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NURSING INTERVENTIONS FOR INFECTION PREVENTION AND CONTROL: FOCUS ON DROPLET INFECTION

A Simulation Scenario for Savonia University of Applied Sciences

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THESIS
Abstract

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Abstract

The awareness of infection prevention and control has risen in the recent one year due to the COVID-19 pandemic spreading around the whole world. The pandemic was firstly outbreaking at the beginning of 2020, until today it is an ongoing global infectious disease with highly variable symptoms from none to life-threatening. The transmission of COVID-19 is mainly through the droplets from person to person. The virus is transmitted through the respiratory route by coughing, sneezing, singing, talking or breathing. To prevent and control the transmission of COVID-19, WHO and CDC strongly recommend utilizing the droplet precautions in the healthcare settings. It is important that nursing students are to be educated with the droplet precautions in case of meeting the patients who have droplet transmissible diseases. This simulation practice is a safe and realistic way for nursing students to practice droplet precautions measures, decision-making and interactions when taking care of the patient with suspected COVID-19.

The purpose of this thesis was to produce a simulation scenario on infection prevention and control for Savonia University of Applied Sciences. The thesis aims to improve and enhance nurse students' knowledge of and competence in infection prevention and control through this created simulation scenario, especially on the droplet transmissible infection control. Qualitative feedback on the simulation scenario from two groups of nursing students at Savonia was collected and analyzed to help to improve the simulation scenario design. The simulation was piloted with the first year and second year international students (29) at Savonia.

According to the written feedback from the students, the simulation increased their knowledge of donning and doffing the PPE of droplet precautions. In addition, they had better understand of taking care of a patient who has the anxiety for COVID-19 and shortness of breath. Most of the students mentioned that simulation was necessary in infection prevention and control. The supervisors of this thesis who were attending and observing the pilot tests gave comments that the simulation scenario was comprehensive for treatment of a COVID-19 case, it can be used in Finland and in many other countries. The objectives of the simulation are realistic and accessible in the simulation.

The production of this development work is a demonstrative scenario of learning and practicing the droplet precautions on donning and doffing PPE, vital signs measurement for the patient with dyspnea, decision-making skills and communication skills between nurses and the patient. In future, a pre-course about droplet precautions and nursing interventions on dyspnea can be planned before this scenario-based simulation. In addition, the simulation could be developed and practiced in different countries in the healthcare settings. The scenario can be adapted and developed for health care personnel from wide range disciplines such as paramedics, mental health, pediatric nursing and radiography for their continuous education. However, no matter how the patient case is to be adapted, the original learning objectives for this scenario-based simulation should not be changed.

Keywords
Droplet transmission, droplet precautions, scenario-based simulation, pilot test, COVID-19, dyspnea

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1 INTRODUCTION

Since the outbreak of the COVID-19 pandemic at the beginning of 2020, there has been evidence that infectious diseases not only affect human health, but also bring a social problem that cause tremendous consequences for each individual and the world. Covid-19, a kind of coronavirus affects the respiratory system (Cascella, Rajnik, Aleem, Scott & Raffaela 2021). According to the World Health Organization (WHO) COVID-19 Dashboard, there have been over 116.8 million confirmed cases of COVID-19, including 2,597,381 deaths by 9 March 2021, and the numbers are still rising (WHO 2021).

Infectious diseases are caused by infectious agents (germs or micro-organisms) that enter the body, multiply, spread, and cause pathogen, sickness, or even death (Potter & Perry 2014, 166). According to WHO report, infectious diseases are one of the leading causes of death. Especially the lower respiratory infections were on the fourth place in the top 10 causes of deaths in the world (WHO 2018). There were 15.5 million visits to physician offices with infectious and parasitic diseases as the primary diagnosis in the United States in 2016 (CDC 2020a). The infectious diseases such as lower respiratory infections, HIV/AIDS, and diarrhea were the main causes of death in Africa in 2016 by killing 2.3 million people (WHO 2016). In Europe, the seasonal influenza epidemics caused roughly about 38,500 deaths not only among the groups with high risks such as elderly and pregnant women, but also among young persons (Preaud, Durand, Macabeo, Farkas, Sloesen, Palache, Shupo & Samson 2014). The COVID-19 epidemic has caused 307,125 deaths in the EU/EEA and UK by 26 November 2020 (ECDC 2020). In Finland, the reported infectious diseases are about 140,000 each year. The COVID-19 has caused 388 deaths out of reported 22,652 cases by 25 November 2020 (THL 2020a).

The Covid-19 pandemic crisis has triggered social and economic recession and disasters worldwide. The spreading of Covid-19 proved that not even today can any country be free from the threat of infectious diseases. Emerging and re-emerging of infectious diseases present dangers and crises around the whole world in a rapid speed nowadays. The scale and complexity of infectious diseases, the increased resistance ability of microbes to drugs, the development of transportation, and the poor condition of sanitation make the crisis of infectious diseases great. Therefore, infection prevention and control from infectious possibilities play significant roles in alleviating threatens and enhancing social and economic development. (Bloom & Cadarette 2019; Smith, Machalaba, Seifman, Feferholts & Karesh 2019; Hauck 2018.)

There are plenty of evidence-based studies identified that infection spreads and transmits due to poorly understood and non-compliance with the guidelines of infection prevention behaviors. For example, ignorance of hand hygiene and inappropriate use of protective equipment in the healthcare practice increase potentials of infection transmissions among nurses and patients. (Alzyood, Jackson, Brooke & Aveyard 2018.)

There are three types of micro-organism transmission routes: contact, droplet and airborne (Potter & Perry 2014, 173). The droplets spread in human beings by talking, breathing, sneezing, and also coughing. Besides, a variety of viruses, bacteria, and fungi may be potentially included. These viruses, bacteria, and fungi are called infectious agents, which have the capability to the host, by a portal of entry, multiply to cause harm and outbreak. Therefore, nurses and nurse students need to be aware of their roles in interrupting transmissible possibilities when having direct contact with patients. Their awareness and competence to carry on the responsibilities of keeping their patients and themselves away from infectious droplets and pathogens play a crucial role in epidemics and infection control. (Rebmann & Carrico 2017.)

Quality training such as intervention in the compliance of hand hygiene can improve nurses' compliance and knowledge of nursing interventions for infection control (Ara, Bashar, Tamal, Siddiquee, Mowla & Sarker 2019). Poor quality adherence to infection control standards can be frequently seen among health care professionals, which can push patients and nurses themselves into potential risks. According to the pilot studies, using high-fidelity simulation training can reinforce infection control skills and improve multi-professional communication. (Luctar-Flude, Baker, Hopkins-Rosseel, Pulling, McGraw, McGraw, Medves, Krause & Brown 2014.)

The purpose of this thesis which is as a development work was to create a simulation scenario on infection prevention and control for Savonia University of Applied Sciences. The thesis aims to improve and enhance nurse students' knowledge of and competence in infection prevention and control through a simulation scenario, especially on the droplet transmissible infection prevention and control. Qualitative feedback on the simulation scenario from nurse students at Savonia was collected and analyzed to help to improve the simulation scenario design. Because the main content of this thesis is to focus on the prevention of droplet transmission infectious diseases, the output of the thesis project will contribute to knowledge of and competence in droplet transmissible infection control based on simulation-based education.

The simulation scenario is also part of a project of Eramus+ Innovative Infection Prevention and Control Practices in Healthcare Settings (InovSafeCare), which started on 01.09.2018 and will be continue till 31.12.2021. The project is carried out by universities in Portugal, Spain, Poland, and Finland. The purpose of the project is to design and develop structured education and training to the students in the healthcare field on innovative infection prevention and control practice. The project will facilitate nursing students to have good practices and awareness of the HAIs prevention and control, and e-book and simulation scenarios will be synthesized systematically based on international recommendations for good practices within HAIs prevention and control. Savonia is one of the health professional education simulation facilities that conducts this project in Finland.

