; HAIs, healthcare-associated infections.

5.4 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. The original structure of the ICSQ (23 items) and the five-construct model suggested by the PCA did not meet the goodness of fit model requirements when tested for CFA. However, the final four-construct model (10 items) showed a good model fit where all the fit indices passed the requirements.

Our findings did not support the original three-construct structure of the ICSQ. However, it should be clarified that the three constructs (HAIs, HH, and SPs) that the original ICSQ evaluates are measured in our proposed Hungarian model (ICSQ-H) but with fewer items. For instance, the SP factor, including 12 items in the original ICSQ, was grouped into two factors in our model: the use of PPE and the use of GLVS, which measure the same parameter in the original questionnaire but with fewer items. Similarly, the HH factor, including eight items in the original ICSQ, can be found in our model as ABHR indications with two items, while another HH question was grouped with the GLVS factor, as it states the application of HH after removing gloves. Finally, in the original ICSQ, the HAI factor included five questions, while in our suggested model, it had only one item. We believe that failing to support the original structure of the ICSQ in our study could be due to the cultural and language differences between the French and Hungarian populations of nurses, as well as the difference in the policies and guidelines applied in the hospitals of the two countries, in addition to the differences in the educational systems and the curricula of nursing degrees that might affect the level of nurses' IPC knowledge.

Our χ^2/df was less than three with an insignificant *p*-value, which indicates a good model fit. However, there are some limitations for χ^2/df model use. The main limitation is having a small sample size where χ^2/df lacks power and might not be able to distinguish between good fitting models and poor fitting models (251,257). When having a large sample size, the χ^2/df model is exact, which is our case (257). Our results showed that GFI, CFI, and TLI values were above 0.95. Given the detrimental effect of the sample size on the GFI index, it is recommended to be used along with other indices that we took into account when conducting our study (251). For instance, CFI is one of the most used and recommended fit indices since it is among the measures least affected by sample size. Similarly, TLI is a fit index that is less affected by sample size. In this study, the values of both CFI and TLI indicated a good model fit (251). RMSEA has recently been suggested as one of the most informative fit indices since it is affected by the total count of the estimated parameters in the model. Until the early 1990s, a value between 0.05 and 1 was considered to reflect a fair model fit (251,258); however, in the late 1990s, a value less than 0.06 was recommended (251,259). Our model

showed a much lower RMSEA, which indicates the goodness of fit of the model. Additionally, SRMR is recommended for use since it is easier to interpret than other fit indices because of its standardized nature. Values closer to zero show a better fit, which is the case for our model (251).

Convergent validity was met for the GLVS and PPE constructs, which indicates a satisfactory level of correlation of multiple items of the same construct (254). 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 (253). Furthermore, it indicates that the latent constructs used for measuring the causal relationships in our model are actually different from each other and do not measure the same thing that could lead to multicollinearity (253).

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) (260).

Finally, the removal of 15 items during the different stages of this study (two items during content validity assessment, 11 items during PCA, and two items during CFA) 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 (261). However, the concise methodology that we have used allows for an adequate start to develop a Hungarian tool to assess IPC knowledge among the Hungarian population.

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. (262) 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 (ICC) by applying the test-retest method. The Kappa index was used for the purpose of agreement. The Portuguese QCSP showed satisfactory ICC and Kappa. However,

validation by discriminant groups did not reveal a statistically significant difference between the two groups. Similarly, the Infection Control Evaluation tool was developed by Wu et al. (96) 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 by six experts using the Content Validity Index (CVI), where an acceptable degree of validity was found, with 68% agreement. Kuder-Richardson 20 was used to test the internal consistency, which revealed a satisfactory value of 0.76. It is worth mentioning that this tool was based on two previously developed tools, mainly Chan et al. (92), who employed the concept of UPs in measuring knowledge. Another tool was developed by Chan et al. (263) in 2008 to examine nurses' knowledge of SPs and transmission-based precautions using four multiple-choice questions. Content validity was assessed by two experts with a CVI= 0.97. Structural validity was assessed using EFA. One factor was found to include four items with factor loadings ranging from 0.76 to 0.86. The scale reliability was assessed via test-retest. Cronbach's alpha showed an acceptable value (0.79). Finally, we noticed that only one study assessed the structural validity of the scale using EFA (263), while neither study performed CFA, which suggests that further research is needed to test the structural validity of these scales using EFA and CFA.

5.4.1 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 (university, county, and city) 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. Second, two factors in our model include fewer than three items. Generally, models containing more items per factor are preferred since they show more accurate parameter estimates and greater reliability. Nevertheless, the ICSQ-H could act as the first step in conducting more research on the development of Hungarian tools that assess nurses' IPC knowledge. 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.

5.4.2 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. On the other hand, our model includes two factors with less than three items, which is not optimal; however, these findings might be a start to think about having more research regarding developing a Hungarian tool to assess IPC knowledge among Hungarian nurses.

5.5 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. The ICSQ-H could contribute to conducting more research on the development of Hungarian tools that assess nurses' IPC knowledge among the Hungarian population. Further research is needed to test the psychometric properties of the ICSQ across different countries and languages.

CHAPTER 6 Summary of Novel Findings

1. Substudy 1:

1.1. Since patient education on IPC is poorly investigated worldwide, a systematic review was conducted following the PRISMA guidelines to be able to select the most appropriate data measurement tool for assessing patient education on IPC. A total of 6740 articles were first screened. Finally, 25 articles were included in the qualitative synthesis. Of them, only two studies assessed patient education on more than one IPC measure using developed questionnaires. The review concluded a low percentage of patient education on IPC.

2. Substudy 2:

2.1. A multisite, cross-sectional study was conducted in the Southern Transdanubian region of Hungary to assess patient and family education on IPC measures. A total of 412 patients and family members from seven hospitals were included. Based on the findings of substudy one, the questionnaire that was developed according to the CDC guidelines for isolation precautions, the part related to patient and family education, was selected to be used in this substudy.

2.2. The highest percentages of education were on respiratory hygiene (89.8%), HAIs (82.5%), and HH (82%). The results show a high level of patient and family education on IPC in Hungary compared to the literature, which might be due to the current COVID-19 situation where patient education became critical so that patients may aid in combating the virus. Education on almost all IPC measures significantly differed across counties. Additionally, education on HAIs, respiratory hygiene, and the distribution of fliers on HH and/or respiratory hygiene significantly varied across nursing units.

2.3. The results of the regression analysis showed that Baranya, Somogy, and Tolna counties were significant predictors of IPC education. 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.

2.4. To our knowledge, this was the first study to assess patient and family education on IPC in Hungary. Efforts are needed at the national and institutional levels to maintain the high percentage of IPC education in Hungary and for further improvements. Based

on our findings, we recommend adding patients' and family members' education on IPC to the existing government regulations that determine IPC practices in hospitals in Hungary. At the institutional level, hospitals are encouraged to enhance the environment of participation of patients and family members in IPC by involving them in discussions and allowing them to ask questions about the information provided.

3. Substudy 3:

3.1. A multisite, cross-sectional study was conducted in the Southern Transdanubian region of Hungary to assess nurses' awareness of IPC, assess patient and family education on IPC from the nurses' perspective, and examine the effect of nurses' IPC awareness on patient and family education. A total of 566 nurses from seven hospitals were included.

3.2. A total of 98.4% of nurses were trained on IPC measures at their current hospital, whereas 75.8% attended the training sessions during the last year. This high training percentage reflects the fact that Hungarian hospitals abide by the regular IPC training obligations as per the government regulation that determines IPC practices in healthcare institutions in Hungary.

3.3. Acceptable/high scores were reached in the IPC overall awareness (16.69 ± 2.504) and SPs (10.11 ± 1.509), while HH (4.69 ± 1.403) and HAI (1.89 ± 0.722) scores were not acceptable/low. The overall IPC mean awareness significantly differed across nursing units, educational degrees, and years of service.

3.4. The results of the regression analysis showed that educational degrees had a significant association with having a high awareness of IPC. Nurses holding a secondary school certificate and those holding a vocational nursing certificate were less likely to have a high awareness of IPC than nurses holding a university nursing degree. Thus, we recommend giving more attention to IPC practices in the curriculum in vocational training institutions in Hungary.

3.5. Concerning patient and family education from the nurses' perspective, nurses educated patients and family members the most on HH (71.9%) and respiratory hygiene (57.2%). Education on the other IPC measures was below 50%. The higher frequency of education on HH and respiratory hygiene is similar to the results of substudy two, where education was assessed from the patients' and family members' perspectives. This similarity in the results of the two substudies is promising and reflects the reliability of our findings. The percentage of education varied across hospital types, where the highest percentages of education were among nurses working at university

and county hospitals. Accordingly, we recommend emphasizing the importance of patient and family education on IPC among city hospitals.

3.6. Regarding the barriers to patient and family education, nurses' shortage (67.3%), time limits (62.5%), and stress (17.3%) were the most common barriers, as stated by nurses.

3.7. Concerning the main objective of our research, to examine the effect of nurses' awareness of IPC on patient and family education, 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 (p= 0.001) and the reason for isolation (p= 0.019).

3.8. 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. 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. We further recommend that hospitals motivate and encourage nurses to acquire high levels of IPC knowledge 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. Concerning the low percentage of patients' and family members' education on IPC, it might be enhanced by improving nurses' awareness of IPC and at the 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 as a way to maintain patient safety.

4. Substudy 4:

4.1. A multisite, cross-sectional study was conducted in the Southern Transdanubian region of Hungary to assess the validity and reliability of the ICSQ-H in Hungarian nurses using factor analysis. The study included 591 nurses from seven hospitals.

4.2. The final four-construct model (use of GLVS, use of PPE, ABHR indications on unsoiled hands, and HAIs), including 10 items, showed a good model fit, where all the fit indices passed the requirements (χ^2/df= 1.183; p= 0.231, GFI= 0.972, CFI= 0.994, TLI= 0.990, RMSEA = 0.028, SRMR= 0.0315).

4.3. Convergent validity was met for the GLVS and PPE constructs. 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.

4.4. The interitem correlations and the corrected item-total correlation were acceptable for all constructs. The internal consistency of the ABHR construct was below 0.6 due to the low number of items in this construct; however, its interitem correlations and the corrected item-total correlations were acceptable.

4.5. Our results show 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 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.

CHAPTER 7 List of Publications

7.1 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

7.2 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

7.3 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

7.4 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.

