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Healthcare personnel's working conditions relationship to risk behaviours for organism transmission

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Abstract

Background: Healthcare personnel (HCP) often experience undesirable working conditions. Risk behaviours for organism transmission can lead to healthcare associated infections, and risk behaviours have been described as being influenced by the working conditions. Still, research is lacking regarding HCP's working conditions relationship to risk behaviours for organism transmission.

Methods: Study I had a mixed-methods convergent design. Observations and interviews were conducted with 79 HCP, i.e. registered nurses (RNs) and assistant nurses (ANs). First-line managers were also interviewed regarding the unit's overall working conditions. The qualitative and quantitative data were analysed separately and then merged. Study II was a cross-sectional study with 417 RNs and ANs. The questionnaire included: self-efficacy to medical asepsis, structural empowerment (SE), work engagement (WE) and work-related stress (WRS). Correlational analysis and group comparisons were performed.

Results: In Study I risk behaviours frequently occurred regardless of measurable and perceived working conditions. The HCP described e.g. that staffing levels and interruptions had an influence on risk behaviours. In the statistical analyses, risk behaviours were more frequent in interrupted activities and when HCP worked together. In Study II the HCP rated high levels of self-efficacy to medical asepsis. Differences were found between self-efficacy and some of the working condition variables that were grouped. Definite, yet small relationships were found between self-efficacy to medical asepsis and SE/WE/WRS.

Conclusion: The HCP rated high levels of self-efficacy to medical asepsis, but risk behaviours frequently occurred regardless of the working conditions. Healthcare managers are responsible for HCP's work environment and should continuously work to promote adequate working conditions and to increase HCP's understanding of risk behaviours, which consequently also promotes patient safety.

Keywords: Working conditions, healthcare personnel, registered nurses, assistant nurses, risk behaviours, organism transmission, infection prevention, self-efficacy, mixed-methods.

Sammanfattning

Bakgrund: Vårdpersonal upplever ofta otillfredsställande arbetsförhållanden. Riskbeteenden för smittspridning kan leda till vårdrelaterade infektioner och riskbeteenden har beskrivits kunna påverkas av arbetsförhållanden. Syftet var att bidra med kunskap om relationen mellan vårdpersonalens arbetsförhållanden och riskbeteenden för smittspridning i vården.
Metod: Studie I hade en konvergent mixad metod. Observationer och intervjuer utfördes med 79 sjuksköterskor och undersköterskor. Intervjuer gällande avdelningarnas arbetsförhållanden utfördes med avdelningscheferna. Data analyserades inledningsvis separat för att sedan integreras. Studie II var en tvärsnittsstudie där 417 sjuksköterskor och undersköterskor besvarade en enkät som innehöll: tilltro till egen förmåga att bedriva ett aseptiskt omvårdnadsarbete, strukturella förutsättningar (SE), arbetsengagemang (WE) samt arbetsrelaterad stress (WRS). Korrelationsanalyser och gruppjämförelser utfördes.
Resultat: Studie I visade att riskbeteenden för smittspridning var vanligt förekommande oberoende av observerade och upplevda arbetsförhållanden. Personalen upplevde bland annat att bemanning och avbrott påverkade deras riskbeteenden. Statistiska analyser visade att avbrott och att arbeta tillsammans bidrog till fler riskbeteenden. I Studie II hade personalen god tilltro till förmåga att bedriva aseptiskt omvårdnadsarbete och vissa skillnader hittades mellan tilltro till förmåga och grupperade arbetsförhållanden. Små men definitiva samband fanns mellan tilltro till förmåga och SE/WE/WRS.
Slutsats: Vårdpersonalen hade god tilltro till egen förmåga att bedriva ett aseptiskt omvårdnadsarbete, å andra sidan var riskbeteenden för smittspridning vanligt förekommande oberoende av arbetsförhållanden. Ledningen ansvarar för personalens arbetsmiljö och behöver därmed arbeta för att främja goda arbetsförhållanden samt öka förståelsen av riskbeteenden för smittspridning vilket i förlängningen också bidrar till en säkrare vård.

Nyckelord: Arbetsförhållanden, vårdpersonal, sjuksköterskor, undersköterskor, riskbeteenden, smittspridning, infektionsprevention, tilltro till egen förmåga, mixad metod.

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List of Papers

This thesis is based on the following papers, which are referred to in the text by Roman numerals.