2 DROPLET TRANSMISSION AS A THREAT TO PATIENTS' SAFETY

Healthcare professionals have responsibilities for patients' safety. In the multi-professional team, nurses work beside the patients for 24 hours, they provide different domains of care and make efforts in prevention and control of HAIs (de Lima Ferreira, Nóbrega de Azevedo, Candido de Oliveira Salvador, Medeiros de Morais, de Melo Paiva R, Pereira Santos 2019). Especially, some infectious diseases are transmissible, which means they have capabilities to spread from person to person through either direct or indirect mechanisms. For example, droplets transmission containing microorganisms generate by coughing, sneezing, and talking. As infectious diseases are a leading cause of illness and death around the world, the Centers for Diseases Control and Prevention (CDC) provides serials of infection precautions for healthcare professionals to reduce possible threats to patients' safety. (CDC 2016.) Among these transmission-based precautions, the droplet transmission and precautions are studied in this chapter.

2.1 Healthcare-associated infections (HAIs), and the chain of infections

Infections acquired in the health care facilities are called healthcare associated infections (HAIs) (Openstax 2020). HAIs is a leading cause of death which is responsible for more deaths than other top leading causes of death in the U.S., although HAIs can be prevented by good practice (Haque, Sartelli, McKimm & Abu Bakar 2018). The HAIs can cause more chronic viral infections, which can be liver and cervical cancers and their threats to patients' safety (CDC 2020a). Besides, infectious diseases can, as known, cause chronic diseases as the hepatitis B virus can turn into hepatocellular carcinoma and helicobacter pylori can become gastric cancer (CDC 2011). Globalization also provides more opportunities for the spreading of infectious diseases. Although scientists have a greater knowledge of microbes and their structure, biological and chemical characteristics, the infectious mutation and adaptation properties make them difficult to overcome (Sanjuán 2012).

HAIs were defined as infections that are not presented at the admission time to a hospital or a healthcare organization and acquired during the treatment process or even after the discharge. In hospitals, there are many risks of infection transmission from one patient to another, health care workers, and even visitors. The mortality and morbidity caused by hospital-acquired infections (HAIs) are quite high in the United States. (Benson & Powers 2011.) HAIs occurred frequently in the healthcare providing process under the factors related to patients' status and the environment of institutions. Patients' status including age, immunity condition, illness, nutrition, medication, and treatment procedure are patient-related factors, whereas institution-related factors are usually concerned with the number and quality of healthcare personnel, the building hardware facility, insufficient hand hygiene, disinfection and isolation practices, and proper usage of personal protective equipment (PPE). (Kirtil & Akyuz 2018.) HAIs are not only public health care problems but also economic issues to society. The prevention and control of infections become one of the most important practices for patient safety issues and a well-functioning health care system. The infection control

practice is to break an element in the chain of infection, which consists of an infectious agent, a reservoir for pathogen growth, a portal of exit from the reservoir, a transmission model, a portal of entry to the host, and a susceptible host. (Potter & Perry 2018, 242.)

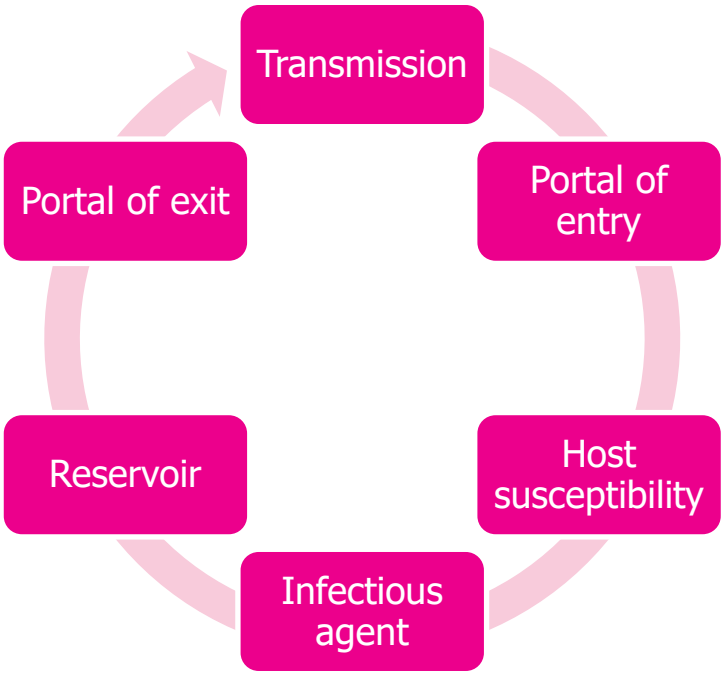

FIGURE 2. Chain of infection (modified from Potter, Perry & Ostendorf 2018, 242)

An infection agent can be a pathogen presented micro-organism such as bacterium, virus, fungus, parasite, or prion. The virulence of organisms is decided by the pathogenicity and the ability of the organism to cause diseases. A reservoir is a place where the micro-organisms live and reproduce. The reservoir can be humans, animals, food, water, and any contaminated surfaces. Rigorous hand hygiene and disinfection measures will minimize the reservoirs for micro-organisms. A portal of exit from the reservoir is the site where the micro-organisms leave the host to enter another new host and cause diseases. The micro-organisms leave the portal of exist through sneezing or coughing. There are four modes of transmission: contact transmission, droplet transmission, airborne transmission, and vehicles. These modes of transmission are introduced in detail in the subchapter below. A portal of entry is a place where a pathogen can have means of getting into the new host. For example, the mucous membranes of mouth and nose and blood supply can be portal entries for pathogens. A susceptible host is a person who is fatigued to be more likely to become infected. Keeping immunity strong, staying healthy and paying attention to personal hygiene will help infection prevention. (Potter, Perry, Stockert & Hall 2013.)

2.2 The droplet transmission

There are four common routes of transmission: contact (direct and indirect) transmission, droplets transmission, airborne transmission, and common vehicle transmission. Contact transmission includes direct and indirect contact routes. Direct contact transmission occurs through physical contacts like skin-to-skin contact between an infected person and a susceptible person. Direct contact

infections spread when a susceptible person has direct physical contact via blood or body fluids with an infected person who carries infection-causing micro-organisms. Indirect contact transmission occurs when an infectious agent is transferred from a reservoir to a host through contaminated objects or surfaces, or vectors such as mites, mosquitoes or rodents. For example, when an individual with common flu coughs or sneezes and then wipes their nose and touches some objectives like the table or doorknob, a susceptible host may later touch the same contaminated objectives, and the infectious agent will be transferred to the new host (Lumenlearning n.d.). Airborne particles containing micro-organisms are suspended in the air for a long period and can be widely spread by air currents. In contrast with larger droplets, airborne transmission via aerosols is long staying dispersed in the air, which allows that it can transmit infectious agency over an extended distance and time. An inhaled virus agency carried by aerosols deposit directly along the human respiratory tract. (Zhang, Li, Zhang, Wang & Molina 2020.) Common vehicle transmission refers to micro-organisms transmitted by vehicles such as water, air, medications, medical devices, and food. The contamination of drinking water caused more than 500,000 deaths each year. (WHO 2019.)

Droplet transmission occurs when someone is close to the infected person within 2m (Jayaweera, Perera, Gunawardana & Manatunge 2020). The droplets contain a large number of epithelial cells, electrolytes including K+, Na+, and Cl- in the saliva and other respiratory secretion forms (Anand & Mayya 2020). These micro-organisms generated by droplets have abilities and possibilities to enter the portal of entry- the new host's system by the spraying of large droplets onto mucous membranes or conjunctiva membranes. For example, the influenza infection droplet particles can retain on the surface of mucous in the upper respiratory tract if they are larger than 10μm. The most common types of viruses that can cause respiratory infections are influenza viruses, coronaviruses, respiratory syncytial viruses (RSV), and rhinoviruses. They can also be generated and transmitted through droplets and aerosols. (Jayaweera, Perera, Gunawardana & Manatunge 2020, WHO 2020a.) If the droplet nuclei are smaller than 5μm, they can be inhaled into and stay in the lower respiratory tract. On the other hand, the term "airborne transmission" is used to describe infection by smaller droplet aerosols. When the droplets linger on the surface of the upper respiratory tract, there are transmission possibilities utilizing contact, so both droplets and contact precautions should be considered at the same time when dealing with droplet transmissible infections. (Killingley & Nguyen-Van-Tam 2013.)