7.5 ABSTRACTS 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.

VALUE IN HEALTH June 2022. ISPORR 2022. Washington DC, USA.

Hammoud S, Amer F, Khatatbeh H, Kocsis B. Assessing Patient and Family Education on Infection Control in Hungary: A Cross-sectional Study.

In: Podolinská, Lucia; Madlenák, Jaroslav (eds.) 3rd International Conference of PhD Students of the Study Program Nursing. May 2022. Martin, Slovakia.

Hammoud S, Amer F, Kocsis B. Are Nurses Aware of Infection Prevention and Control Practices? A Descriptive Study from Hungary.

In: Molnár, Dániel; Molnár, Dóra (eds.) XXV. Tavaszi Szél Konferencia 2022. Absztraktkötet.

Budapest, Hungary: Association of Hungarian PHD and DLA Students (2022) pp. 1-797. Paper: 492, 1 p.

Hammoud S, Khatatbeh H, Zand A, Kocsis B. A survey of nurses' awareness of infection control measures in Baranya County, Hungary

In: Kajos, L F; Bali, C; Preisz, Z; Polgár, P; Glázer-Kniesz, A; Tislér, Á; Szabó, R (eds.), 10th INTERDISCIPLINARY DOCTORAL CONFERENCE 2021 BOOK OF ABSTRACTS. Pécs, Hungary: Doctoral Student Association of the University of Pécs (2021) 347 p. p. 249. 1 p.

Hammoud S, Patient Education on Infection Control: A Systematic Review.

In: International Webinar on Microbiology and Infectious Diseases (2021).

Hammoud S, Kocsis B. Patient Education on Infection Control in Pécs, Hungary: A Pilot Study

In: Csiszár, B; Hankó, Cs; Kajos, L F; Kovács, O B; Mező, E; Szabó, R; Szabó-Guth, K (eds.) IX. INTERDISZCIPLINÁRIS DOKTORANDUSZ KONFERENCIA 2020 ABSZTRAKTKÖTET: 9th INTERDISCIPLINARY DOCTORAL CONFERENCE 2020 BOOK OF ABSTRACTS

Pécs, Hungary: Doctoral Student Association of the University of Pécs (2020) 384 p. p. 56, 1 p.

Hammoud S, Kocsis B. The Effect of Nurses' Awareness of Infection Control Measures on Patient and Family Education

HeilberufeScience 10: 1-2 p. S9, 1 p. (2019).

Hammoud S, Ghazi B, Nassredine M, Abou Haidar M, Kocsis B. Nurses' Awareness of Infection Control in Lebanon: A Cross Sectional Survey

In: Csiszár, Beáta; Bódog, Ferenc (eds.) Medical Conference for Ph.D. Students and Experts of Clinical Sciences: Book of abstracts

Pécs, Hungary: Doctoral Student Association of the University of Pécs (2019) 87 p. p. 47, 1 p.

Hammoud S, Ghazi B, Nassredine M, Abou Haidar M, Kocsis B. Nurses' Awareness of Infection Control Measures

In: Németh, Katalin (eds.) Tavaszi Szél 2019 Konferencia. Nemzetközi Multidiszciplináris Konferencia: Absztraktkötet

Budapest, Hungary: Association of Hungarian Ph.D. and DLA Students (2019) 742 p. pp. 535, 1 p.

7.6 ADDITIONAL ABSTRACTS “HEALTH SCIENCES”

Hammoud S, Onchonga D, Amer F, Kocsis B. The Burden of Communicable Diseases in Lebanon: Trends in the Last Decade

In: Csiszár, Beáta; Hankó, Csilla; Kajos, Luca Fanni; Mező, Emerencia (eds.) Medical Conference for Ph.D. Students and Experts of Clinical Sciences 2021: Book of Abstracts.

Pécs, Hungary: Doctoral Student Association of the University of Pécs (2021) 128 p. p. 18, 1 p.

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.

VALUE IN HEALTH June 2022. ISPORR 2022. Washington DC, USA.

Amer F, **Hammoud S**, Khatatbeh H, Lohner S, Boncz I, Endrei D. A Systematic Review: Which Dimensions to Employ in the Performance Evaluation of Health Care Organizations.

In: Molnár, Dániel; Molnár, Dóra (eds.) XXV. Tavaszi Szél Konferencia 2022. Absztraktkötet.

Budapest, Hungary: Association of Hungarian PHD and DLA Students (2022) pp. 1-797. Paper: 490-491, 2 p.

Amer F, **Hammoud S**, Farran B, Boncz I, Endrei D. Assessment of Lockdown Effectiveness: Covid-19

In: Csiszár, B; Hankó, Cs; Kajos, L F; Kovács, O B; Mező, E; Szabó, R; Szabó-Guth, K (eds.) IX. INTERDISZCIPLINÁRIS DOKTORANDUSZ KONFERENCIA 2020 ABSZTRAKTKÖTET: 9th INTERDISCIPLINARY DOCTORAL CONFERENCE 2020 BOOK OF ABSTRACTS

Pécs, Hungary: Doctoral Student Association of the University of Pécs (2020) 384 p. p. 57

REFERENCES

1. Moralejo D, El Dib R, Al Prata R, Barretti P, Corrêa I. Improving adherence to standard precautions for the control of health care-associated infections. Cochrane Database Syst Rev. 2018;(2):1–58.
2. World Health Organization. Prevention of hospital-acquired infections. A practical guide [Internet]. WHO. 2002 [cited 2021 Dec 30]. Available from: https://www.who.int/csr/resources/publications/drugresist/WHO_CDS_CSR_EPH_2002_12/en/
3. World Health Organization. Health care-associated infections FACT SHEET [Internet]. WHO. 2015 [cited 2021 Dec 30]. Available from: https://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf
4. Centers for Disease Control and Prevention. Types of healthcare-associated infections [Internet]. CDC. 2014 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/hai/infectiontypes.html
5. Bayleyegn B, Mehari A, Damtie D, Negash M. Knowledge, attitude and practice on hospital-acquired infection prevention and associated factors among healthcare workers at university of gondar comprehensive specialized hospital, northwest Ethiopia. Infect Drug Resist. 2021;14:259–66.
6. Mortell M. Hand hygiene compliance: is there a theory-practice-ethics gap? Br J Nurs. 2012;21(17):1011–4.
7. Mortell M, Balkhy HH, Tannous EB, Jong MT. Physician "defiance" towards hand hygiene compliance: Is there a theory-practice-ethics gap? J Saudi Hear Assoc. 2013;25(3):203–8.
8. Abdallah SA, Al-Shatti L, Al-Awadi B, Al-Hammad N. Disinfectants use awareness among college of nursing students and nurses in some healthcare settings, Kuwait. Middle East J Sci Res. 2012;12(7):964–9.
9. Joshi M, Kaur S, Kaur HP, Mishra T. Nosocomial infection: Source and prevention. Int J Pharm Sci Res. 2019;10(4):1613–24.
10. Fredericks J, Henriksen M. How to control pests in health care facilities [Internet]. Health Facilities Management. 2015 [cited 2022 May 8]. Available from: https://www.hfmmagazine.com/articles/1478-how-to-control-pests-in-health-care-facilities
11. Khan HA, Baig FK, Mehboob R. Nosocomial infections: Epidemiology, prevention, control and surveillance. Asian Pac J Trop Biomed. 2017;7(5):478–82.
12. Lau DH. Patient empowerment — a patient-centred approach to improve care. Hong Kong Med J. 2002;8(5):372–4.
13. Andersson AE, Bergh I, Karlsson J, Nilsson K. Patients' experiences of acquiring a deep surgical site infection: An interview study. Am J Infect Control. 2010;38(9):711–7.
14. Haque M, McKimm J, Sartelli M, Dhingra S, Labricciosa FM, Islam S, et al. Strategies to prevent healthcare-associated infections: A narrative overview. Risk Manag Healthc Policy. 2020;13:1765–80.
15. Tartari E, Tomczyk S, Pires D, Zayed B, Coutinho Rehse AP, Kariyo P, et al. Implementation of the infection prevention and control core components at the national level: a global situational analysis. J Hosp Infect. 2021;108:94–103.
16. Tchouaket EN, Beogo I, Sia D, Kilpatrick K, Séguin C, Baillot A, et al. Protocol for a systematic review of economic analyses of nosocomial infection prevention and control interventions in OECD hospitals. BMJ Open. 2020;10(e037765):1–8.

17. Kim H, Hwang YH. Factors contributing to clinical nurse compliance with infection prevention and control practices: A cross-sectional study. Nurs Heal Sci. 2020;22(1):126–33.
18. Bereket W, Hemalatha K, Getenet B, Wondwossen T, Solmon A, Zeynudin A, et al. Update on bacterial nosocomial infections. Eur Rev Med Pharmacol Sci. 2012;16:1039–44.
19. Centers for Disease Control and Prevention. Antibiotic resistance threats in the United States 2019 [Internet]. CDC. Atlanta, GA: U.S.; 2019 [cited 2022 May 8]. p. 1–139. Available from: https://www.cdc.gov/drugresistance/pdf/threats-report/2019-ar-threats-report-508.pdf
20. Caini S, Hajdu A, Kurcz A, Böröcz K. Hospital-acquired infections due to multidrug-resistant organisms in Hungary, 2005-2010. Eurosurveillance. 2013;18(2):1–9.
21. Centers for Disease Control and Prevention. Central line-associated bloodstream infections: Resources for patients and healthcare providers [Internet]. CDC. 2011 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/hai/bsi/clabsi-resources.html
22. Centers for Disease Control and Prevention. Bloodstream infection event (Central line-associated bloodstream infection and non-central line associated bloodstream infection) [Internet]. CDC. 2021 [cited 2021 Dec 30]. p. 1–50. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf
23. Liang SY, Marschall J. Update on emerging infections: News from the centers for disease control and prevention. Ann Emerg Med. 2011;58(5):447–50.
24. Warren JW. Catheter-associated urinary tract infections. Int J Antimicrob Agents. 2001;17(4):299–303.
25. Gray J. Infection control: Beyond the horizon. J Hosp Infect. 2015;89(4):237–40.
26. Centers for Disease Control and Prevention. Catheter-associated Urinary Tract Infections (CAUTI) [Internet]. CDC. 2015 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/hai/ca_uti/uti.html
27. Hunter JD. Ventilator associated pneumonia. BMJ. 2012;344(3325):1–7.
28. Koenig SM, Truwit JD. Ventilator-associated pneumonia: Diagnosis, treatment, and prevention. Clin Microbiol Rev. 2006;19(4):637–57.
29. Centers for Disease Control and Prevention. Ventilator-associated Pneumonia (VAP) [Internet]. CDC. 2021 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/hai/vap/vap.html
30. Anderson DJ. Surgical site infections. Infect Dis Clin North Am. 2011;25(1):135–53.
31. Centers for Disease Control and Prevention. Surgical Site Infection (SSI) [Internet]. CDC. 2010 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/hai/ssi/ssi.html
32. Országos Epidemiológiai Központ. A nemzeti nosocomialis surveillance rendszer 2017. Évi Eredményeiről [2017 Annual results of the national nosocomial surveillance system] [Internet]. A Nemzeti Nosocomialis Surveillance Rendszer. 2017 [cited 2021 Dec 30]. p. 1–66. Available from: https://www.antsz.hu/data/cms88661/NNSR_2017.pdf
33. Suetens C, Latour K, Kärki T, Ricchizzi E, Kinross P, Moro ML, et al. Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: Results from two European point prevalence surveys, 2016 to 2017. Eurosurveillance. 2018;23(46):1–17.
34. Centers for Disease Control and Prevention. Healthcare-associated infections [Internet]. CDC. 2015 [cited 2021 Dec 30]. p. 20–5. Available from: https://www.cdc.gov/winnablebattles/report/HAIs.html
35. Vincent J, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. JAMA. 2009;302(21):2323–9.