Paper I
Arvidsson, L., Lindberg, M., Skytt, B., & Lindberg, M. (2021). Healthcare personnel's working conditions in relation to risk behaviours for organism transmission: A mixed- methods study. Journal of Clinical Nursing, 00: 1–17. https://doi.org/10.1111/jocn.15940

Paper II (manuscript) Submitted to *WORK*
Arvidsson, L., Skytt, B., Lindberg, M., & Lindberg, M. Healthcare personnel assessed self-efficacy levels to medical asepsis and their relationship to structural empowerment, work engagement and work-related stress

Abbreviations

HCP	Healthcare personnel
RN	Registered nurse
AN	Assistant nurse
FLM	First-line manager
HCAI	Healthcare-associated infections
JD-R	The Job Demands-Resources model

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Introduction

The importance of adequate hygiene in healthcare has been known for a long time. Florence Nightingale (1820-1910) identified the importance of cleanness for health and healing (1), and Ignaz Semmelweis (1818-1865) was one of the first to draw attention to the importance of good hand hygiene and its significance in reducing healthcare-associated infections (HCAI) (2). HCAIs are a global concern (3,4), and they can be the consequence of inadequate infection prevention behaviours among healthcare personnel (HCP) (5,6). Previous research indicates that inadequate working conditions experienced by HCP have been found to increase the frequency of HCAIs (7–9), likewise adequate working conditions are essential for HCP's well-being at work (10). Good working conditions are thus central for the HCP's own well-being as well as for their ability to provide patients with safe care (7–10). Human risk behaviours are described as being affected by working conditions (11), nevertheless there is a lack of research that studies risk behaviours for organism transmission in relation to HCP's working conditions. When we can establish if there are relationships between risk behaviours and working conditions, and identify the explicit working conditions involved, appropriate measures can be put in place where they are needed most. This could benefit both the HCP and the patients they care for.

Background

Healthcare personnel's working conditions

Healthcare services and HCP are constantly challenged to make adaptations to the population and the environment. Demographic alterations, technological improvements, increased knowledge in pharmacological and health sciences requires continuous adjustments from healthcare services and the HCP (12). At the same time, the ageing population generates increasing demands and puts further pressure on the healthcare systems (13). A literature review found that registered nurses (RNs) worldwide were experiencing inadequate working conditions with, e.g. lack of support, lack of resources, lack of information, lack of sufficient time for reflection, poor working environments, increased patient acuity, heavy workloads and high job demands (14). HCP in Europe have had the fourth-highest rate of work-related health problems among all job sectors and the highest regarding work-related stress (15). Long working hours combined with shift work and night work are normal circumstances for HCP (16,17). A study from 12 European countries that included Sweden, reported that RNs who worked 12 hours or longer had reported job dissatisfaction more frequently (18), while high job satisfaction had been found among RNs who assessed their working conditions as adequate (10).

There is a shortage of HCP both internationally (12,15,19) and nationally (20), and a reason given for leaving their profession is often connected with their working conditions. Staffing levels, the psychosocial work environment, work-related stress, long working hours, work overload, professional relationships, work engagement, and perceptions of leadership are all examples of factors that have been found to affect HCPs reasons for leaving the profession (12,21–24). Overtime is often used to compensate for the shortages of HCP, which reduces rest time between shifts and puts additional pressure on the existing HCP (16). The shortages in HCP and competence have long been considered a major global problem in health care (26). Difficulties in recruiting and retaining enough educated HCP have been reported in practically every country worldwide (12).

There is no unified definition of working conditions. According to the International Labour Organization, working conditions involve a wide series of topics covering anything from physical conditions, psychological factors, to worktimes and salaries (25). The European Foundation for the Improvement of Living and Working Conditions (Eurofound) describes working conditions as covering the employee's working environment and aspects of both the terms and conditions of employment, e.g. work activities, work organisation, education and skill development, opportunities, the employee's health, well-being and safety as well as work-life balance (26). In the first study (Study I) of this thesis, the included working conditions were: staffing levels, patient ratios, bed

occupancy, experienced patient-level workload, interruptions and physical environmental factors (e.g. patient rooms). In Study II, structural empowerment, work engagement and work-related stress were included, see Figure 1.

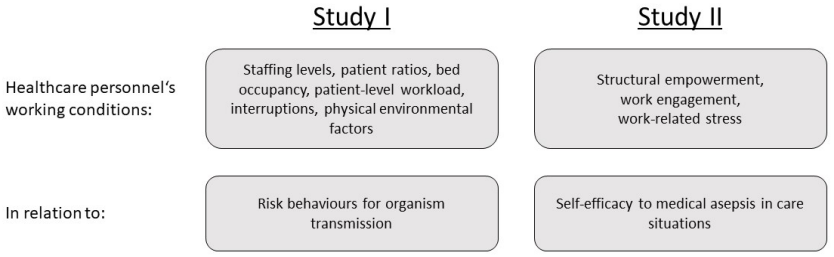

Figure 1. This thesis included working conditions in relation to risk behaviours and self-efficacy.