The term droplet usually refers to droplet >5 μm in diameter and fall rapidly on the ground, the contaminated distance is limited (e.g. ≤1 m). Droplet nuclei refers to ≤5 μm droplets in diameter that can stay in the air for some time that allow them to suspend and transfer to over 1m ranges. However, other studies may use small and large droplets and droplet nuclei to describe ≤60 μm in diameter and >60 μm in diameter and <10 μm in diameter. (Atkinson, Chartier & Pessoa-Silva et al. 2009.) The World Health Organization (WHO) also pointed out that the particles of more than 5μm may be defined as droplets, with less than 5 μm as aerosols or droplet nuclei. The term "airborne transmission" is used to describe infection by smaller droplet aerosols. However, there are some other different definitions of droplets and aerosols that aerodynamic diameter of 20 μm or less should be defined as aerosols since they have the ability to linger in the air for a prolonged time as

well. The small aerosols are more easily to be inhaled into the deep lung and even reach in the alveolar tissues, while the droplets are more susceptible to be attached in the upper respiratory tract. (Jayaweera, Perera, Gunawardana & Manatunge 2020.) Figure 3 explains the distinction between droplet transmission and aerosol transmission.

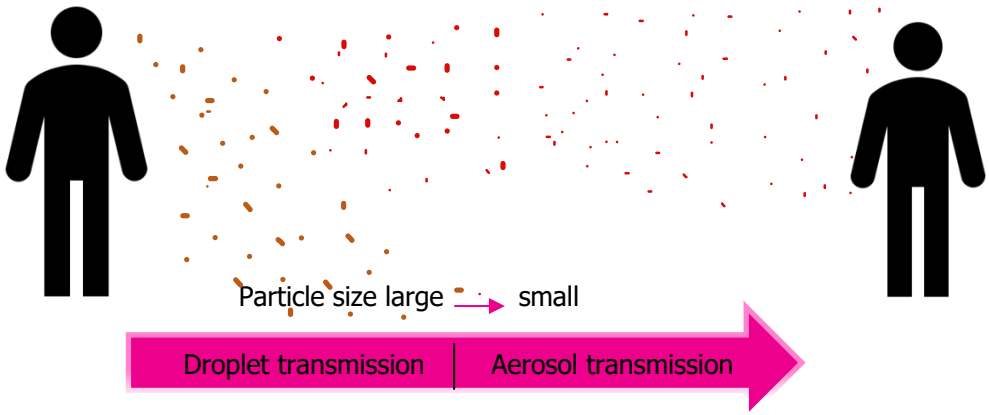

FIGURE 3. Comparison between droplet transmission and aerosol transmission (modified from Pan, Lednicky & Wu 2019)

2.3 Prevention of HAIs in droplet transmissible infectious diseases

The droplet precautions are designed to be used in addition to standard precautions especially to the health care professionals when the patient may have known or suspected infection (THL 2020d). The prevention strategies of droplet transmission are standard precautions for all patient care and droplet precautions for patients who are infected or suspected with infectious agents to prevent infection transmission (CDC 2016). Standard precautions are used to prevent the risk of transmission of infections including dealing with all body fluids and wastes. The aims of standard precautions are using common sense of practices and personal protective equipment (PPE) to protect health care workers and the spread of infection from patient to patient. Standard precautions include performing hand hygiene, using personal protective equipment (PPE), following respiratory hygiene, ensuring appropriate patient placement and handling patient care equipment and instruments properly. (WHO 2014; CDC 2016.) Moreover, the standard precautions also mention handling textiles and laundry carefully, following safe injection practices, and ensuring health care workers' safety including proper handling of needles and other sharps. THL classifies that droplet precautions belong to transmission-based precautions, which are the second tier of infection control. (CDC 2016, WHO 2020c, THL 2020d.) Droplet precautions are to be used when patients are known or suspected with risks for droplet transmission. Droplet precautions include source control, ensuring appropriate patient placement, using PPE appropriately, and limiting the transport and movement of patients. (CDC 2016, WHO 2020c, THL 2020d.) To prevent the HAIs, nurses should clean the patient equipment every time before and after using them and carefully store and draw up the doses of medications (Irish Medicines Board 2010).

TABLE 1. Summaries of standard precautions and droplet precautions (Minnesota Department of Health 2019; CDC 2016)

	Standard precautions	Droplet precautions
PPE	Clean and non-sterile gloves used when touching contaminated items Fluid resistant, non-sterile gown used when contacting with blood or body fluid Masks used when potential contacting with respiratory secretions and sprays of blood or body fluids Goggles and face shields used for potential splash or spray of blood, body fluid or respiratory secretions	Long sleeves gown, surgical mask, face shield, and gloves are worn just before entering the room Make sure eyes, nose and mouth are fully covered before room entry Masks and respirators: surgical mask or FFP2 or FFP3 or N95
Hand hygiene	Always Before entering room After contacting the patient Before leaving room	Always Before entering room After contacting the patient Before leaving room
Inject safety	Proper use and handling supply for injection and infusions	Proper use and handling supply for injection and infusion
Equipment	Proper handle, clean and disinfect patient care equipment and devices	Proper handle, clean and disinfect patient care equipment and devices
Room		Place the patient in a single room with a closed door or in a separate area as far from other patients as possible
Patient		Limit transport and movement of patients outside Instruct patient that wearing a facemask if moving outside of the room is necessary

Based on the infection precautions guidelines from the CDC and the State of Minnesota Department of Health, the author of the thesis made a table (Table 1) to introduce the standard precautions and

droplet precautions explicitly. Standard precautions are the minimum prevention steps to the infections whereas droplet precautions are necessary when facing a patient infected with infections that are transmittable through droplets (Douedi & Douedi 2020).

The COVID-19 virus was firstly reported in Wuhan, China in December 2019. Coronavirus can cause severe acute respiratory syndrome and has been proved to be transmitted from human to human via droplet and contact transmission. (Jayaweera, Perera, Gunawardana & Manatunge 2020.) It has affected worldwide over 116 million confirmed cases by 9 March 2021 (WHO 2021). The form of the Covid-19 virus is usually round or elliptic shape and often with pleomorphic. The diameter of the virus is approximately 60–140 nm. It is sensitive to ultraviolet rays and heat. Also, the virus is effectively inactivated by lipid solvents including ethanol, chlorine-containing disinfectant, and peroxyacetic acid. (Cascella, Rajnik, Aleem et al. 2021.) Although some publications mention about the airborne transmission possibility of the COVID-19 virus, the transmission is proved to occur via respiratory droplets from coughing and sneezing (THL 2020c).The Finnish Institute for Health and Welfare (THL) also claims that Covid-19 is transmitted through direct contact and droplets (THL 2020d). The transmission of the COVID-19 virus can also occur through fomites in the environment where the infected person has stayed (WHO 2020a). Airborne transmission may be possible for COVID-19. However, it still needs more evidence-based studies to prove the potential mode of transmission by airborne. (Klompas, Baker & Rhee 2020.) WHO continues to recommend droplet precautions and contact precautions for healthcare workers who care for COVID-19 patients. WHO also recommended that when managing with patients infected with COVID-19, the healthcare workers should be provided with appropriate personal protective equipment (PPE) by following the standard and droplet precautions. (WHO 2020b.)