36. A Nemzeti Nosocomialis Surveillance Rendszer (NNSR) [National Center for Epidemiology] [Internet]. A Nemzeti Nosocomialis Surveillance Rendszer. 2021 [cited 2021 Dec 30]. Available from: http://www.oek.hu
37. Jemal K, Gashaw K, Kinati T, Bedada W, Getahun B. Clean and safe healthcare environment: Knowledge, attitude, and practice of infection prevention and control among health workforce at North Showa zone Oromiya region. J Environ Public Health. 2020;2020:1–10.
38. Accardi R, Castaldi S, Marzullo A, Ronchi S, Laquintana D, Lusignani M. Prevention of healthcare associated infections: a descriptive study. Ann di Ig. 2017;29(2):101–15.
39. The Joint Commission. National patient safety goals Effective July 2020 for the hospital program [Internet]. The Joint Commission. 2020 [cited 2021 Dec 30]. Available from: https://www.jointcommission.org/-/media/tjc/documents/standards/national-patient-safety-goals/2020/npsg_chapter_hap_jul2020.pdf
40. World Health Organization. Introduction to Infection Prevention and Control (IPC) [Internet]. WHO. 2016 [cited 2021 Dec 30]. Available from: https://openwho.org/courses/IPC-INTRO-EN
41. World Health Organization. Infection prevention and control [Internet]. WHO. 2021 [cited 2021 Dec 30]. Available from: https://www.who.int/teams/integrated-health-services/infection-prevention-control
42. Moodley SV, Zungu M, Malotle M, Voyi K, Claassen N, Ramodike J, et al. A health worker knowledge, attitudes and practices survey of SARS-CoV-2 infection prevention and control in South Africa. BMC Infect Dis. 2021;21(138):1–9.
43. Haley RW, Culver DH, White JW, Morgan WM, Emori TM, Munn VP, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am J Epidemiol. 1985;121(2):182–205.
44. Harbarth S, Sax H, Gastmeier P. The preventable proportion of nosocomial infections: An overview of published reports. J Hosp Infect. 2003;54(4):258–66.
45. Schreiber PW, Sax H, Wolfensberger A, Clack L, Kuster SP, Swissnoso. The preventable proportion of healthcare-associated infections 2005-2016: Systematic review and meta-analysis. Infect Control Hosp Epidemiol. 2018;39(11):1277–95.
46. Dixon RE. Control of health-care-associated infections, 1961--2011 [Internet]. Vol. 60, Centers for Disease Control and Prevention. 2011 [cited 2021 Dec 30]. p. 58–63. Available from: https://www.cdc.gov/mmwr/pdf/other/su6004.pdf
47. Schreiner S. Ignaz Semmelweis: a victim of harassment? Wiener Medizinische Wochenschrift. 2020;170(11–12):293–302.
48. Kadar N. Rediscovering Ignaz Philipp Semmelweis (1818−1865). Am J Obstet Gynecol. 2019;220(1):26–39.
49. Kadar N, Romero R, Papp Z. Ignaz Semmelweis: the “Savior of Mothers”: On the 200th anniversary of his birth. Am J Obstet Gynecol. 2018;219(6):519–22.
50. Torriani F, Taplitz R. History of infection prevention and control. In: Infectious Diseases. Elsevier; 2010. p. 76–85.
51. McGowan JE, Barnes MW, Finland M. Bacteremia at Boston City Hospital: occurrence and mortality during 12 selected years (1935-1972), with special reference to hospital acquired cases. J Infect Dis. 1975;132(3):316–35.
52. Finland M, McGowan JE. Nosocomial infections in surgical patients. Observations on effects of prophylactic antibiotics. Arch Surg. 1976;111(2):143–5.
53. Credé W, Hierholzer WJ. Surveillance for quality assessment: I. surveillance in infection control success reviewed. Infect Control Hosp Epidemiol. 1989;10(10):470–4.
54. Scheckler WE, Brimhall D, Buck AS, Farr BM, Friedman C, Garibaldi RA, et al. Requirements for infrastructure and essential activities of infection control and

epidemiology in hospitals: A consensus panel report. Infect Control Hosp Epidemiol. 1998;19(2):114–24.
55. Gray J, Oppenheim B, Mahida N. The Journal of Hospital Infection – a history of infection prevention and control in 100 volumes. J Hosp Infect. 2018;100(1):1–8.
56. Wallis J. In the shadow of the asylum: The stanley royd *Salmonella* outbreak of 1984. Med Humanit. 2016;42(1):11–6.
57. O'Mahony MC, Stanwell-Smith RE, Tillett HE, Harper D, Hutchison JGP, Farrell ID, et al. The Stafford outbreak of Legionnaires' disease. Epidemiol Infect. 1990;104(3):361–80.
58. Howard AJ. Infection control organization in hospitals in England and Wales, 1986. J Hosp Infect. 1988;11(2):183–91.
59. Mehtar S. Infection control programmes—are they cost-effective? J Hosp Infect. 1995;30(t):26–34.
60. Kolmos HJ. Role of the clinical microbiology laboratory in infection control - A Danish perspective. J Hosp Infect. 2001;48(SUPPL. A):S50–4.
61. Bettercare Learning Programmes. Role and structure of infection prevention and control programme [Internet]. Bettercare Learning Programmes. [cited 2021 Dec 30]. Available from: https://bettercare.co.za/learn/infection-prevention-and-control/text/01.html
62. Lee F, Lind N. The infection control committee [Internet]. Infection Control Today. 2000. Available from: https://www.infectioncontroltoday.com/view/infection-control-committee
63. European Commission. COUNCIL RECOMMENDATION of 9 June 2009 on patient safety, including the prevention and control of healthcare associated infections [Internet]. European Commission. 2009 [cited 2021 Dec 30]. Available from: https://ec.europa.eu/jrc/sites/jrcsh/files/2_June_2009 patient safety.pdf
64. 20/2009. (VI. 18.) EüM rendelet az egészségügyi ellátással összefüggő fertőzések megelőzéséről, e tevékenységek szakmai minimumfeltételeiről és felügyeletéről [20/2009. (VI. 18.) The Hungarian act on the prevention of healthcare-associated infections] [Internet]. Wolters Kluwer. 2009 [cited 2021 Dec 30]. Available from: 20/2009. (VI. 18.) EüM rendelet az egészségügyi ellátással összefüggő fertőzések megelőzéséről, e tevékenységek szakmai minimumfeltételeiről és felügyeletéről - Hatályos Jogszabályok Gyűjteménye (jogtar.hu)
65. Dombrádi V, Margitai B, Dózsa C, Bárdos-Csenteri OK, Sándor J, Gáll T, et al. Investigation of the conditions affecting the joining of Hungarian hospitals to an accreditation programme: A cross sectional study. BMJ Open. 2018;8(e019232):1–9.
66. Az Emberi Erőforrások Minisztériuma közleménye a Magyar Egészségügyi Ellátási Standardok kézikönyv (MEES) (2.0. változat) közzétételéről [Announcement of the Ministry of Human Resources on the publication of the handbook of the Hungarian health care standards [Internet]. Magyar Gyógyszerészi Kamara - Értékteremtő Érdekvédelem. 2019 [cited 2021 Dec 30]. Available from: https://www.mgyk.hu/korhazi-minosegiranyitasi-standardok.html
67. EMMI közlemény fekvő- és járóbetegellátás standardjai [EMMI communication inpatient and outpatient standards] [Internet]. Magyar Gyógyszerészi Kamara - Értékteremtő Érdekvédelem. 2016 [cited 2021 Dec 30]. Available from: https://www.mgyk.hu/korhazi-minosegiranyitasi-standardok.html
68. Centers for Disease Control and Prevention. Infection control basics [Internet]. CDC. 2016 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/infectioncontrol/basics/index.html
69. Centers for Disease Control and Prevention. Perspectives in disease prevention and health promotion update: Universal precautions for prevention of transmission of