Staffing levels, patient ratios, bed occupancy, patient-level workload, interruptions and physical environmental factors

Staffing levels and patient ratios are well-researched working conditions in health care (27). Patient ratios refers to how many patients each HCP is responsible for during a shift. In inpatient care, there is a constant need for adequate staffing levels and for the HCP to have sufficient education and experience to ensure that the patients' medical and caring needs are met 24 hours a day (28). Safe staffing levels are described as essential for the HCP's job satisfaction and well-being at work (28). Hospital bed occupancy rates are an indicator that provides information regarding the service capacity of the hospitals (29). Patient-level workload, i.e. workload based on the patients' clinical conditions can be a tool for calculating nursing workload (30). For the different care contexts, there are several patient classification systems available to measure the patients' needs and the personnel's workloads. The classification systems measure, e.g. the patients' medical and nursing needs regarding respiration, circulation, communication, movement limitations, nutrition and needs of assistance with activities of daily living such as personal hygiene (31–33). Measured workloads do not always correspond to the HCP's perceived workload. Previous research has found that perceived workloads may be connected to other non-patient factors such as meetings, co-operation with colleagues, supervision of students or mental stress (34).

Interruptions are common in health care (35–37), and HCP have described how they accept interruptions as a part of the job (38). However, interruptions have been described as leading to increased cognitive loads, frustration (37), difficulties in retaining focus, and forced re-prioritizing by the HCP, which can be easier for those with extended professional experience (38). Furthermore, interruptions can delay work routines and disorganise work plans (39). Sources for interruptions in health care are, e.g. colleagues, patients, relatives, alarms from the nurse call button, work phone, technical advice and self-interruptions (40–42). HCP have emphasised that there is less risk for interruptions when

patients have a single room (43). However, it is common for patients to share rooms. HCP have described both advantages and disadvantages with single and shared patient rooms. Shared rooms can facilitate monitoring and communication, but it can also lead to more confined work areas (43).

Structural empowerment, work engagement and work-related stress

Kanter's theory of structural empowerment consists of four components: information (knowledge about the workplace and organisation), opportunities (to develop skills, knowledge and grow professionally), support (obtaining feedback and guidance from colleagues, subordinates and management) and resources (access to sufficient time, finances, and materials). Access to these components are influenced by formal (related to work-role) and informal (related to personal-network) power (44,45). Employees who have access to these structures experience feelings of control at work (44) and the possibility to influence organisational effectiveness (46). In previous nursing research, high access to structural empowerment has been said to increase HCPs psychological empowerment and job satisfaction, and at the same time, decrease job strain (47).

Work engagement is described as "a positive, fulfilling work-related state of mind that is characterised by vigour, dedication and absorption" (48 p 74), and the construct is used as an indicator of a healthy workplace (48). Vigour implies high levels of energy and a willingness to go the extra mile. Absorption is characterised by being captivated and concentrated in one's work, and dedication is characterised by feelings of meaning, inspiration and pride about one's work (49). Since work engagement refers to an employee's psychological state of mind at the workplace (48), it was included in this thesis as a working condition. Previous research has found that people who are engaged in their work experience positive emotions and better psychological health, and they have the ability to transfer their engagement to others more often, which affects the psychosocial working environment of their colleagues (50). Work engagement is not the same as workaholism (50). Engaged employees work hard and are dedicated to their work. For people with high levels of engagement, work is fun but not an addiction; in contrast to workaholics. Employees with high levels of work engagement have been found to perform better at work, which is beneficial for them and the organisation where they are employed (50).

Stress is described as a personal experience and a reaction to extensive pressures (51), and work-related stress can be seen both as a working condition and as a consequence of working conditions. However, several reports have found work-related stress to be a common concern in health care worldwide (15,52). Work-related stress has different definitions. In this thesis, the United Kingdom Health & Safety Executive was used to measure work-related stress. They describe work-related stress as being based on six different stressor areas: demands, control, support, relationships, roles and change (53). Demands refer

to workload and working environment. Control is about employees' autonomy and how much say they have in their job. Support is divided into Management Support and Colleague Support, which concerns encouragement. Relationships include how improper behaviour and conflicts are handled in order to promote a favourable environment for employees. Roles involve ensuring the employees will not have conflicting roles and how well employees are aware of their role within the organisation. Change refers to how organisational changes are communicated and accomplished (53). In previous research heavy workload is a commonly reported stressor (54), which can be especially difficult for newly graduated RNs (24). Shift work has been found to be a reason for work-related stress among RNs working in hospitals, which results in psychological complaints at work and in their social life (17).

The Swedish healthcare system and the healthcare personnel's working conditions in Sweden

Sweden has 21 regions that are responsible for organizing health care and access to it for every citizen. The goal is to assure adequate health and care on equal terms for the entire population. The basis of Swedish health care is primary care, which consists of over 1000 health centres all over the country. There are different types of hospitals. The community hospitals are smaller and do not always have the specialist clinics that the district hospitals have. Sweden also has regional/university hospitals where patients can receive more highly specialized and advanced care. Private for-profit providers exist, and most private care providers have agreements with the different regions that entitles them to the same compensation as public care providers (55,56).