2.4 Nurses' roles in the prevention of droplet transmission

The application of standard and transmission-based precautions and required immediate actions are basic clinical skills and should be mastered by all nurses. Nurses are in particular with the responsibility of providing daily patient care, it is important for nurses to apply infection prevention and control to prevent HAIs. (Mitchell, Gardner, Stone, Hall & Pogorzelska-Maziarz 2018.) The International Council of Nurses (ICN) has reported that more than 3,000 nurses died from COVID-19 in 60 countries since March 2020 and estimated millions of nurses have been reeling under the COVID-19 (Majeed 2021). Therefore, the infection prevention and control of this new virus require more rigorous measures and methods from prompt detection, diagnosis, treatment, and isolation. Evidence-based studies demonstrated that it is very important for nurses to have sufficient education and skills to be able to carry out their knowledge into practice. (Kirtil & Akyuz 2018.) Thus, developing an education program on infection prevention and control for nurse students and nurses is extremely necessary (Salem 2019).

The transmission of infections between patients and health care workers are not rare cases in hospitals due to their mutual relationships (Waramlah & Huda 2019). The exposure to blood and body fluids, the syringe needle injuries, the mucocutaneous contact, and exposure to contaminated surfaces increase the risks of HAIs in nurses' work (Shokuhi, Gachkar, Alavi-Darazam, Yuhanaee &

Sajadi 2012). Nurses are more likely to be exposed to blood or body fluids. Different exposure routes require nurses to have different practicing interventions for preventing infections (Gooch & Wadhwa 2020). There are approximately 100,000 healthcare-associated infections (HAIs) in Finland each year (THL 2020b). The route of transmission, the method of transmission, and the patient and their immunity compose a chain of events that cause HAIs (Rebmann & Carrico 2017).

Therefore, nurses play significant roles in preventing HAIs, not only by following the evidence-based healthcare practice but also by building up consciousness of infection prevention and control through nursing education and training. Nurses should master different modes of precautions of infection control in different circumstances (according to the CDC guidance), for example, standard precautions are aimed to minimize the transmission possibilities that apply to all patient care. If standard precautions alone cannot be applied to prevent transmission, then nurses should consider transmission-based precautions such as droplet precautions to prevent the diseases that can spread through coughing, sneezing and breathing. (AMN Healthcare 2015.)

In the droplet precautions, nurses should be familiar with the procedure steps when facing an isolated patient with a possible or confirmed droplet transmissible disease. First of all, hand hygiene is another important measure for nurses to prevent infections. Effective hand washing is accomplished with plain soap or antimicrobial soap and alcohol-based hand rubs as acceptable substitutes. (AMN Healthcare 2015.) Then nurses need to don the necessary PPE to the anteroom or the area immediately outside the patient's room. PPE for droplet precautions include surgical mask, long sleeves gown, goggles, non-sterile gloves, which should cover the cuffs of the gown. When doff the used PPE, discard and remove them appropriately in the patient's room, mask is the last one to be discarded, and before doffing the mask, hand hygiene should be performed. The patient with droplet transmissible risk is always placed in a private room or with another patient with the same diagnosis, the door should be kept closed. Nurses have the responsibilities to educate the patient about the limitation of movement beyond the room. Also, nurses educate the patient to adhere to cough etiquette and respiratory hygiene. At the same time, nurses are educated to pay attention to the patient's psychological status as well. (EBSCO Health 2018.)

Nurses must always keep the awareness of fostering a safe environment to minimize the risks of infections. All in all, nurses hold the roles of setting appropriate measures in infection prevention and control by using their knowledge, skills and judgement in different nursing contexts. Nurses also hold the roles of following the principles and guidance to practice diligently and keep safety in mind. (AMN Healthcare 2015.)

3 DEVELOPING SCENARIO-BASED SIMULATION EDUCATION

The term "simulation" was defined as a pedagogy using one or more typologies to improve participants' skills and knowledge. This broad definition applies to various experiences and methods from low fidelity of learning psychomotor skills to producing high-fidelity scenarios with mannequins which can talk and have vital functions, or with standardized patients. (Bambini 2016.) Simulation-based education was initially designed for aviation industry and this method has been adapted for medical education in learning specific skills in urgent situations. Later it was introduced in the whole training of treatment practices as well as in the nursing education. (Haugland & Reime 2018, Bilotta, Wearner, Bergese & Rosa 2013.)

Simulation-based education provides an active learning method for learners to develop their critical thinking, problem-solving and reflection skills through mimicking realistic clinical situations in a life-like but a safe environment (Sim-Versity 2020a). Nowadays simulation plays a significant role in nursing education. Learning through simulations can allow students to participate by themselves in the professional context and receive experiences through clinical environment and reflection. (Abe, Kawahara, Yamashina & Tsuboi 2013.)

3.1 The scenario-based simulation in nursing education

The scenario-based simulation education mimics real situations in the health care settings to allow students to put theories into practice, to increase their competency and to gain a reflective attitude toward their profession (Haugland & Reime 2018). The scenario includes the objectives, target population, description of the situation, and expected actions for the students (WHO Europe 2018). Scenario-based simulation can improve and reinforce health care students' infection control and interprofessional communication skills (Luckar-Flude, Baker, Hopkins-Rosseel, Pulling, McGraw, Medves, Krause & Brown 2014). It is also proved that scenario-based simulation has the strengths of allowing verifiable learning outcomes from simulation actions that consisted by lectures and clinical setting with unpredictable critical events (Abe, Kawahara, Yamashina & Tsuboi 2013).

There are three types of scenario-based simulations: low-fidelity simulation, in which objectives focus on knowledge and psychomotor skills, medium-fidelity simulation, in which objectives focus on in-depth knowledge and psychomotor skills and techniques, and high-fidelity simulation, in which objectives focus on non-technical skills like communication and teamwork. (Bambini 2016.) Fidelity has been defined as the degree to the reality that is implemented in the simulation. In recent years, high-fidelity simulation which uses human patient simulators has been playing a significant role in the scenario-based simulations. A computer-based mannequin, decision making based on the experiential training skills and knowledge, and a safety environment are available in this type of simulation. High-fidelity simulation provides learners with a safety environment, which can also develop non-technical skills to avoid mistakes and correct them in real time. In addition, high-fidelity simulation increases learning retention and knowledge reinforcement as well as it improves healthcare team outcomes. (Carey & Rossler 2020.)

Scenario-based simulation motivates students to engage in a realistic situation and experience the treatment practice. Participants learn by thinking, acting, and reflecting as a whole group together. (Silén-Lipponen 2014.) This type of simulation has been used in nursing education and it is attracting more and more attention, as involving the contents about medical error, patient safety, fast response in settled clinical practice, and a desire to provide clinical experiences for nursing students and staffs (Nalge, McHale, Alexander & French 2009). Although the expense of personnel, clinical supplies and equipment to support a simulation is costly and time-consuming, simulation provides students with a non-threatening learning environment and encourages students to involve in the process to foster learnings, problem-solving and application of clinical knowledge (Martin, Cross & Attoe 2020). WHO strongly recommended using simulation methods in health professionals' education and training (WHO 2013).

There are many studies that show that scenario-based simulation education has brought significant improvement to nursing education. According to Aura et al. 2017, radiographers in the simulation-based group had better learning results than the web-based learning group. Also, Bland and Tobbell (2016) stated that simulation education facilitated students to learn to nurse in a supportive, motivating and intellectually curious environment which enabled them to have more successful learning outcomes. Besides, debriefing in the simulation is effective as it can improve performance and individuals' self-perception of competence. Students have learnt from their mistakes by reflecting on the experiences and observations (Dufrene & Young 2014) and there has been shown greater retention than in the lecture-based learning methods (Maddry, Varney, Sessions, Heard, Thaxton & Ganem 2014). Well-designed simulations can increase students' satisfaction and self-confidence, expand and consolidate knowledge, improve critical thinking and clinical reasoning in complex care situations. Besides, students' clinical skills, such as venipuncture, intubation and PPE administration, can be practiced for ensuring safety clinical practice environment. Simulations also help students in developing ethical attitudes and behaviors and the ability for decision-making in clinical situations. (WHO Europe 2018.)