Human Immunodeficiency Virus, Hepatitis B virus, and other bloodborne pathogens in health-care settings. Morb Mortal Wkly Rep. 1988;37(24):377–88.
70. Jawaid M, Iqbal M, Shahbaz S. Compliance with standard precautions: A long way ahead. Iran J Public Health. 2009;38(1):85–8.
71. Centers for Disease Control and Prevention. Update: Human Immunodeficiency Virus infections in health-care workers exposed to blood of infected patients. Morb Mortal Wkly Rep. 1987;36(19):285-.
72. McCarthy G. Universal precautions. J Can Dent Assoc. 2000;66(10):556–7.
73. Adebayo O, Labiran A, Imarhigbe L. Standard precautions in clinical practices: A review. Int J Heal Sci Res. 2015;5(9):521–8.
74. Centers for Disease Control and Prevention. 2007 Guideline for isolation precautions: Preventing transmission of infectious agents in healthcare settings [Internet]. CDC. 2007 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/infectioncontrol/pdf/guidelines/isolation-guidelines-H.pdf
75. Judson S, Prescott J, Munster V. Understanding Ebola virus transmission. Viruses. 2015;7(2):511–21.
76. World Health Organization. Standard precautions in health care [Internet]. WHO. 2007 [cited 2021 Dec 30]. Available from: https://www.who.int/csr/resources/publications/EPR_AM2_E7.pdf
77. Centers for Disease Control and Prevention. Healthcare providers [Internet]. CDC. 2021 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/handhygiene/providers/index.html
78. Centers for Disease Control and Prevention. Respiratory hygiene/Cough etiquette in healthcare settings [Internet]. CDC. 2009 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/flu/professionals/infectioncontrol/resphygiene.htm
79. Centers for Disease Control and Prevention. Information for providers [Internet]. CDC. 2011 [cited 2021 Dec 30]. Available from: https://www.cdc.gov/injectionsafety/providers.html
80. Gottenborg EW, Barron MA. Isolation precautions in the inpatient setting. Hosp Med Clin. 2016;5:30–42.
81. Centers for Disease Control and Prevention. Transmission-based precautions [Internet]. CDC. 2016 [cited 2021 Dec 30]. Available from: Transmission-Based Precautions %7C Basics %7C Infection Control %7C CDC"
82. Al-Faouri I, Okour SH, Alakour NA, Alrabadi N. Knowledge and compliance with standard precautions among registered nurses: A cross-sectional study. Ann Med Surg. 2021;62:419–24.
83. Pittet D, Allegranzi B, Sax H, Bertinato L, Concia E, Cookson B, et al. Considerations for a WHO European strategy on health-care-associated infection, surveillance, and control. Lancet Infect Dis. 2005;5(4):242–50.
84. Pittet D, Allegranzi B, Storr J, Nejad SB, Dziekan G, Leotsakos A, et al. Infection control as a major World Health Organization priority for developing countries. J Hosp Infect. 2008;68(4):285–92.
85. Parmeggiani C, Abbate R, Marinelli P, Angelillo IF. Healthcare workers and health care-associated infections: Knowledge, attitudes, and behavior in emergency departments in Italy. BMC Infect Dis. 2010;10(35):1–9.
86. Gammon J, Gould D. Universal precautions A review of knowledge, compliance and strategies to improve practice. J Reseach Nurs. 2005;10(5):529–47.
87. Cutter J, Jordan S. Uptake of guidelines to avoid and report exposure to blood and bodyfluids. J Adv Nurs. 2004;46(4):441-.
88. Duarte Valim M, Marziale MHP, Richart-Martínez M, Sanjuan-Quiles Á. Instruments

for evaluating compliance with infection control practices and factors that affect it: An integrative review. J Clin Nurs. 2013;23(11–12):1–18.
89. Efstathiou G, Papastavrou E, Raftopoulos V, Merkouris A. Factors influencing nurses' compliance with Standard Precautions in order to avoid occupational exposure to microorganisms: A focus group study. BMC Nurs. 2011;10(1):1–12.
90. Efstathiou G, Papastavrou E, Raftopoulos V, Merkouris A. Compliance of Cypriot nurses with standard precautions to avoid exposure to pathogens. Nurs Heal Sci. 2011;13(1):53–9.
91. Askarian M, McLaws M-L, Meylan M. Knowledge, attitude, and practices related to standard precautions of surgeons and physicians in university-affiliated hospitals of Shiraz, Iran. Int J Infect Dis. 2007 May;11(3):213–9.
92. Chan R, Molassiotis A, Eunice C, Virene C, Becky H, Chit-ying L, et al. Nurses' knowledge of and compliance with universal precautions in an acute care hospital. Int J Nurs Stud. 2002;39(2):157–63.
93. Darawad MW, Al-Hussami M. Jordanian nursing students' knowledge of, attitudes towards, and compliance with infection control precautions. Nurse Educ Today. 2013 Jun;33(6):580–3.
94. AL-Rawajfah OM, Tubaishat A. Nursing students' knowledge and practices of standard precautions: A Jordanian web-based survey. Nurse Educ Today. 2015;35(12):1175–80.
95. Salehi AS, Garner P. Occupational injury history and universal precautions awareness: A survey in Kabul hospital staff. BMC Infect Dis. 2010;10(19):2–5.
96. Wu CJ, Gardner GE, Chang AM. Taiwanese nursing students' knowledge, application and confidence with standard and additional precautions in infection control. J Clin Nurs. 2008;18(8):1105–12.
97. Tavolacci MP, Ladner J, Bailly L, Merle V, Pitrou I, Czernichow P. Prevention of nosocomial infection and standard precautions: knowledge and source of information among healthcare students. Infect Control Hosp Epidemiol. 2008;29(7):642–7.
98. Brosio F, Kuhdari P, Stefanati A, Sulcaj N, Lupi S, Guidi E, et al. Knowledge and behaviour of nursing students on the prevention of healthcare associated infections. J Prev Med Hyg. 2017;58:E99–104.
99. D'Alessandro D, Agodi A, Auxilia F, Brusaferro S, Calligaris L, Ferrante M, et al. Prevention of healthcare associated infections: Medical and nursing students' knowledge in Italy. Nurse Educ Today. 2013;34(2):191–5.
100. Colosi A, Ergasti G, Murzilli G, Paolini V, Semeraro V, Trapani MM, et al. Healthcare students and their knowledge of healthcare-associated infections. Ann Ig. 2011;23(1):203–8.
101. Khubrani A, Albesher M, Alkahtani A, Alamri F, Alshamrani M, Masuadi E. Knowledge and information sources on standard precautions and infection control of health sciences students at King Saud bin Abdulaziz University for Health Sciences, Saudi Arabia, Riyadh. J Infect Public Health. 2018;11(4):546–9.
102. Amin TT, Al Noaim KI, Bu Saad MA, Al Malhm TA, Al Mulhim AA, Al Awas MA. Standard precautions and infection control, medical students' knowledge and behavior at a Saudi university: the need for change. Glob J Health Sci. 2013 Apr;5(4):114–25.
103. Bello A, Asiedu EN, Adegoke BO, Quartey JN, Appiah-Kubi KO, Owusu-Ansah B. Nosocomial infections: knowledge and source of information among clinical health care students in Ghana. Int J Gen Med. 2011;4:571–4.
104. Labrague LJ, Rosales RA, Tizon MM. Knowledge of and compliance with standard precautions among student nurses. Int J Curr Res Multidiscip Stud. 2017;4(1):19–30.
105. Ojulong J, Mitonga KH, Iipinge SN. Knowledge and attitudes of infection prevention and control among health sciences students at University of Namibia. Afr Health Sci.

2013;13(4):1071–8.
106. Goyal M, Chaudhry D. Impact of educational and training programs on knowledge of healthcare students regarding nosocomial infections, standard precautions and hand hygiene: A study at tertiary care hospital. Indian J Crit Care Med. 2019;23(2):227–31.
107. Seale H, Chughtai AA, Kaur R, Crowe P, Phillipson L, Novytska Y, et al. Ask, speak up, and be proactive: Empowering patient infection control to prevent health care-acquired infections. Am J Infect Control. 2015;43(5):447–53.
108. Castro EM, Van Regenmortel T, Vanhaecht K, Sermeus W, Van Hecke A. Patient empowerment, patient participation and patient-centeredness in hospital care: A concept analysis based on a literature review. Patient Educ Couns. 2016;99(12):1923–39.
109. Kieffer CH. Citizen empowerment : A developmental perspective. Prev Hum Serv. 1984;3(2–3):9–36.
110. Pekonen A, Eloranta S, Stolt M, Virolainen P, Leino-Kilpi H. Measuring patient empowerment – A systematic review. Patient Educ Couns. 2020;103(4):777–87.
111. World Health Organization. WHO health 2020, a European policy framework supporting action across government and society for health and well-being [Internet]. WHO. 2013 [cited 2021 Dec 30]. Available from: https://www.euro.who.int/__data/assets/pdf_file/0006/199536/Health2020-Short.pdf
112. Bonsignore C, Brolis E, Ionescu A, Karusinova V, Mitkova Z, Raps F, et al. Patient empowerment and centeredness [Internet]. European Health Parliament. 2015 [cited 2022 Jan 5]. Available from: http://www.healthparliament.eu/wp-content/uploads/2017/09/EHP-papers_Patients-empowerment.pdf
113. Gibson CH. A concept analysis of empowerment. J Adv Nurs. 1991;16(3):354–61.
114. Kuokkanen L, Leino-Kilpi H. Power and empowerment in nursing: Three theoretical approaches. J Adv Nurs. 2000;31(1):235–41.
115. Rappaport J. Terms of empowerment/exemplars of prevention: Toward a theory for community psychology. Am J Community Psychol. 1987;15(2):121–48.
116. Funnell MM, Anderson RM, Arnold MS, Barr PA, Donnelly M, Johnson PD, et al. Empowerment: An idea whose time has come in Diabetes education. Diabetes Educ. 1991;17(1):37–41.
117. Leino-Kilpi H, Luoto E, Katajisto J. Elements of empowerment and MS patients. J Neurosci Nurs. 1998;30(2):116–23.
118. World Health Organization. Ottawa Charter for Health Promotion [Internet]. WHO. 1986 [cited 2021 Dec 30]. Available from: https://www.euro.who.int/__data/assets/pdf_file/0004/129532/Ottawa_Charter.pdf
119. Bravo P, Edwards A, Barr PJ, Scholl I, Elwyn G, McAllister M, et al. Conceptualising patient empowerment: A mixed methods study. BMC Health Serv Res. 2015;15(252):1–14.
120. Fumagalli LP, Radaelli G, Lettieri E, Bertele' P, Masella C. Patient empowerment and its neighbours: Clarifying the boundaries and their mutual relationships. Health Policy (New York). 2015;119(3):384–94.
121. McAllister M, Dunn G, Payne K, Davies L, Todd C. Patient empowerment: The need to consider it as a measurable patient-reported outcome for chronic conditions. BMC Health Serv Res. 2012;12(157):1–8.
122. Menichetti J, Libreri C, Lozza E, Graffigna G. Giving patients a starring role in their own care: A bibliometric analysis of the on-going literature debate. Heal Expect. 2014;19(3):516–26.
123. World Health Organization. WHO guidelines on hand hygiene in health care [Internet]. WHO. Geneva: WHO; 2009 [cited 2021 Dec 30]. Available from: https://apps.who.int/iris/bitstream/handle/10665/44102/9789241597906_eng.pdf?sequ