The World Health Organization defines HCP as "all people engaged in actions whose primary intent is to enhance health" (57 p 2). In this thesis, HCP refer to RNs and assistant nurses (ANs). In Sweden, ANs are a non-licenced profession that can be achieved through high school education or municipal adult education. RNs are a licenced profession that requires three years university education (58). Even though the number of graduated nursing students and the total number of employed RNs has increased (59), there is a considerable shortage of licenced personnel in health care (60). Healthcare managers in Sweden assess the shortages of RNs and specialist RNs as the most critical shortage in health care, and the issues of insufficient staffing and competence is widespread in the country. The shortages have different consequences, and one common consequence is an increased workload for the HCP. High workloads and work-related stress without the possibility of being able to recover from them are described as problematic since they lead to increased levels of sick leave, personnel turnover, and lack of personnel continuity. Managers describe difficulties in both recruiting and retaining HCP (60).

In the Lancet in 2020, a rather comprehensive systematic analysis measured universal health coverage based on an index of effective coverage of health services in 204 countries and territories (61). According to this report, Sweden

has a very effective coverage of health services, which implies that the inhabitants can receive the health care they need without financial distress and the care is of high quality (61). Working conditions for HCP such as working hours, annual leave and parental leave are regulated by Swedish national laws. Other aspects such as minimum staffing levels and patient ratios are mandated to the hospitals, which leads to variations in the work situation and working conditions (59). A comprehensive survey study from Sweden that included over 10,000 RNs from medical and surgical units, found staffing levels (nurse to patient ratios) and total staffing levels (including support staff) varied relative to the time of the shift. For day shifts the average nurse to patient ratio was 5.5 patients per RN, for afternoon and evening shifts the average was seven patients and for night shifts the average nurse to patient ratio was 11.5 patients (62). Bed occupancy rates in Sweden have steadily increased in hospitals, and it is common with overcrowding and off-service placement of patients to a different specialised unit (63). Sweden has few patient beds in relation to its population and among the lowest numbers of RNs per inhabitants, compared to other European countries (59,64).

Sweden has a few different patient classification systems to measure patient-level workload, and Zebra is one of the oldest (33,65). Information on how many hospital units in the country that use some kind of patient classification system has not been found. Regarding interruptions, a study from Sweden found that HCP frequently experienced interruptions and that different factors such as content and nature of the interruption, competence, workload, frequency and state of mind influenced how the HCP perceived the interruptions (66). Other research conducted in Sweden found that HCP rated high levels of emotional exhaustion, which were related to lack of support and extended working hours. Emotional exhaustion was also connected to "stress of conscience" (67). In a study from an emergency department that included physicians, RNs and ANs; the RNs assessed better working conditions than the physicians and ANs after an organisational change into interprofessional teams. Additionally, all three professions reported high levels of work-related stress (68). Regarding work engagement, a survey study with RNs, ANs and physicians found relatively high levels of work engagement among all professions (69). Another Swedish study found that nursing managers with high access to structural empowerment also provided their subordinates with higher levels of structural empowerment (70).

Research studying the ANs experiences of their work situation is limited, but an interview study published in 2005 described experiences from ANs working in Swedish hospitals. They described a heavy workload and felt they had a weak position and lacked the power to improve their situation (71). Another interview study with ANs working in home care described considerable musculoskeletal complaints, which they associated with both their physical and psychosocial working conditions (72). However, two newly published qualitative studies from Sweden presented several reasons why RNs liked to work in

hospitals and wanted to remain in the profession (73,74). They described satisfaction when they had enough time to care for each patient and liked the variability of the work (73,74). Supportive leadership, good teamwork and convenient workload were described as beneficial factors that made it so they wanted to stay, and they emphasized that their work was meaningful and they were proud of their job and profession (74).

Medical asepsis in care situations and risk behaviours for organism transmission

Healthcare personnel are obligated to adhere to valid hygiene principles to prevent organism transmission (75,76). HCP's infection prevention behaviour is a crucial factor in preventing HCAIs (5,6,75). Some, but not all, HCAIs can be prevented by providing medical asepsis in care situations (75,77). Medical asepsis in care situations involves procedures performed by HCP that aim to reduce micro-organisms and prevent risks for organism transmission in health care (75). It should not be confused with a complete sterile/aseptic technique used in surgical or invasive procedures that aims to eliminate rather than reduce micro-organisms (75). Human risk behaviours have been described as a causal part of a sequence of events and is accordingly influenced by the context in which the individual act is performed (11). Risk behaviours for organism transmission involve behaviours that the HCP do or do not do that can lead to organism transmission. The epic3 guidelines from England is a comprehensive evidence-based guide for preventing HCAIs that consists of evidence from more than 500 studies worldwide. It describes in detail how to prevent organism transmission in health care (75). Non-compliance with hand hygiene is widely regarded as the major risk behaviour for organism transmission (3,5,75). Inadequate use of gloves or protective clothing (75,78), unclean surfaces, omitting the cleaning of objects between patients and patients sharing items (75,78,79) are also risks. Other potential risks for organism transmission in health care are insufficient aseptic techniques (75,78), HCP not washing their hands with soap and water while caring for patients experiencing vomiting or diarrhoea (75), inappropriate use of gloves (75,80) and insufficient placement of materials (78).