3.2 Designing a scenario-based simulation

In order to design a scenario-based simulation, building the scenarios and preparing the environment should always be included. When designing a scenario-based simulation, the prewritten clinical scenario should be geared to the experience and skill level of the learners. (Hsu, Chang & Hsieh 2014.) The script of scenario is usually written on a template which includes the learning objectives, scenario introduction, the participants' roles, the needed equipment, clinical parameters for the patient, tasks for observers, back-up plan or exception strategies, termination of the simulation and some questions and points to be discussed in the debriefing. In order to maximize the benefits from simulations, the scenarios should be well-designed to ensure students to have a positive learning experience in applying new theory and skills into practice. (Bambini 2016.)

The scenario script consists of the objectives of learning and different phases of learning processes (Bambini 2016). Identifying the educational outcomes and students' level is important when designing a scenario. The scenario is the plan that provides a detailed context for the simulation to describe an actual situation and to set the realistic objectives for the simulation. Objectives mean the specific outcomes and behaviors students involved in the simulation are wanted to learn. The objectives should be clear and made based on students' knowledge and skills. (Bambini 2016.)

The next step is to describe the patient in a settled situation. The description also offers a context that tells the care unit, the patient's background, equipment, supplies, and available resources (Bambini 2016, Harrington & Simon 2020). The description helps the teachers and students to understand the process in the scenario (WHO Europe 2018). The patient case should be as realistic as possible so that students have more confidence in putting their knowledge into real-world practice. Therefore, the presenting symptoms, medication, allergies, data summary, labs, and patient examination should be realistic in a scenario design to allow for a planned action. (Harrington & Simon 2020.) The flow of scenario includes patient's care needs assessment such as vital signs and symptoms and the patient's condition changes in different phases during the process (Bambini 2016). In other words, the content of the simulation scenario includes the patient's medical history, current situation and the potential changes in the situation with the patient.

The role description of the teacher and the presence of another teacher or facilitator to guide the progress and support to achieve the objectives of the simulation are always important (WHO Europe 2018). Also, the roles of actors in the scenario are divided, observers' tasks are divided, and the objectives of the simulation are emphasized (Sim-Versity 2020a).

When designing the scenario, it is significant to decide what kind of simulator will be used in the simulation. The chosen simulator should be the most appropriate to meet the needs and objectives of the simulation. An expensive high-fidelity simulator is not suitable for developing specific skills as an economic low-fidelity mannequin can fulfill the requirement. However, a high-fidelity simulator can create a realistic and accurate clinical practical scenario. (WHO Europe 2018.)

After the scenario designing, the next step is preparing the environment. Preparing the environment includes ensuring the availability of realistic materials and equipment that are similar to those used in an actual clinical setting, such as (depending on the scenario) medical gas wall outlets (suction, oxygen and air), a fully supplied emergency cart, results from diagnostic exams, patient charts (in paper or digital format) and a phone, among others. Some complexity factors can be added to the scenario. The roles of relatives or other health professionals may become facilitators or barriers to support the achievement of the objectives. (Bambini 2016.)

To advance the science of simulation and provide a framework for promoting effective simulation-based practice, the International Nursing Association for Clinical Simulation and Learning (INACSL) developed the standardized simulation design INACSL Standards of Best Practice. This INACSL

standards develop and facilitate effective well-structured health care simulation design by providing 11 criteria (see Table 2).

TABLE 2. Criteria of the INACSL standards (INACSL 2016).

Criteria to meet the standard	**Content**
Criterion 1 needs assessment	A needs assessment to provide well-designed simulation-based experiences
Criterion 2 objectives construction	Construct measurable objectives to optimize the achievement of expected outcomes
Criterion 3 format of simulation	Structure the format based on purpose, theory and modality
Criterion 4 scenario	Design a scenario to provide the context
Criterion 5 fidelity	Design appropriate types of fidelity to create the required perception of realism
Criterion 6 facilitators	Maintain a facilitative approach that using a level of facilitators to achieve the expected outcomes
Criterion 7 briefing	Conduct briefing phase to identify the expectations based on learners' levels and theoretical framework
Criterion 8 debriefing	Debriefing after the simulation to enrich learning
Criterion 9 evaluation	Evaluation of the learners, the facilitators, the simulation and the facility to ensure the quality of effectiveness
Criterion 10 preparation	Offer preparation materials and resources to learners for addressing the knowledge, skills and expected outcomes
Criterion 11 pilot test	Pilot test before full implementation of the simulation to ensure content validity and reliability

These criteria provide detailed design process for developing simulation-based experiences and improving the simulation expected outcomes and operating procedures. The criteria also guide the design and implementation of the scenario-based simulation for this thesis to approach optimal and efficient utilization of resources as well as meet identified objectives and outcomes. (INACSL 2016.)

3.3 Implementation of a scenario-based simulation and debriefing

A scenario-based simulation consists of three steps: briefing, action and debriefing (Sim-Versity 2020c). Briefing happens before the simulation action, the aim is to prepare and orientate learners

with psychologically safety learning environment. The psychological safety in the environment is created by tackling previous studies to identify what should be known, reviewing the learning objectives, familiarizing the education equipment and environment. (Hughes & Hughes 2020.)

During the simulation action, the patient care situation is played, and it will be ended when the education goals and outcomes are achieved. The observers reflect the gains and decays through their observations of the simulation act. The evidence-based studies show that there is no difference between observers' learning and the role-play participants' learning. (Rode, Callihan & Barnes 2016; Johnson 2019.) During the action, the agreed roles of the learners carry on the simulation based on the guidance of the instructor. The instructor controls the simulation to keep the simulation as realistic as possible. The students are allowed to have some flexibility in the decision-making and interventions. (Lateef 2010.) Stopping or restarting the simulation can be used if necessary, because of serious errors, for instance. Then the instructor should provide support and cues to learners about the correct intervention and let the learners think about the reasons and how to do it. The simulation can continue after the discussion and suggestion. (Sim-Versity 2020a.) Time-out /time-in technique can be used to support the learners' actions into the correct direction in the scenario as instructors expect (Bambini 2016).

The debriefing occurs shortly after the action, including the learners' reflection on what happened in the action and what can be done differently (Oliveira, Massaroli, Martini & Rodrigues 2018; Sim-Versity 2020c.). After the action, the instructor also leads the debriefing about feelings and reactions to the simulation, the positive actions and actions which need to be developed, and then encourages the learners to identify what knowledge and skills they have learned from the simulated scenario. The learners are encouraged to express their own opinions and feedback on the simulation. However, their feedback may not always be correct, and therefore the instructor should have the ability to guide the discussion into a right direction. The debriefing is a very important step of the scenario-based simulation as it contributes to future teamwork, the realization of weaknesses, ethical behavior, knowledge of clinical techniques, and methods in the same clinical context (Sim-Versity 2020b.) In general, debriefing is a process where there is self-reflection, self-assessment and discussion about the learnings and experiences during simulation practice that reinforces good practice, facilitates to learn from the mistakes, and fosters decision-making and teamwork abilities. The action step together with debriefing provides students opportunities to develop critical thinking, creative ability and decision-making ability. (Bortolato-Major, Mantovani, Felix, Boostel, Silva & Caravaca-Morera 2019.)