ence=1
124. Wagner EH, Glasgow RE, Davis C, Bonomi AE, Provost L, Mcculloch D, et al. Quality improvement in chronic illness care: A collaborative approach. Jt Comm J Qual Improv. 2001;27(2):63–80.
125. Greenfield S, Kaplan SH, Ware JE, Yano EM, Frank HJL. Patients' participation in medical care: Effects on blood sugar control and quality of life in Diabetes. J Gen Intern Med. 1988;3(5):448–57.
126. Wagner EH, Grothaus LC, Sandhu N, Galvin MS, McGregor M, Artz K, et al. Chronic care clinics for Diabetes in primary care: A system-wide randomized trial. Diabetes Care. 2001;24(4):695–700.
127. Greenfield S, Kaplan S, Ware JE. Expanding patient involvement in care: Effects on patient outcomes. Ann Intern Med. 1985;102(4):520–8.
128. Chen Y-C, Li I-C. Effectiveness of interventions using empowerment concept for patients with chronic disease: a systematic review. JBI Libr Syst Rev. 2009;7(27):1179–233.
129. Londoño AMM, Schulz PJ. Influences of health literacy, judgment skills, and empowerment on asthma self-management practices. Patient Educ Couns. 2015;98(7):908–17.
130. Jerofke T, Weiss M, Yakusheva O. Patient perceptions of patient-empowering nurse behaviours, patient activation and functional health status in postsurgical patients with life-threatening long-term illnesses. J Adv Nurs. 2014;70(6):1310–22.
131. Koekenbier K, Leino-Kilpi H, Cabrera E, Istomina N, Stark ÅJ, Katajisto J, et al. Empowering knowledge and its connection to health-related quality of life: A cross-cultural study. A concise and informative title: Empowering knowledge and its connection to health-related quality of life. Appl Nurs Res. 2016;29:211–6.
132. Coulter A, Entwistle V, Gilbert D. Sharing decisions with patients: Is the information good enough? Bmj. 1999;318:318–22.
133. Manojlovich M. Empowerment in nursing: Looking backward to inform the future. Online J Issues Nurs. 2007;12(1).
134. Landers T, Abusalem S, Coty MB, Bingham J. Patient-centered hand hygiene: The next step in infection prevention. Am J Infect Control. 2012;40(4 SUPPL 1):S11–7.
135. National Patient Safety Agency. Patient safety alert. Clean hands save lives [Internet]. NHS. 2008 [cited 2021 Dec 30]. Available from: http://data.parliament.uk/DepositedPapers/Files/DEP2009-0728/DEP2009-0728.pdf
136. Pittet D, Sax H, Hugonnet S, Harbarth S. Cost implications of successful hand hygiene promotion. Infect Control Hosp Epidemiol. 2004;25(3):264–6.
137. Pittet D, Allegranzi B, Storr J, Donaldson L. "Clean care is safer care": the global patient safety challenge 2005-2006. Int J Infect Dis. 2006;10(6):419–24.
138. Storr JA, Engineer C, Allan V. Save lives: Clean your hands: a WHO patient safety initiative for 2009. World Hosp Heal Serv. 2009;45(1):23–5.
139. Pan SC, Tien KL, Hung I-C, Lin Y-J, Yang Y-L, Yang M-C, et al. Patient empowerment in a hand hygiene program: Differing points of view between patients/family members and health care workers in Asian culture. Am J Infect Control. 2013;41(11):979–83.
140. Abbate R, Giuseppe G Di, Marinelli P, Angelillo IF, the Collaborative Working Group. Patients' knowledge, attitudes, and behavior toward hospital-associated infections in Italy. Am J Infect Control. 2008 Feb;36(1):39-47s.
141. Sengupta A, Rand C, Perl TM, Milstone AM. Knowledge, awareness and attitudes regarding Methicillin-Resistant *Staphylococcus aureus* among caregivers of hospitalized children. J Pediatr. 2011;158(3):416–21.
142. Chittick P, Koppisetty S, Lombardo L, Vadhavana A, Solanki A, Cumming K, et al.

Assessing patient and caregiver understanding of and satisfaction with the use of contact isolation. Am J Infect Control. 2016;44(6):657–60.
143. Srigley JA, Cho SM, O'Neill C, Bialachowski A, Ali RA, Lee C, et al. Hand hygiene knowledge, attitudes, and practices among hospital inpatients: A descriptive study. Am J Infect Control. 2020;48(5):507–10.
144. World Health Organization. Report on the burden of endemic health care-associated infection worldwide Clean care is safer care [Internet]. Geneva: WHO; 2011 [cited 2022 Jan 5]. Available from: https://apps.who.int/iris/bitstream/handle/10665/80135/9789241501507_eng.pdf;jsessionid=54DF98E8EDBF72927B1F7FB01A24B244?sequence=1
145. Wyer M, Jackson D, Iedema R, Hor S, Gilbert GL, Jorm C, et al. Involving patients in understanding hospital infection control using visual methods. J Clin Nurs. 2015;24:1718–29.
146. Weinstein RA. Nosocomial infection update. Emerg Infect Dis. 1998;4(3):416–20.
147. Yokoe DS, Classen D. Improving patient safety through infection control : A new healthcare imperative. Infect Control Hosp Epidemiol. 2008;29(october):3–11.
148. Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are estimating reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol. 2011;32(2):101–14.
149. Vandijck D, Cleemput I, Hellings J, Vogelaers D. Infection prevention and control strategies in the era of limited resources and quality improvement: A perspective paper. Aust Crit Care. 2013;26(4):154–7.
150. World Health Organization. The evolving threat of antimicrobial resistance. Options for action [Internet]. Geneva: WHO; 2012 [cited 2022 Jan 5]. Available from: https://apps.who.int/iris/handle/10665/44812
151. National Health Service. Creating a patient-led NHS delivering the NHS improvement plan [Internet]. NHS. London: NHS; 2005 [cited 2022 Jan 5]. Available from: https://www.plymouth.ac.uk/uploads/production/document/path/1/1921/dh_4106507.pdf
152. McGuckin M, Taylor A, Martin V, Porten L, Salcido R. Evaluation of a patient education model for increasing hand hygiene compliance in an inpatient rehabilitation unit. Am J Infect Control. 2004;32(4):235–8.
153. Joint Commission International Accreditation Standards for Hospitals. 6th ed. JCI; 2017.
154. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS Med. 2009;6(7):1–28.
155. Vandenbroucke JP, Elm E V, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): Explanation and elaboration. PLoS Med. 2007;4(10):1628–54.
156. Higgins JP, Deeks JJ, editors. Chapter 7: Selecting studies and collecting data. In: Cochrane Handbook for Systematic Reviews of Interventions. Chichester: John Wiley & Sons; 2008. p. 151–83.
157. Seale H, Novytska Y, Gallard J, Kaur R. Examining hospital patients' knowledge and attitudes toward hospital-acquired infections and their participation in infection control. Infect Control Hosp Epidemiol. 2015 Apr;36(4):461–3.
158. Gasink LB, Singer K, Fishman NO, Holmes WC, Weiner MG, Bilker WB, et al. Contact isolation for infection control in hospitalized patients: Is patient satisfaction affected? Infect Control Hosp Epidemiol. 2008;29(3):275–8.

159. Li Y, Liu Y, Zeng L, Chen C, Mo D, Yuan S. Knowledge and practice of hand hygiene among hospitalised patients in a tertiary general hospital in China and their attitudes: a cross-sectional survey. BMJ Open. 2019 Jun;9(6):e027736.
160. Anderson M, Ottum A, Zerbel S, Sethi A, Gaines ME, Safdar N. A survey to examine patient awareness, knowledge, and perceptions regarding the risks and consequences of surgical site infections. Am J Infect Control. 2013 Dec;41(12):1293–5.
161. Merle V, Van Rossem V, Tavolacci M-P, Czernichow P. Knowledge and opinions of surgical patients regarding nosocomial infections. J Hosp Infect. 2005 Jun;60(2):169–71.
162. Miller PJ, Farr BM. Survey of patients' knowledge of nosocomial infections. Am J Infect Control. 1989 Feb;17(1):31–4.
163. Duncan C. An exploratory study of patient's feelings about asking healthcare professionals to wash their hands. J Ren Care. 2007;33(1):30–4.
164. Ocran I, Tagoe DNA. Knowledge and attitude of healthcare workers and patients on healthcare associated infections in a regional hospital in Ghana. Asian Pacific J Trop Dis. 2014;4(2):135–9.
165. Madeo M, Shields L, Owen E. A pilot study to investigate patients reported knowledge, awareness, and beliefs on health care-associated infection. Am J Infect Control. 2008;36(1):63–9.
166. Knighton SC, Richmond M, Zabarsky T, Dolansky M, Rai H, Donskey CJ. Patients' capability, opportunity, motivation, and perception of inpatient hand hygiene. Am J Infect Control. 2020;48(2):157–61.
167. Barker A, Sethi A, Shulkin E, Caniza R, Zerbel S, Safdar N. Patient hand hygiene at home predicts their hand hygiene practices in the hospital. Infect Control Hosp Epidemiol. 2014;35(5):585–8.
168. 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. Eur Sci J. 2017;13(27):59–76.
169. Anderson M, Ottum A, Zerbel S, Sethi A, Safdar N. Are hospitalized patients aware of the risks and consequences of central line-associated bloodstream infections? Am J Infect Control. 2013;41(12):1275–7.
170. Minejima E, Lee E, Quach S, Santos N, Lou M, Wong-Beringer A. Understanding patient perceptions and attitudes toward urinary tract infections and treatment in a medically underserved population. J Am Coll Clin Pharm. 2019;2(6):616–22.
171. Burnett E, Lee K, Kydd P. Hand hygiene: What about our patients? Br J Infect Control. 2008;9(1):19–24.
172. Hari M, Rosenzweig M. Incidence of preventable postoperative readmissions following pancreaticoduodenectomy: Implications for patient education. Oncol Nurs Forum. 2012;39(4):408–12.
173. Smyth W, Abernethy G, Mason M, Carrucan J, Hayes M, Shields L. Patients' perceptions of hospital-acquired infections in northern Queensland, Australia: A pilot study. Am J Infect Control. 2015;43(4):418–9.
174. Haverstick S, Goodrich C, Freeman R, James S, Kullar R, Ahrens M. Patients' hand washing and reducing hospital-acquired infection. Crit Care Nurse. 2017 Jun;37(3):e1–8.
175. Ong AYJ, Tan J, Yeo HL, Goh ML. Patient-centred hand hygiene information in orthopaedics units: an evidence-based implementation project. Int J Evid Based Healthc. 2017;15(1):22–9.
176. Sunkesula VCK, Knighton S, Zabarsky TF, Kundrapu S, Higgins PA, Donskey CJ. Four moments for patient hand hygiene: A patient-centered, provider-facilitated model to