Compliance with hygiene guidelines

Compliance with hygiene guidelines, and primarily compliance with hand hygiene, are frequently researched. Interventional studies aiming to increase compliance with hand hygiene are numerous, but many lack sufficient evidence (81). Many studies measure hand hygiene compliance via My five moments for hand hygiene (before touching a patient, before clean and aseptic procedures, after body fluid exposure, after touching a patient, after touching patient surroundings) (82–84). Several studies have found compliance rates weakest in the moments before patient contact and before aseptic procedures, and higher after contact with patients (82,84–86). The World Health Organization has framed multimodal strategy guidelines to improve hand hygiene

compliance, which consists of five components: system change (which is related to the infrastructure and equipment), training/education, evaluation/feedback, reminders and institutional safety climate (87). A systematic review investigating the efficacy of the World Health Organization's multimodal strategy concluded that the multimodal strategy is frequently used worldwide and it is effective, particularly when all components are applied (88). Studies from all over the world have shown various rates of compliance to hygiene guidelines. An observational study from Finland implemented the World Health Organization's multimodal strategy for hand hygiene, and compliance rates increased from 76.4% to 88.5% (89). In another observational study from Austria, compliance rates among HCP in intensive care units increased from 71.1% to 88.6% after an intervention consisting of lectures, practical demonstrations, and the installation of more disinfection agents. (83). A study from Germany found compliance rates of up to 74% (84), and another from the US found compliance to be 39% (86). Compliance has sometimes been reported as low as 22% (Ethiopia) (82) and 29% (Canada) (85). In Sweden, annual measurements based on the basic hygiene routines SOSFS 2015:10 (76) are conducted. In the latest measurements from 2021, the proportion of the correct use of all aspects had increased from 85.1% in 2020 to 86.3% (90). However, according to the pyramid of evidence, these measurements have low levels of evidence (91).

In qualitative research, HCP have described several factors that influence their compliance with hygiene guidelines. In a systematic qualitative literature review by Smiddy et al. (2015), the factors were categorised into two broad categories: motivational factors and perceptions of the work environment. Motivational factors that influence the HCP's hygiene behaviour included social stimuli, e.g. actions from colleagues, patient care acuity, reminders, and the need for self-protection. Perceptions of the work environment were influenced by resources such as knowledge, the workplace's organisational culture, and the availability of disinfection supplies. The authors in this review concluded that the HCP's perceptions of the work environment are closely connected to Kanter's theory of structural empowerment (92). Other qualitative studies have found that RNs associate non-compliance to hygiene routines with understaffing, high workloads, physical factors such as poor access to sinks, equipment and materials and inconvenient hand disinfection locations. Furthermore, they described education, supervision, and being able to discuss and reflect upon hygiene guidelines as necessary for compliance. Attitudes and support from managers and colleagues in leading positions were also described as necessary (93,94).

Healthcare-associated infections as a consequence of risk behaviours for organism transmission

Healthcare-associated infections (HCAIs) are infections occurring in patients due to the care process in hospitals or other healthcare facilities that were not present at the time of admission (4). HCAIs are the most frequent adverse event

threatening patient safety worldwide (3,4). HCAIs also include occupational infections occurring among HCP (4). HCP are at risk of being infected by, e.g. airborne infections, blood-borne infections via needle-stick injuries and gastrointestinal pathogens encountered at work (95). The global burden of HCAI is unknown due to difficulties in collecting reliable data (4). Reporting the prevalence of HCAIs in developing countries has been described as being particularly challenging, but systematic reviews have described the prevalence to vary between 2.5% to 14.8%, and in surgical units up to 45% in developing countries (96,97). In Europe, about 3.8 million patients are affected each year (98), and for hospitalised patients it ranges from 3.5–12% (4). More than 90,000 European citizens die each year as a result of HCAIs (99). In Sweden, HCAIs are the most frequent healthcare injury (77). According to the Swedish public health authority, recurring measurements show that HCAIs affect about 9% of the hospitalised patients (100). HCAIs lead to 1,300 deaths each year in Sweden, in other words, 3–4 people per day (77). They also increase the financial burden in societies worldwide (4,99). In Sweden, on average, an HCAI leads to an extended care period of ten days. The cost of HCAIs in Sweden is estimated to vary between 1.5 to 2.2 billion Swedish krona per year, and the total costs to society are far more significant (77). Pneumonia, urinary tract infections, surgical site infections, bloodstream infections and gastrointestinal infections are the most frequently reported types of HCAIs globally (101). In Sweden, the most commonly reported HCAIs are urinary tract infections and wound infections (102).