TABLE 3. Three steps of clinical scenario (Sim-Versity 2020c; Hughes & Hughes 2020)

Step	**Content**
Briefing	• Reviewing the learning objectives • Introducing background of the scenario and revealing knowledge gaps

	• Creating psychologically safety environment
Action (simulation)	• Role players are guided to the simulated environment while the observers observe from a screen in an adjacent room • Outcomes and instructors' corrections are based on learners' interventions
Debriefing	• Common, teacher guides reflection of the role players and observers • Highlight the positive actions aligned with the learning objectives • Reinforce critical thinking skill and consolidate knowledge and skills

To implement a scenario, the instructor should consider the required materials and resources to achieve the educational objectives, the available equipment and elements that can guide and support students' decision-making during the process of the simulation. Also, the instructor should pay attention to the cultural perspectives during the simulation teaching. The cultural perspectives include learners from multicultural group and communication and patient guidance under cultural context. Students may feel stressed if they do not know how much criticism there will be, so it is important to provide a psychologically safe environment before the simulation. (Sim-Versity 2020c.)

However, for a successful simulation, the learning environment should be staged, the scenario well-designed and the objectives clarified before performance. Moreover, the instructors should have the ability to facilitate the process and students actively motivated (Bland & Tobbell 2016). If the environment in which the scenario takes place during the simulation does not accurately replicate reality, students will not experience it as simulated clinical practice (WHO Europe 2018).

4 IMPLEMENTATION OF DEVELOPMENT WORK

In this chapter, the aims and purposes of the thesis and the research method used in this thesis are reviewed. The planning and process of the thesis work and in addition the pilot test and feedback on the simulation from a group of students are introduced in this chapter.

4.1 The aim, purpose and target group

The purpose of this development work was to produce a simulation scenario for the training of nursing students on droplet transmissible infection control. The client organization was Savonia University of Applied Sciences. This thesis project aims to improve nursing students' competencies and skills in preventing HAIs for droplet transmissible infections.

The target group of this development work are nursing student groups, especially both first year and second year nursing students. The co-operational institution is Savonia University of Applied Sciences which is one of the health professional education simulation facilities in the project InovSafeCare Project. This transnational educational project is co-financed by Erasmus+, the aim of which is "Educating students for innovative infection prevention and control practices in healthcare settings". The project provides structured education and training for preventing and controlling of HAIs. This project aims to produce simulation scenarios and to facilitate nursing students to learn and develop good practices in the field of HAIs prevention and control. The simulation scenarios for this project are made from the synthesized versions of good practices in HAIs prevention and control. This simulation scenario design is appropriate for nursing students and nursing staffs as the scenario design is targeted at prevention and control of HAIs by promoting droplet precautions.

4.2 Method/ production process

This thesis is a development work which aims to produce innovative and better services, means of production or methods. The final objective for the development can be a product, service, work community, method, and own work development. (Savonia Moodle 2020.)

The idea of writing a thesis about prevention and control of infectious diseases came from the outbreak of COVID-19 at the beginning of 2020 in the author's home country. The identification of the development target that focuses on creating a scenario for droplet precautions was instructed by the supervisors of the thesis. The thesis process chart shows the design and work process of the thesis.

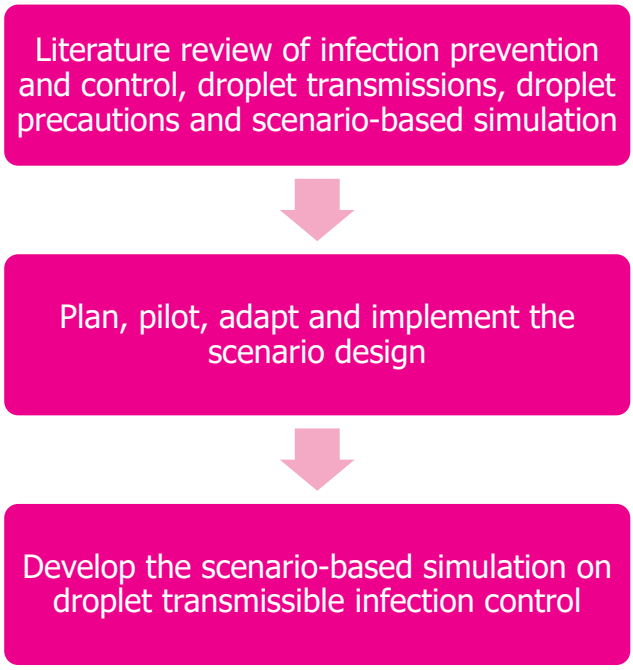

FIGURE 1. Work process of the thesis project

Before the scenario design, theoretical background on nurses' role in infection control, mode of transmission, especially droplet transmission and scenario-based simulation education were reviewed. Previous literature reviews were searched from the databases such as CIHNAL and Google Scholar using the key words "scenario-based nursing simulation", "HAIs", "infection prevention", "infection control", "droplet transmission" and "droplet precautions". After that, when designing the simulation scenario, there were many times adaptations based on the supervisors' suggestions and pilots among the Savonia nurse students. The result of the thesis was the production of a simulation scenario, which can be available to nursing students and the healthcare educator to improve the competence of nurse students in droplet transmissible infection control and arise the awareness of prevention and control of HAIs.

4.3 Planning and Implementation

When starting to plan the scenario, I was thinking for a long time about what kind of simulation scenario could be suitable for the first year and second year nursing students who do not have too much nursing care and also simulation experiences. The reasons for designing this droplet precautions scenario for the first-year nursing student group are: firstly, there was a course "Nursing Assessment and Interventions" in which the infection control and modes of infections were taught during the first academic year; secondly, infection prevention and control are very important concepts for the new students to know to protect the patients as well as the students themselves; thirdly, the new nursing students can complete droplet precautions by reading through the pre-materials carefully and therefore their confidence on the future simulations gets better.

The context of the scenario should be clear and simple, and of course, as real as possible. The high-fidelity simulation could provide students with timely messages and corrections of mistakes. The

COVID-19 virus as the typical droplet transmissible infectious agent was firstly to be considered into the scenario case, and to make the case close to the reality, the veritable cases of COVID patients, the laboratory tests and their treatment were studied. During the whole process of designing the scenario, I received feedback and instructions from my supervisors who have many years' simulation pedagogy experience and knowledge. For example, at the beginning of the scenario design, the ABCDE-protocol was included as one of the objectives of the simulation. While my supervisors suggested that the main objective of the scenario-based simulation should be focused on droplet precautions, it would be more complicated for the new nursing students if the focus was on the ABCDE-protocol as well. Instead, only few vital signs measurements were added to the simulation practice as they are the basic nursing interventions for a COVID-19 patient.

Before the piloting of the simulation, there were many adaptations and discussions on the scenario template between me and my supervisors. To implement the development work, my supervisors arranged two pilot tests of the scenario designed with two groups of English-speaking nursing students in the October 2020 and January 2021. After the pilot tests, some necessary changes in the scenario were made, based on the observations of the simulation practice and feedback from the students.

4.4 The pilot tests and feedback on the simulation

The scenario-based simulation was piloted with 15 first year and 14 second year nursing students. The aims of the pilot tests were to develop the scenario design (the scenario template was removed due to confidential purpose) and to achieve the learning outcomes of droplet infection precautions. The pilot tests were held in the Savonia simulation center. However, most of first year students told they had not visited the simulation center before, and for some of them, it was their first time to have a simulation. The questionnaire (Appendix 1) was prepared before the pilot tests. The questions were about the previous knowledge and information on droplet precautions for COVID-19, students' opinions about the pre-reading materials, students' opinions about briefing, students' learning outcomes, students' opinions about the way to learn infection control and suggestions to improve the simulation scenario. The preliminary reading materials were sent by my supervisors so that every participant would have sufficient theoretical knowledge and confidence to join in this simulation. The pre-reading materials included a video on donning and doffing PPE for COVID-19 care and reading materials for standard and droplet precautions. According to the observation of debriefing and feedback from the students, these materials were helpful, especially on the video, some students noticed and learnt the order of donning and doffing PPE.