improve patient hand hygiene. Infect Control Hosp Epidemiol. 2015 Aug;36(8):986–9.
177. Pokrywka M, Buraczewski M, Frank D, Dixon H, Ferrelli J, Shutt K, et al. Can improving patient hand hygiene impact *Clostridium difficile* infection events at an academic medical center? Am J Infect Control. 2017;45(9):959–63.
178. Ardizzone LL, Smolowitz J, Kline N, Thorn B, Larson EL. Patient hand hygiene practices in surgical patients. Am J Infect Control. 2013 Jun;41(6):487–91.
179. Guilley-Lerondeau B, Bourigault C, Guille des Buttes AC, Birgand G, Lepelletier D. Adverse effects of isolation: a prospective matched cohort study including 90 direct interviews of hospitalized patients in a French University Hospital. Eur J Clin Microbiol Infect Dis. 2017;36(1):75–80.
180. Allegranzi B, Conway L, Larson E, Pittet D. Status of the implementation of the World Health Organization multimodal hand hygiene strategy in United States of America health care facilities. Am J Infect Control. 2014;42(3):224–30.
181. Pittet D. Compliance with hand disinfection and its impact on hospital-acquired infections. J Hosp Infect. 2001;48(SUPPL. A):40–6.
182. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011;377(9761):228–41.
183. Alzyood M, Jackson D, Brooke J, Aveyard H. An integrative review exploring the perceptions of patients and healthcare professionals towards patient involvement in promoting hand hygiene compliance in the hospital setting. J Clin Nurs. 2018;27(7–8):1329–45.
184. McGuckin M, Govednik J. Patient empowerment and hand hygiene, 1997-2012. J Hosp Infect. 2013;84(3):191–9.
185. Davis R, Parand A, Pinto A, Buetow S. Systematic review of the effectiveness of strategies to encourage patients to remind healthcare professionals about their hand hygiene. J Hosp Infect. 2015;89(3):141–62.
186. McGuckin M, Waterman R, Storr J, Bowler ICJW, Ashby M, Topley K, et al. Evaluation of a patient-empowering hand hygiene programme in the UK. J Hosp Infect. 2001;48(3):222–7.
187. McGuckin M, Waterman R, Porten L, Bello S, Caruso M, Juzaitis B, et al. Patient education model for increasing handwashing compliance. Am J Infect Control. 1999;27(4):309–14.
188. McGuckin M, Storr J, Longtin Y, Allegranzi B, Pittet D. Patient empowerment and multimodal hand hygiene promotion: A win-win strategy. Am J Med Qual. 2011;26(1):10–7.
189. Vaismoradi M, Jordan S, Kangasniemi M. Patient participation in patient safety and nursing input - a systematic review. J Clin Nurs. 2015;24(5–6):627–39.
190. Prey JE, Woollen J, Wilcox L, Sackeim AD, Hripcsak G, Bakken S, et al. Patient engagement in the inpatient setting: A systematic review. J Am Med Informatics Assoc. 2014;21(4):742–50.
191. Davis RE, Jacklin R, Sevdalis N, Vincent CA. Patient involvement in patient safety: What factors influence patient participation and engagement? Heal Expect. 2007;10(3):259–67.
192. Thompson AGH. The meaning of patient involvement and participation in health care consultations: A taxonomy. Soc Sci Med. 2007;64(6):1297–310.
193. Schwappach DLB. Engaging patients as vigilant partners in safety: A systematic review. Med Care Res Rev. 2010;67(2):119–48.
194. Saw SM, Ng TP. The design and assessment of questionnaires in clinical research. Singapore Med J. 2001;42(3):131–5.

195. de Carvalho Nagliate P, Nogueira PC, de Godoy S, Mendes IAC. Measures of knowledge about standard precautions: A literature review in nursing. Nurse Educ Pract. 2013;13(4):244–9.
196. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine (Phila Pa 1976). 2000;25(24):3186–91.
197. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Recommendations for the cross-cultural adaptation of the DASH & QuickDASH outcome measures. Institute for Work & Health. 2007. p. 1–45.
198. Sousa VD, Rojjanasrirat W. Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: A clear and user-friendly guideline. J Eval Clin Pract. 2011;17(2):268–74.
199. Hammoud S, Amer F, Lohner S, Kocsis B. Patient education on infection control: A systematic review. Am J Infect Control. 2020;48(12):1506–15.
200. Dadich A, Wyer M. Patient involvement in healthcare-associated infection research: A lexical review. Infect Control Hosp Epidemiol. 2018;39(6):710–7.
201. Pittet D, Panesar SS, Wilson K, Longtin Y, Morris T, Allan V, et al. Involving the patient to ask about hospital hand hygiene: A National Patient Safety Agency feasibility study. J Hosp Infect. 2011;77(4):299–303.
202. Magill SS, O'Leary E, Janelle SJ, Thompson DL, Dumyati G, Nadle J, et al. Changes in prevalence of health care–associated infections in U.S. hospitals. N Engl J Med. 2018;379(18):1732–44.
203. Hostiuc S, Molnar AJ, Moldoveanu A, Aluaş M, Moldoveanu F, Bocicor I, et al. Patient autonomy and disclosure of material information about hospital-acquired infections. Infect Drug Resist. 2018;11:369–75.
204. Stenberg U, Vågan A, Flink M, Lynggaard V, Fredriksen K, Westermann KF, et al. Health economic evaluations of patient education interventions a scoping review of the literature. Patient Educ Couns. 2018;101:1006–35.
205. Erdek FO. The effects of training inpatients and their relatives about infection control measures and subsequent rate of infection. North Clin Istanbul. 2017;4(1):29–35.
206. Srigley JA, Furnesss CD, Gardam M. Interventions to improve patient hand hygiene: a systematic review. J Hosp Infect. 2016;94(1):23–9.
207. Thompson SK. Sampling. Third edit. Hoboken, New Jersey: A JOHN WILEY & SONS, INC.; 2012. 59–60 p.
208. Hungarian Central Statistical Office [Internet]. 2018 [cited 2021 Dec 30]. Available from: https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_fea001.html
209. Szmuda T, Özdemir C, Ali S, Singh A, Syed MT, Słoniewski P. Readability of online patient education material for the novel coronavirus disease (COVID-19): a cross-sectional health literacy study. Public Health. 2020;185:21–5.
210. Hammoud S, Khatatbeh H, Zand A, Kocsis B. A survey of nurses' awareness of infection control measures in Baranya County, Hungary. Nurs Open. 2021;8(6):3477–83.
211. Kratzel A, Todt D, V'kovski P, Steiner S, Gultom M, Thao TTN, et al. Inactivation of Severe Acute Respiratory Syndrome Coronavirus 2 by WHO-recommended hand rub formulations and alcohols. Emerg Infect Dis. 2020;26(7):1592–5.
212. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. J Hosp Infect. 2020;104(3):246–51.
213. O'Dowd K, Nair KM, Forouzandeh P, Mathew S, Grant J, Moran R, et al. Face masks and respirators in the fight against the COVID-19 pandemic: A review of current materials, advances and future perspectives. Materials (Basel). 2020;13:1–27.

214. World Health Organization. Coronavirus disease (COVID-19) advice for the public [Internet]. WHO. 2021 [cited 2022 Jan 5]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public
215. 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. Nurs Health Sci. 2022;24(1):140–51.
216. Hill JN, Evans CT, Cameron KA, Rogers TJ, Risa K, Kellie S, et al. Patient and provider perspectives on Methicillin-Resistant *Staphylococcus aureus*: A qualitative assessment of knowledge, beliefs, and behavior. J Spinal Cord Med. 2013;36(2):82–90.
217. Bányai G, Dombrádi V, Katona C, Boruzs K, Dezső G, Nagy A, et al. Preference for patient-centered communication among the citizens of the Visegrad countries. Patient Educ Couns. 2021;1–7.
218. Nasiri A, Balouchi A, Rezaie-Keikhaie K, Bouya S, Sheyback M, AL Rawajfah O. Knowledge, attitude, practice, and clinical recommendation toward infection control and prevention standards among nurses: A systematic review. Am J Infect Control. 2019;47(7):827–33.
219. Gentilotti E, De Nardo P, Nguhuni B, Piscini A, Damian C, Vairo F, et al. Implementing a combined infection prevention and control with antimicrobial stewardship joint program to prevent caesarean section surgical site infections and antimicrobial resistance: A Tanzanian tertiary hospital experience. Antimicrob Resist Infect Control. 2020;9(1):1–11.
220. Liu W, Guo T, Li H, Zhao Y, Zhang K, Hai Y, et al. Healthcare-associated infection prevention and control management in a tertiary hospital and an overall evaluation. Ann Palliat Med. 2020;9(4):1536–44.
221. Gaughan AA, Walker DM, Depuccio MJ, Macewan SR, Mcalearney AS. Rewarding and recognizing frontline staff for success in infection prevention. Am J Infect Control. 2020;49:123–5.
222. Agreli HF, Murphy M, Creedon S, Bhuachalla CN, O'Brien D, Gould D, et al. Patient involvement in the implementation of infection prevention and control guidelines and associated interventions: A scoping review. BMJ Open. 2019;9(e025824):1–11.
223. Braun BI, Chitavi SO, Suzuki H, Soyemi CA, Puig-Asensio M. Culture of safety: Impact on improvement in infection prevention process and outcomes. Curr Infect Dis Rep. 2020;22:34–41.
224. Reynolds S, Boyd S. Healthcare worker's perspectives on use of memes as an implementation strategy in infection prevention: An exploratory descriptive analysis. Am J Infect Control. 2020;1–3.
225. Puto G, Wójkowska-Mach J, Wałaszek M, Repka I, Różańska A. Selected aspects of the knowledge and practice concerning hand hygiene guidelines in the context of infection control structures in hospitals and long-term care facilities – findings of a questionnaire survey. Med Pr. 2020;71(5):531–7.
226. Lacotte Y, Årdal C, Ploy MC. Infection prevention and control research priorities: What do we need to combat healthcare-associated infections and antimicrobial resistance? Results of a narrative literature review and survey analysis. Antimicrob Resist Infect Control. 2020;9(142):1–10.
227. Pryor R, Godbout EJ, Bearman G. Precision infection prevention: the next frontier in patient safety. J Hosp Infect. 2020;105:232–3.
228. Mitchell BG, Say R, Wells A, Wilson F, Cloete L, Matheson L. Australian graduating nurses' knowledge, intentions and beliefs on infection prevention and control: A cross-sectional study. BMC Nurs. 2014;13(43):1–7.
229. Triantafillou V, Kopsidas I, Kyriakousi A, Zaoutis TE, Szymczak JE. Influence of