Healthcare personnel's working conditions significance for healthcare-associated infections and other patient outcomes

The association between the HCP's working conditions and patient outcomes is well researched. One of the working condition areas most investigated concerns staffing levels/patient ratios. Many studies as well as several systematic reviews have reported insufficient staffing levels and high patient ratios to be associated with increased risks for several patient outcomes such as mortality, HCAIs, patient falls, pressure ulcers and risk for information loss (12,27,103–106). Another study concluded that an increase in the staffing levels with ANs cannot compensate for the RN shortages when it comes to patient safety (107). A Swedish study conducted at medical and surgical units in acute care hospitals also found that insufficient staffing levels increased the risk for care being left undone (62). Even in qualitative research, RNs have described that patient safety is threatened when there are staffing shortages, high workloads or high levels of patient turnover (73). Not surprisingly, studies have reported that patients cared for in hospitals where the HCP assessed decent working conditions such as sufficient staffing levels and work hours, a higher quality of care and more satisfied patients resulted (10,27).

A study from England found high bed occupancy rates increased patient mortality (108) and another from Wales found high occupancy rates increased the risk for organism transmission (109). A systematic review found intermediate evidence regarding associations between bed occupancy and risks for HCAIs (8). High bed occupancy rates are reported to increase overcrowding and off-service placement of patients. Off-service placement of patients to different units has been found to increase the risks for deficits in verbal and oral documentation and communication, deficiencies in patient follow-ups and risk for insufficient medical and nursing competencies if the HCP are not experienced in caring for patients with certain conditions and diagnoses (63). Multiple admissions of new patients and patient-level workload have also been reported to affect patient safety (30,107). Physical factors such as patients sharing hospital rooms have also been found to affect the risk for HCAIs. A systematic review reported single-occupancy patient rooms decreased the risk for HCAIs (110). Another systematic review concluded other physical factors, e.g. access to materials and equipment such as hand disinfection dispensers increases hand hygiene among HCP and consequently decreases the risk for HCAIs (8). In a mixed methods study, the HCP described how single patient rooms decreased the risk for organism transmission, but no evidence was found in the statistical analyses (43).

Positive relationships between structural empowerment and RN's assessed quality of care and patient safety climate have been found (46). Furthermore, empowered nurses are better skilled in sharing information and providing support, and they can also empower their patients to a greater extent (111). Previous research in health care has found an association between work engagement and patient outcomes, such as hospital mortality (112), as well as RN's perceptions of the quality of care (113). High levels of work-related stress such as time constraints and difficulties concentrating as well as long work hours have also been found to impact cognitive failures and consequently affect patient safety, e.g. risk for HCAIs (114). Being interrupted is another working condition that can influence patient safety (39,115), and a relationship between interruptions and making mistakes in health care has been described (116). Interruptions have been studied mainly in relation to medication safety (35–37,41). Interruptions while dispensing medications can lead to procedural failure and clinical errors (42). Interruptions have also been found to influence the incidence of the HCP's risk behaviours for organism transmission (117,118). Aside from these studies (117,118), research is scarce regarding HCP's working conditions and HCP's risk behaviours for organism transmission.

Self-efficacy

Bandura has defined self-efficacy as a person's belief in their ability to succeed in specified situations (119). Self-efficacy has been described as being based on four basic elements; where the first one is a person's earlier performance outcomes, which are indicators of capability. The second is about vicarious

experiences, which infers the observance of others completing tasks successfully and the transmission of competencies. The third element is verbal persuasion, which involves people being coached by others to believe in their ability to complete tasks. The last one has to do with how psychological states can influence a person's belief that they are capable of something (119). Self-efficacy has been described as being able to influence an employee's incentive, perception, and performance (119). Additionally, employees with high levels of self-efficacy are more driven and are more willing to demonstrate initiative at work (119). People with high levels of self-efficacy are more prone to make an effort to complete tasks (120). Furthermore, they can see, to a greater extent that challenges are something to be dealt with rather than problems to avoid (119). Individuals with high levels of self-efficacy are more inspired and creative than individuals with lower levels of self-efficacy (120,121). In nursing research, self-efficacy has been found to positively correlate with adaptation to professional nursing facilities and affect RN's behaviours and performance at work (122). In educational research, it has been stated that people modify their attitudes and behaviours by the actions of others and the social environment in which the individual acts. In other words, self-efficacy has a social influence on people (123). In previous infection prevention research, indications that self-efficacy may enhance the effectiveness of interventions aiming to improve compliance with hand hygiene have been reported (124).