All students in the two pilot tests thought they have learnt from this simulation, especially the non-technical skills of communication and co-operation with co-workers. They also learnt the clinical skills of nursing interventions including where to start when taking care of a patient who suffers from shortness of breath and anxiety. Both student groups were very active under the instructors' guidance in the debriefing, did critical thinking from the observers' and actors' viewpoint. In particular, the second-year students had a deep discussion on communication between the nurses and the

patient and between the nurses. One student from their group also took his working experience as an example to explain his opinion on the order of donning PPE. The first-year students deepened the discussion on PPE equipment of droplet precautions as well as supporting the psychological state of the patient.

Based on the 28 feedback papers submitted by the students, there were 29 participants, as 2 students shared one questionnaire paper because of the insufficient number of questionnaires papers. Most of the students told that they had previous knowledge of or information about droplet precautions for COVID-19, for instance, the PPE equipment used in case of COVID-19. Some mentioned they followed the guidance from THL, news, work and social media. 27 students out of the total 29 students thought the pre-reading materials were understandable and informative, some thought it would be better to add more materials such as more videos or animations and information about nursing assessment and interventions. All the participants thought they got enough information during the briefing, and in the first pilot test, some suggested it would be better if the medication list could be explained more, so the medication list was updated for the second pilot test. Most participants told the simulation deepened their knowledge and skills of droplet transmission as it was informative and necessary. Some even mentioned the simulation was educational before going to the next nursing care internship.

When asked how they thought about simulation as a learning method in infection control, most of the participants answered that they thought simulation was a good and efficient learning method that should be included in many classes since they got a chance to get feedback instantly and to enhance learning by doing. Also, some students mentioned that simulation is an effective way to combine theories with practices. However, one participant mentioned that she/he did not learn so much about infection control. Most participants told that they did not have any comments or ideas to help the improvement of the simulation scenario to foster learning of infection, but one still gave comment about improving the technician hardware equipment used in the simulation, such as the microphones as they could not hear clearly. One suggested that the students should read the pre-reading materials well, another suggested that the patient's information should be given more in the briefing and one suggested to give more information and time to the actors to let them think and reflect on the steps.

From my supervisors' perspective, the simulation developed as a comprehensive scenario of a COVID-19 patient care situation. It is a valuable learning method in nursing education and can be used in Finland and in many other countries. The pre-reading material is accurate and rather easy to read before the simulation. The objectives of the simulation are realistic and accessible in the simulation.

5 DISCUSSION

In the discussion of this development project work, the reliability and ethics are evaluated, then the success and development needs of the simulation scenario are reviewed. The critical thinking of developing the simulation scenario is discussed at the end of this chapter as well as the author's own learning process when doing this thesis project in terms of professional development.

5.1 Reliability and ethics

Development work research is not an independent research approach as it can combine several research methods (Kananen 2012). In my research process, I carried out a literature review and used qualitative analysis method when analyzing the collected feedback from the pilot groups. There are two dimensions to verify the reliability of a development work: reliability and validity. Reliability means the steadiness of research results, so that the research can be repeated, and one always receives the same results (Kananen 2012). In order to establish the reliability, the simulation scenario was piloted twice, and the collected feedback presented the similar results that the usability of the simulation as a learning method can strengthen the learning of droplet precautions. However, the two groups have different understanding of the simulation. The first group paid more attention on the importance of non-technical skills such as communication between the patient and nurses. The second group was more interested in the PPE of droplet precautions and its donning and doffing in the simulation. Validity means that the concept, conclusion or measurement is well founded and likely corresponds accurately to the real properties, characteristics or world (Kananen 2012). The scenario designing was processed based on the principle that high-fidelity simulation technique was used in the scenario. The purpose is to provide students with a confidential and realistic environment in which they can develop non-technical skills and are allowed to make mistakes, correct those on time and gain knowledge without fear.

The first step of a development work process is to identify the development needs and target. The development work is close to life and its purpose is to provide practical development or problem solution. (Moodle 2020.) In this development work, the need for the prevention and control of droplet transmissible diseases emerged from the worldwide pandemic of coronavirus COVID-19, and the need for developing a simulation scenario of the infection prevention control came from both Savonia University of Applied Sciences and the InovSafeCare Project. During the whole process of doing the thesis, from the planning phase to the implementation and evaluation phase, I followed the Finnish National Board on Research Integrity TENK ethical recommendations for research conducting. The research takes due account of the work and achievement of other researchers by respecting their work, citing their publications appropriately. (TENK 2012.) This means, that I studied and obeyed the ethical guidelines for thesis work, for example, understood that my final thesis will be published as a public document, every researcher's works should be respected, and the thesis will be examined in a plagiarism identification system. In addition, the ethical principles including honest report of the collected data, keeping promises and agreements, protecting personal confidentiality

and being open to criticism and new ideas were presented in my thesis work. (TENK 2012; Arene 2018; David & Resnik 2020.)

The research follows the principles of integrity, meticulousness, and accuracy in conducting research and the author of this thesis complies with the standards for scientific knowledge in conducting the research, in reporting the research results and in recording the data obtained during the research process (TENK 2012). The topic of my thesis was carefully selected as the infection prevention and control is my own field of interest. As a nurse student in the internship places in the hospitals, I found the extraordinary significance of infection prevention and control in the internal medical departments and operation theaters. Coincidentally, the outbreak of a newly discovered coronavirus COVID-19 and its highly infectious ability, together with my supervisors' suggestions prompted the planning of a simulation scenario about droplet precautions. The scenario is designed for nursing students to prepare themselves well when meeting a patient with suspected COVID-19. The scenario-based simulation provides a safety learning environment for nursing students who are without or with little learning experience of droplet precautions. Therefore, the development work is necessary in the education of nursing students.

The references used in this thesis are as new as possible. The data bases CIHNAL and Google scholar, where I searched data, were trustful. In addition, many resources and materials I used were from WHO and THL webpages as these are the non-profit organizations and institutions which aim to strengthen health and welfare systems nationally and worldwide. However, because the topic of COVID-19 was quite new there were so much information and resources available and I did not have time to read through so big a number of studies and articles about it. For that reason, I was not sure whether I used the best quality resources in the thesis. The high-quality clinical research needs results in a clear and timely way to provide evidence-based practice, which is most critical to disciplinary knowledge and professional practice (Pickler 2018).

For creating a reliable simulation scenario, I studied theories of simulation-based education and the steps of designing a simulation scenario. Besides, the reliability of my simulation scenario that emerged as a result of this development work was also due to the fact that my supervisors are the professionals in the field of simulation pedagogy. They offered me many high-quality references about scenario-based simulation and instructions on designing a simulation scenario, for instance, Bland and Tobbell's article about simulation that enables learning in nurse education (Bland & Tobbell 2016). Therefore, I have done a lot of reading and studying before planning the simulation scenario. The data of vital signs, medications and laboratory tests used in the scenario were learnt from the real cases of COVID-19 patients. The nursing interventions of dealing with a patient with shortness of breath and droplet precautions practices were learnt from respiratory diseases and infection control guidance.

The simulation script of the scenario template was modified based on the pilots and feedback from the English-speaking nursing student groups. For the nursing students who did not have much working experience of taking care a patient having the droplet transmissible disease, this simulation

practice provided a very safe learning and practical environment (Reierson, Haukedal, Hedeman & Bjork 2017).

5.2 Evaluation of the simulation scenario

The simulation scenario can be used for nursing students, paramedic students and students from other fields of social and health care as it is applicable in a variety of infection prevention and control areas. The simulation can be arranged after studying the theories of infection control and vital signs assessment during the nursing students' first- or second-year studies.

The simulation scenario can be also designed and modified into other precautions such as contact precautions and airborne precautions. Also, all the diseases that require droplet precautions can be applied in the scenario, for instance, influenza, pertussis and other viral respiratory illnesses, which need droplet precautions. However, the PPE, vital signs, laboratory tests and medications used in the simulation should be complied with the disease and patient history and the whole scenario description. (Bambini 2016.)