national culture and context on healthcare workers' perceptions of infection prevention in Greek neonatal intensive care units. J Hosp Infect. 2020;104:552–9.
230. Jeanes A, Coen PG, Drey NS, Gould DJ. Moving beyond hand hygiene monitoring as a marker of infection prevention performance: Development of a tailored infection control continuous quality improvement tool. Am J Infect Control. 2020;48:68–76.
231. Pereira FMV, Lam SC, Chan JHM, Malaguti-Toffano SE, Gir E. Difference in compliance with standard precautions by nursing staff in Brazil versus Hong Kong. Am J Infect Control. 2015;43(7):769–72.
232. Croke L. Fostering patient engagement can aid in infection prevention efforts. AORN J. 2020;111(5):P5.
233. Tartari E, Weterings V, Gastmeier P, Rodríguez Baño J, Widmer A, Kluytmans J, et al. Patient engagement with surgical site infection prevention: An expert panel perspective. Antimicrob Resist Infect Control. 2017;6(45):1–9.
234. Betlehem J, Pek E, Banfai B, Olah A. Current characteristics of the Hungarian nurses' workforce. In: Teaching and Learning in Nursing. IntechOpen; 2017. p. 100–11.
235. Ness MM, Saylor J, Di Fusco LA, Evans K. Healthcare providers' challenges during the Coronavirus Disease (COVID-19) pandemic: A qualitative approach. Nurs Heal Sci. 2021;23(2):389–97.
236. Xiang YT, Yang Y, Li W, Zhang L, Zhang Q, Cheung T, et al. Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. The Lancet Psychiatry. 2020;7(3):228–9.
237. Khalid I, Khalid TJ, Qabajah MR, Barnard AG, Qushmaq IA. Healthcare workers emotions, perceived stressors and coping strategies during a MERS-CoV outbreak. Clin Med Res. 2016;14(1):7–14.
238. Speroni KG, Seibert DJ, Mallinson RK. Nurses' perceptions on Ebola care in the United States, Part 2: A qualitative analysis. J Nurs Adm. 2015;45(11):544–50.
239. Puspitasari IM, Yusuf L, Sinuraya RK, Abdulah R, Koyama H. Knowledge, attitude, and practice during the COVID-19 pandemic: A review. J Multidiscip Healthc. 2020;13:727–33.
240. El-Gilany AH, Badawy K, Sarraf B. Knowledge of health care providers of standard precautions and infection control at students' hospital, Mansoura University, Egypt. TAF Prev Med Bull. 2012;11(1):1–6.
241. World Health Organization. Getting your workplace ready for COVID-19 [Internet]. WHO. 2020 [cited 2022 Jan 5]. Available from: https://www.who.int/docs/default-source/coronaviruse/getting-workplace-ready-for-covid-19.pdf
242. Center for Disease Control and Prevention. Interim infection prevention and control recommendations for healthcare personnel during the Coronavirus Disease 2019 (COVID-19) pandemic [Internet]. CDC. 2020 [cited 2022 Jan 5]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control.html
243. Seale H, Travaglia J, Chughtai AA, Phillipson L, Novytska Y, Kaur R. 'I don't want to cause any trouble': the attitudes of hospital patients towards patient empowerment strategies to reduce healthcare-acquired infections. J Infect Prev. 2015;16(4):167–73.
244. Bouchoucha SL, Moore KA. Factors influencing adherence to standard precautions scale: A psychometric validation. Nurs Heal Sci. 2019;21(2):178–85.
245. Polit DF, Beck CT. The content validity index: Are you sure you know what's being reported? Critique and recommendations. Res Nurs Health. 2006;29:489–97.
246. Davis LL. Instrument review: Getting the most from a panel of experts. Appl Nurs Res. 1992;5(4):194–7.
247. Lynn MR. Determination and quantification of content validity. Nurs Res. 1986;35(6):382–6.

248. Knafl GJ, Grey M. Factor analysis model evaluation through likelihood cross-validation. Stat Methods Med Res. 2010;16(2):77–102.
249. Williams B, Onsman A, Brown T. Exploratory factor analysis: A five-step guide for novices. J Emerg Prim Heal Care. 2010;8(3):1–13.
250. Brown JD. Choosing the right type of rotation in PCA and EFA. JALT Test Eval SIG Newsl. 2009;13(3):20–5.
251. Hooper D, Coughlan J, Mullen MR. Structural equation modelling: Guidelines for determining model fit. Electron J Bus Res Methods. 2008;6(1):53–60.
252. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. J Mark Res. 1981;18(1):39–50.
253. Bookter AI. Convergent and divergent validity of the learning transfer questionnaire [Internet]. LSU Historical Dissertations and Theses. 1999. Available from: https://digitalcommons.lsu.edu/gradschool_disstheses/7068
254. Ab Hamid MR, Sami W, Mohmad Sidek MH. Discriminant validity assessment: Use of Fornell & Larcker criterion versus HTMT criterion. J Phys Conf Ser. 2017;890:1–5.
255. Kamya L, Hansson E, Weick L, Hansson E. Validation and reliability testing of the Breast-Q latissimus dorsi questionnaire: cross-cultural adaptation and psychometric properties in a Swedish population. Health Qual Life Outcomes. 2021;19(174):1–11.
256. Janssens W, Wijnen K, De Pelsmacker P, Van Kenhove P. Marketing research with SPSS. Edinburgh: Pearson Education; 2008. 1–441 p.
257. Kenny DA, McCoach DB. Effect of the number of variables on measures of fit in structural equation modeling. Struct Equ Model. 2003;10(3):333–51.
258. MacCallum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structure modeling. Psychol Methods. 1996;1(2):130–49.
259. Hu L-T, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct Equ Model. 1999;6(1):1–55.
260. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ. 2011;2:53–5.
261. Alnaami N, Al Haqwi A, Masuadi E. Clinical learning evaluation questionnaire: A confirmatory factor analysis. Adv Med Educ Pract. 2020;11:953–61.
262. Duarte Valim M, Pinto PA, Marziale MHP. Questionnaire on standard precaution knowledge: Validation study for Brazilian nurses use. Texto Context Enferm. 2017;26(3):1–8.
263. Chan MF, Ho A, Day MC. Investigating the knowledge, attitudes and practice patterns of operating room staff towards standard and transmission-based precautions: results of a cluster analysis. J Clin Nurs. 2008;17(8):1051–62.

APPENDIX A

PubMed search strategy

Number	Search Term	Results
#1	Search inpatient*[Title]	22,357
#2	Search (hospital*[Title] AND patient*[Title])	53,887
#3	Search hospitali*[Title/Abstract]	243,254
#4	Search (admitted[Title/Abstract] OR admission[Title/Abstract])	329,702
#5	Search (institutionalised[Title/Abstract] OR institutionalized[Title/Abstract])	10,412
#6	Search inpatients[MeSH Terms]	21,479
#7	Search hospitalization[MeSH Terms]	236,177
#8	Search hospital medical staff[MeSH Terms]	24,754
#9	Search (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8)	714,645
#10	Search educat*[Title/Abstract]	602,809
#11	Search information[Title/Abstract]	1,197,566
#12	Search knowledge[Title/Abstract]	684,510
#13	Search communicat*[Title/Abstract]	295,487
#14	Search leaflet*[Title/Abstract]	21,964
#15	Search pamphlet*[Title/Abstract]	1,974
#16	Search health communication[MeSH Terms]	2,199
#17	Search information dissemination[MeSH Terms]	16,415
#18	Search access to information[MeSH Terms]	7,475
#19	Search patient education[MeSH Terms]	84,817
#20	Search health knowledge, attitudes, practice[MeSH Terms]	109,807
#21	Search (#10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20)	2,538,277
#22	Search (hand*[Title/Abstract] AND wash*[Title/Abstract])	6,566
#23	Search (hand*[Title/Abstract] AND rub*[Title/Abstract])	2,774
#24	Search infection control[Title/Abstract]	20,091
#25	Search precaution*[Title/Abstract]	21,245
#26	Search Personal protective equipment[Title/Abstract]	2,812
#27	Search (((glove[Title/Abstract]) OR gloves[Title/Abstract])) OR ((gown[Title/Abstract]) OR gowns[Title/Abstract])) OR ((apron[Title/Abstract]) OR aprons[Title/Abstract])) OR ((mask[Title/Abstract]) OR masks[Title/Abstract])))	45,247
#28	Search ((patients isolat*[Title/Abstract]) OR patient isolat*[Title/Abstract])	1,230
#29	Search (("respiratory hygiene"[Title/Abstract]) OR "cough etiquette"[Title/Abstract]))	77
#30	Search respiratory tract infection*[Title/Abstract]	22,807
#31	Search ventilator* associated pneumonia[Title/Abstract]	5,359
#32	Search (((bloodstream infection*[Title/Abstract]) OR blood stream infection*[Title/Abstract]) OR central line infection*[Title/Abstract])	11,162
#33	Search urinary tract infection*[Title/Abstract]	41,835
#34	Search ((surgical site infection*[Title/Abstract]) OR surgical infection*[Title/Abstract])	12,550

#35	Search (((associated infection*[Title/Abstract]) OR acquired infection*[Title/Abstract]) OR nosocomial infection*[Title/Abstract]))	29,408
#36	Search Catheter-Related Infections[MeSH Terms]	4,930
#37	Search surgical wound infection[MeSH Terms]	36,094
#38	Search pneumonia, ventilator associated[MeSH Terms]	3,442
#39	Search infection control[MeSH Terms]	62,983
#40	Search (prevention and control[MeSH Terms])	187
#41	Search hand hygiene[MeSH Terms]	6,661
#42	Search universal precautions[MeSH Terms]	1,608
#43	Search personal protective equipment[MeSH Subheading]	319
#44	Search patient isolation[MeSH Terms]	3,841
#45	Search (#22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44)	184,961
#46	Search #9 AND #21 AND #45	2,714