The Job Demands-Resources model

The Job Demands-Resources model (JD-R) can be applied by human resource management and can be used as a tool to improve employees well-being and performances at work (125). The model focuses on both positive and negative aspects of working conditions, and is divided into two categories: job demands and job resources. Job demands are the negative aspects and they relate to physical, psychological, social or organisational aspects of the job that require persistent physical and/or psychological efforts that consequently lead to physiological and/or psychological costs. Examples of demands are: hostile physical environments, time constraints, shift work and psychologically demanding work tasks. Job demands do not necessarily lead to negative consequences, but they can if it requires long-lasting efforts or when individuals do not have sufficient opportunity for recovery. The positive aspects of working conditions are job resources. Job resources also involve physical, psychological, social as well as organisational aspects that include for example feedback, control, participation and support (126). The earliest JD-R model was developed in an attempt to understand the antecedents of burnout. With the JD-R model, high job demands predict feelings of exhaustion, and insufficient job recourses predict work disengagement. A combination of high job demands and inadequate resources can lead to burnout syndromes (126). Work engagement was added to the JD-R model when it was revised in 2004. The authors found burnout and engagement to be negatively related. Burnout was found to be predicted mainly by job demands and likewise by lack of job resources; while engagement was exclusively predicted by job resources (127,128) The authors stated that the

JD-R model can be applied by management to reduce employees burnout and enhance engagement. Decreasing job demands was considered to be preferred over increasing job resources; a responsibility that lies within the realm of management (127).

Rationale for the thesis

Healthcare personnel worldwide often report that they are experiencing inadequate working conditions (14). Relationships between the healthcare personnel's working conditions and the frequency of healthcare associated infections have been identified (7–9). Even though numerous interventions have focused on increasing compliance with hygiene routines (81), compliance is often lacking (82–86) and healthcare-associated infections are still a global concern (3,4). However, research that studies working conditions relationship to healthcare personnel's infection prevention behaviour is missing. It is relevant to study this since human risk behaviours are described as a casual part of the sequence of events affected by the environment in which individuals act (102). When the relationship is known, appropriate measures can be put in place for the healthcare personnel. As this is an uncharted phenomenon, it needs to be approached with different research methods.

Overall and specific aims

The overall aim of this thesis was to generate knowledge about healthcare personnel's working conditions relationship to risk behaviours for organism transmission in health care.

The specific aims of the included studies were:

Study I

To investigate healthcare personnel's working conditions in relation to risk behaviours for organism transmission.

Study II

To investigate the relationship between healthcare personnel assessed self-efficacy levels to medical asepsis in care situations and structural empowerment, work engagement and work-related stress.

In Study II, we hypothesised: **H1** Healthcare personnel who rate high levels of structural empowerment also rate high levels of self-efficacy to medical asepsis. **H2** Healthcare personnel who rate high levels of work engagement also rate high levels of self-efficacy to medical asepsis. **H3** Healthcare personnel who rate low levels of work-related stress rate high levels of self-efficacy to medical asepsis. We were also interested in if the assessment of risk for organism transmission at work was related to self-efficacy to medical asepsis and therefore an additional hypothesis was generated. **H4** Healthcare personnel who assess a low risk for organism transmission either in general on the unit, own risk of contributing to organism transmission or risk for oneself becoming infected at work; rate high levels of self-efficacy to medical asepsis.

Methods

Design

To study HCP's working conditions and their relationships to risk behaviours for organism transmission, different approaches were used. Study I used a mixed-methods convergent design where qualitative and quantitative data were collected in parallel, given equal priority, analysed separately, and then merged (129). According to Tashakkori and Creswell (2007), the definition of mixed methods is "Research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry" (129 p 4). Study II used a descriptive and correlational design to investigate the relationship between healthcare personnel's self-efficacy to medical asepsis in care situations and structural empowerment, work engagement and work-related stress. An overview of the included studies is presented in Table 1.

Table 1. An overview of the studies included in the thesis.

Study	Design and approach	Setting and Sample	Data collection and year	Data analysis
I	Mixed methods. Descriptive and correlational design. Qualitative and quantitative approach.	8 hospital units. 37 registered nurses, 42 assistant nurses and 8 first-line managers.	Observations, semi-structured interviews and structured interviews. 2019.	Qualitative content analysis. Pearsons's chi-squared $x^{2,}$ Kruskal-Wallis H, Mann-Whitney U.
II	Descriptive and correlational design. Quantitative approach.	25 hospital units. 204 registered nurses and 197 assistant nurses.	Questionnaires. 2019.	Descriptive statistics and correlational analyses. Spearman's rho, Kruskal-Wallis H.