The highlight of the simulation scenario is that it can be applied internationally in the universities involved in the InovSafeCare Project. It can also be used in many other countries like in Asia and Africa for the purpose of infection prevention and control education. It is advisable to simulate any epidemic prevention measures before their implementation (Vyklyuk, Manylic, Skoda, Radovanovic & Petrovic 2021). The current information and situation about COVID-19 pandemic arises people's awareness of droplet precautions around the world, especially in the social and health care institutions. This simulation scenario combined with appropriate pre-studying materials on droplet precautions and nursing interventions of shortness of breath certainly can provide an effective way to train nursing students to prepare themselves well when facing a patient with COVID-19 or suspected with COVID-19.

The simulation was piloted, then some changes of the script were made based on the feedback, the supervisors' suggestions and the pilot. The design of simulation scenarios is complex and encompasses a wide range of components to replicate the clinical setting (Munroe, Buckley, Curtis & Morris 2016). During the first pilot test, some students in the pilot test did not notice on the orders of donning and doffing PPE, while this is one very important goal of the simulation. I added the notice in front of the related pre-studying link to remind the students to pay special attention to the orders of donning and doffing PPE. I did not consider preparing a medication list beforehand, so my handwriting and little explanation about the medications made the participants in the nurse roles confused. In addition, during the process of preparing the simulation, my supervisors suggested to make a change of an oxygen mask into an oxygen cannula at the beginning of the simulation so that nurses can make a decision about whether to use a mask or a cannula for this patient. And the oxygen saturation level after the treatment was 94%, but my supervisors recommended to change it into 95% as the students who do not have so much simulation experience would have greater motivation from this simulation. A high degree of realism is necessary to help students to engage in simulation

scenarios and do the right response as they would do in the actual clinical setting (Munroe, Buckley, Curtis & Morris 2016). To make the simulation as real as possible, we also put i.v. line ready before the simulation started.

The goals of the simulation were achieved based on the feedback from the students. In the first simulation pilot test, the students who acted in the simulation did not complete all the tasks as the course of the scenario planned. One reason was that it was their first time in the simulation, and they mentioned they did not get enough information in the briefing for example on the medication. They had no idea about what vital signs they should measure in the simulation when they met a patient with shortness of breath. That is why studying the pre-reading materials is especially important in the simulation. With the second pilot group, the actors did donning and vital sign measurement just in the right way as the scenario planned. In the debriefing phase of both groups the instructors gave very clear and professional guidance on what the right orders of donning and doffing PPE are, one student from the first pilot group, however, even explained why the orders should be like the video shows according to his own working experience. Besides, the steps of taking care of a patient who has shortness of breath were discussed in the debriefing as well as what we have learnt from the simulation. The non-technical skills such as communication skills between the two nurses in both pilot tests were very well presented and this is strongly needed in the high-fidelity simulation. The two simulation pilot tests also prove that simulation-based education helps improve students' skills and confidence in the nursing studies. It is a useful approach to provide nursing students with learning opportunity of practical clinical skills, communication skills and decision-making skills as Bland & Tobbel pointed it out in their research (Bland & Tobbell 2016).

5.3 Learning experience during the development work

Carrying out the development work, I have developed the professional competencies in both factors in droplet precautions and treatment of a patient with shortness of breath. In the literature review, I have gone through the theories of HAIs, chain of infections, modes of transmission, droplet transmission and scenario-based simulation education. Especially, the scenario-based simulation education was new to me as a nursing student. Since my first year of nursing studies, I have become accustomed to the simulation practice and the teaching method, which is an efficient way to absorb the knowledge through practices by observation and participation. So, I got interested in doing this development work when my supervisors offered me this opportunity. In my previous simulation experience, I have practiced the nursing assessment and interventions of a patient who has shortness of breath and gone through the lectures about infection and infection control. There was no simulation scenario about treating a patient with suspected COVID-19 and dyspnea available for nursing students, and this time we really need a practical simulation to develop these skills due to the rigorous situation of COVID-19 spreading out around the world. Therefore, I decided to do a development work on creating a simulation scenario of this topic. This development work deepened my professional competences in both factors of droplet infection control and simulation pedagogy.

Working in the thesis project work brought me a deeper knowledge of infection prevention and control, nurses' roles and responsibilities in prevention of infections, and simulation education. Thus, I know how to take actions when facing an isolated patient by taking into consideration the transmissible diseases precautions. I also deepened my knowledge of simulation-based education, which will certainly be beneficial for my future working and studying life as nowadays nursing career requires more simulation trainings (Martin, Cross & Attoe 2020).

For myself, I felt I learnt a lot from this simulation. The appropriate order of donning and doffing the PPE is an essential step to build protective barriers to infectious viruses and diseases. The collaboration requires effective and strong communication skills between co-workers. The ABCDE-protocol used when taking care of a patient with shortness of breath includes the basic nursing assessment and interventions that nurses should master. The patience and calmness that nurses should have when facing an anxious patient can make the patient eased. This simulation learning has deepened my knowledge after reading the theoretical knowledge.

Carrying out the thesis, on the other hand, gave me more challenges in addition to other studies and working life. However, motivation, my supervisors' encouragement, and the efficient use of time and scheduling helped me to develop my skills in coping with pressure. As a nursing student graduate, I also learnt the information retrieval and critical thinking method in evidence-based nursing. Identifying the problem, gathering information, screening out eligible data, and critical assessment and application of the collected data and information are very important skills for us in the field of the constant information-updating health care. (Papathanasiou, Kleisiaris, Fradelos, Kakou & Kourkouta 2014.)

A limitation of the study is that after the simulation session, the feedback time left for students was quite short and the feedback was briefly written. Giving the questionnaire via email after the simulation and setting a deadline for submission of the feedback would be a better way to collect more detailed feedback in future. Another limitation of the study is related to a real-life situation: there can be an unlimited number of choices and options. No matter how accurate the simulation is, not all of the options from real life can be reproduced. This simulation also requires of students a certain knowledge before the simulation of droplet precautions and nursing interventions in dyspnea, so the pre-reading materials and the briefing session are very significant in this simulation scenario setting. Without pre-knowledge of these, the simulation is difficult to be carried out as planned. However, besides the limitations, the goals of this scenario-based simulation were achieved and the learning process of doing the simulation scenario design and development work will be an unforgettable experience and memory, which definitely benefit me in my future nursing career and studies.

This simulation is advisable to refer to the health care personnel's educational curriculum for their continuous education as well, and more particularly to social workers, paramedics, registered nurses and radiography nurses. When re-planning the scenario for a group of qualified health care personnel, it is recommended to analyze the needs and expected learning outcomes when carrying out this

simulation training (Herrington & Gupta 2020). The scenario can be tailored according to the expected learning outcomes. Because of the importance of infection prevention and control, the simulation scenario can also be translated into different languages and used in different countries for nursing students and other health care educational groups.

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APPENDIX 1: QUESTIONNAIRE

QUESTIONNAIRE FOR PARTICIPANTS IN THE INFECTION CONTROL SIMULATION PILOT TEST

You just participated in the infection control simulation. I hope you will give me feedback on the simulation scenario and its implementation to help the development of the simulation scenario. The feedback will be collected anonymously, and your identity will not be revealed when giving the feedback. I really appreciate to get your opinion on all the questions.

1. What previous knowledge or information did you have of droplet precautions for COVID-19?

2. What do you think about the pre-reading materials? Would you like to have any more content added?

3. What do you think about the orientation to the simulation during the briefing? Did you get enough information about the patient to act as an observer or actor during the simulation?

4. How do you think this simulation deepened your knowledge and skills of droplet transmission?

5. What do you think about simulation as a learning method in infection control? You can describe your experiences about the whole session including briefing, simulation action and debriefing.

6. Do you have any ideas or comments to help the improvement of the simulation scenario to foster learning of infection control?