Embase search strategy

Number	Search Term	Results
#1	'hospital medical staff'/exp	303
#2	'hospitalization'/mj	36,017
#3	'hospital patient'/mj	26,236
#4	institutionalised:ti,ab OR institutionalized:ti,ab	13,352
#5	((admitted* OR admission) NEAR/3 (patient* OR subject* OR person* OR adult* OR individual* OR men OR women)):ti,ab	189,662
#6	(hospitali* NEAR/3 (patient* OR subject* OR person* OR adult* OR individual* OR men OR women)):ti,ab	130,147
#7	hospital*:ti AND patient*:ti	84,325
#8	inpatient*:ti	33,144
#9	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8	416,271
#10	'attitude to health'/exp	112,648
#11	'patient education'/exp	111,639
#12	'medical information'/mj	11,255
#13	'information dissemination'/mj	4,761
#14	'access to information'/mj	2,880
#15	educat*:ti,ab	775,703
#16	information:ti,ab	1,543,519
#17	knowledge:ti,ab	861,192
#18	communicat*:ti,ab	376,284
#19	leaflet*:ti,ab	30,731
#20	pamphlet*:ti,ab	2,653
#21	#10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20	3,228,396
#22	hand*:ti,ab AND wash*:ti,ab	10,974
#23	hand*:ti,ab AND rub*:ti,ab	5,299
#24	'infection control':ti,ab	26,749
#25	precaution*:ti,ab	28,816
#26	'personal protective equipment':ti,ab	3,273
#27	glove?:ti,ab OR gown?:ti,ab OR apron?:ti,ab OR mask?:ti,ab	19,723
#28	(patient? NEAR/1 isolat*):ti,ab	2,152
#29	'respiratory hygiene':ti,ab OR 'cough etiquette':ti,ab	120
#30	((respiratory NEAR/2 infection?):ti,ab) OR ((ventilator* NEAR/2 pneumonia):ti,ab)	49,382
#31	(urinary NEAR/2 infection?):ti,ab	34,815
#32	((blood* NEAR/2 infection?):ti,ab) OR (('central line' NEAR/2 infection?):ti,ab)	13,610
#33	((surgery OR surgical) NEAR/2 infection?):ti,ab	11,379
#34	'nosocomial infection*':ti,ab OR 'acquired infection*':ti,ab OR 'associated infection*':ti,ab	39,146
#35	'healthcare associated infection'/exp	4,604
#36	'universal precaution'/exp	285
#37	'infection control'/exp	106,188
#38	'prevention and control'/mj	12,843

#39	'hand washing'/mj	4,333
#40	'protective clothing'/mj	4,203
#41	'patient isolation'/exp	752
#42	#22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41	320,343
#43	#9 AND #21 AND #42	2,824

CINAHL search strategy

Number	Search Term	Results
#1	(MM "Hospitalization")	15,411
#2	(MM "Adolescent, Hospitalized") OR (MM "Aged, Hospitalized") OR (MM "Patients") OR (MM "Inpatients")	16,708
#3	(MH "Medical Staff, Hospital+/ED")	838
#4	TI inpatient*	15,182
#5	TI hospital* AND TI patient*	28,896
#6	TI (hospitali*) N3 (patient* OR subject* OR person* OR adult* OR individual* OR men OR women)	9,879
#7	AB (hospitali*) N3 (patient* OR subject* OR person* OR adult* OR individual* OR men OR women)	28,908
#8	TI (admitted* OR admission) N3 (patient* OR subject* OR person* OR adult* OR individual* OR men OR women)	3,530
#9	AB (admitted* OR admission) N3 (patient* OR subject* OR person* OR adult* OR individual* OR men OR women)	43,245
#10	TI institutionalised OR AB institutionalised	817
#11	TI institutionalized OR AB institutionalized	4,090
#12	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11	129,167
#13	TI educat* OR AB educat*	385,021
#14	TI information OR AB information	395,769
#15	TI knowledge OR AB knowledge	225,167
#16	TI communicat* OR AB communicat*	132,780
#17	TI (pamphlet* or brochure* or leaflet* or booklet*) OR AB (pamphlet* or brochure* or leaflet* or booklet*)	8,913
#18	(MH "Patient Education+")	83,903
#19	(MH "Health Education+")	137,623
#20	(MH "Health Information+")	29,926
#21	(MM "Access to Information")	9,591
#22	(MH "Health Knowledge")	33,754
#23	S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22	1,055,364
#24	TI hand* OR AB hand*	131,586
#25	TI wash* OR AB wash*	27,246
#26	S24 AND S25	2,804
#27	TI rub* OR AB rub*	9,516
#28	S24 AND S27	1,024
#29	TI "infection control" OR AB "infection control"	11,922
#30	TI precaution* OR AB precaution*	7,546
#31	TI Personal protective equipment OR AB Personal protective equipment	1,694
#32	TI (Glove? OR gown? OR apron? OR mask?) OR AB (Glove? OR gown? OR apron? OR mask?)	11,558
#33	TI Patient? N1 isolat* OR AB Patient? N1 isolat*	4,656
#34	TI "respiratory hygiene" OR AB "respiratory hygiene"	33
#35	TI "cough etiquette" OR AB "cough etiquette"	33

#36	TI respiratory N2 infection? OR AB respiratory N2 infection?	9,608
#37	TI urinary N2 infection? OR AB urinary N2 infection?	9,821
#38	TI blood* N2 infection? OR AB blood* N2 infection?	6,255
#39	TI 'central line' N2 infection? OR AB 'central line' N2 infection?	1,137
#40	S38 OR S39	6,355
#41	TI ventilator* N2 pneumonia OR AB ventilator* N2 pneumonia	3,399
#42	TI ((surgery OR surgical) N2 infection?) OR AB ((surgery OR surgical) N2 infection?)	7,090
#43	TI ("nosocomial infection*" OR "acquired infection*" OR "associated infection*") OR AB ("nosocomial infection*" OR "acquired infection*" OR "associated infection*")	10,309
#44	(MH "Catheter-Related Infections+")	7,558
#45	(MM "Pneumonia, Ventilator-Associated")	2,641
#46	(MM "Surgical Wound Infection")	7,228
#47	S44 OR S45 OR S46	17,276
#48	(MH "Infection Control+")	76,042
#49	(MH "Handwashing+")	9,279
#50	(MM "Universal Precautions")	685
#51	(MH "Protective Clothing+")	7,023
#52	(MH "Patient Isolation+") OR (MM "Isolation, Reverse")	2,783
#53	S26 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S40 OR S41 OR S42 OR S43 OR S47 OR S48 OR S49 OR S50 OR S51 OR S52	147,162
#54	S12 AND S23 AND S53	1,176

DATA AVAILABILITY STATEMENT

The datasets, questionnaires and informed consent used in this research are available from the author upon reasonable request.

ETHICAL APPROVAL

UNIVERSITY OF PÉCS
CLINICAL CENTER
Regional and Local Research Ethics Committee

Sahar Hammoud
PhD Student
University of Pécs, Hungary
Faculty of Health Sciences
Doctoral School of Health Sciences
Pricipal investigator

Pécs, 08. June 2019.

Dear Principal investigator,

The Ethics Committee as the Institutional Review Board **discussed** your application on its meeting held on 07th of June 2019.

Title (old): Nurses' Awareness of Infection Control Measures Improves Patient and Family Education
Title (new): The Effect of Nurses' Awareness of Infection Control Measures on Patient and Family Education

Supervisor:
Bela Kocsis MD PhD MedHabil Assoc. Professor Department of Medical Microbiology and Immunology, Medical School, University of Pécs, Hungary

Attachments:
(1.) Description of scientific background of this study;
(2.) Research plan;
(3.) Study protocol
(4.) the original English and translated Hungarian questionnaires for nurses, patients and their family members
(1.)Recommendation letter from the Secretary of the Doctoral School of Health
(2.) Sciences, Faculty of Health Sciences, University of Pécs, Hungary and from the Supervisor.

Decision: The Ethics Committee as the Institutional Review Board **discussed** and **accepted** your application on its meeting held on 08th of June 2019. **The Board approves and supervises of the data management** of anonymous clinical and study data. All parts of this work should keep the act LXIII of 1992 on the Protection of Personal Data and Publicity of Information of Public Interest and its updates. We would like to ask the Principal investigator to send for our Committee a final summary of her study when this work will be finished.

Record number: 7862/2019-PTE.

Yours sincerely

György Kosztolányi
Professor of Human Genetics
Chairman of the Regional Research Ethics Committee of the Medical Center, Pécs Institutional Review Board
H-7623 Rákóczi str. 2. Pécs/HUNGARY
phone 00-36-72-536302
fax 00-36-72-536301

Béla Kocsis
Associate professor of Clinical Microbiology
Secretary of the Regional Research Ethics Committee of the Medical Center, Pécs Institutional Review Board
H-7624 Szigeti str. 12. Pécs/HUNGARY
phone 00-36-72-536001-31905

SUBMISSION OF THE DOCTORAL DISSERTATION AND DECLARATION OF THE ORIGINALITY OF THE DISSERTATION

Submission of the doctoral dissertation and declaration of the originality of the dissertation

The undersigned,
Name: Sahar Hammoud
Maiden name: Sahar Hammoud
Mother's maiden name: Souha Abed Elsater
Place and time of birth: Lebanon, El Karaoun 07/06/1986

on this day submitted my doctoral dissertation entitled:

THE EFFECT OF NURSES' AWARENESS OF INFECTION CONTROL MEASURES ON PATIENT AND FAMILY EDUCATION

to the
PR-1. Frontiers of Health Sciences Programme
of the Doctoral School of Health Sciences, Faculty of Health Sciences, University of Pécs.
Names of the supervisor(s): Dr. Med. habil. Béla Kocsis

At the same time, I declare that
- I have not submitted my doctoral dissertation to any other Doctoral School (neither in this country nor abroad),
- my application for degree earning has not been rejected in the past two years,
- in the past two years I have not had unsuccessful doctoral procedures,
- my doctoral degree has not been withdrawn in the past five years,
- my dissertation is independent work, I have not presented others' intellectual work as mine, the references are definite and full, on preparation of the dissertation I have not used false or falsified data.

Dated: 10/06/2022

Dr. Med. habil. Béla Kocsis
Supervisor

Sahar Hammoud
Candidate