Setting

In both Study I and II, the setting was surgical and orthopaedic hospital units in Sweden. In Study I, a convenience sampling was used that resulted in the inclusion of three community hospital units, three district units and two regional/university units from five hospitals. Four of the units were surgical, and four were orthopaedic. In Study II, 42 surgical and orthopaedic units were randomised from a list of all 207 existing surgical and orthopaedic units in Sweden. Ten orthopaedic and 15 surgical units from 22 hospitals agreed to participate. Two of the randomised units had also agreed to participate in Study I. Accordingly, two units participated in both Study I and II.

Sample

In Study I, 37 RNs, 42 ANs and their respective first-line managers (FLM) (n=8) participated. In Study II, the sample consisted of 204 RNs and 197 ANs.

Study I had no inclusion criteria and in Study II the inclusion criteria were that the HCP had to be working presently, have permanent employment, or be paid hourly. The HCP could have full time or part-time employment. Exclusion criteria were HCP who were not working at the present, e.g. on parental leave or long-term sick leave. An overview of the characteristics of the settings and samples in the studies are presented in Table 2.

Table 2. Characteristics of the settings and samples in the thesis.

SETTING	Study I	Study II
Hospital units		
Community hospital units	3	5
District hospital units	3	10
Regional/university hospital	2	9
Private hospital units	0	1
Unit speciality		
Surgical	4	15
Orthopaedic	4	10
Number of patient beds per unit		
10-19	3	5
20-29	5	17
30-39	0	2
40-29	0	1
Entire unit open		
Yes	4	13
No (due to lack of personnel)	4	12
Type of patient rooms at the unit		
Only single patient rooms	2	1
Single and double bed rooms	3	8
Single/double/three beds per room	0	3
Single/double/four beds per room	2	13
Single/double/four/six beds per room	1	0
SAMPLE		
Healthcare personnel		
Age, years mean (SD)	39.6 (12.8)	40.5 (13.9)
Gender		
Women	70	378 (91.1)
Men	9	37 (8.9)
Education		
Assistant nurse	42	197 (47.2)
Registered nurse	37	204 (48.9)
Specialised nurse	0	16 (3.8)
Working experience, years mean (SD)	11.6 (13.3)	13.5 (12.9)
Years at present unit, mean (SD)	6.4 (8.4)	7.8 (9.0)
First-line managers*		
Gender		
Women	8	21
Men	0	4
Professional degree		
Registered nurse	8	22
Other education	0	3
Years as FLM, mean (SD)	4.1 (7.7)	3.1 (4.0)
Number of subordinates		
20-39	1	7
40-59	6	12
60-79	1	6

*The first-line managers were not a part of the sample in Study II. Their interviews were only to gain characteristics of the units.

Data collection

Observations

Several data collection procedures have been used for this thesis. One of the procedures in Study I was focused observations with a mobile positioning (131), which meant that the observer followed the participant through a complete activity. The observations were conducted from February to May 2019, and the observer spent three mornings at each of the included units. During each observation, 2–4 HCP were observed while they performed different activities. When one activity was finished, the observer either continued to follow the same participant or observed another. Field notes comprising all observed behaviours were written by hand, and the location for each activity was noted. The field notes were written in a different colour for each participant to facilitate preparations for the subsequent interviews and enable the linking of the field notes to the HCP working conditions in the analyses. After the observations, the fields notes were transcribed. In total, 151 hours were spent at the units and 104 hours conducting the observations. The observer did not participate in the patient care to prevent alterations in the working conditions, but did wear clothes like the HCP to blend in and a badge with Gävle University's name and logo. Prior to the data collection, the observer practiced her observation technique skills at a medical unit. Data from these observations were not included in the thesis.

Interviews

Semi-structured interviews

Semi-structured interviews (132) were conducted with all of the observed RNs and ANs in Study I. All interviews were conducted face-to-face and lasted between 5–27 minutes. The majority were recorded. Some participants did not want to be recorded, and on those occasions, notes were written by hand. On two occasions, the HCP wished to have the interview together with another colleague who had also participated in the study. In those cases, notes were written in different colours to link the interviews to each participant and their working conditions. The interviews aimed to ask questions regarding the participants' reflections on the day's working conditions, how they perceived the working conditions in relation to their infection prevention behaviour and reflections on risk behaviours that occurred during the observations. The interviews started with an open initial question such as: *"Please describe how you have experienced your working conditions today?" or "From your experience, how conducive are the working conditions for you to be able to follow basic hygiene routines and work to prevent the spread of infection?"* Questions like "*What do you mean*" or "*Can you please tell me more*" were used to acquire more information. An interview guide was used to ensure all topics were discussed. The HCP in Study I were also asked to provide demographics about themselves and information about their present work conditions, e.g. the number of patients they were responsible for, staffing level, bed occupancy, and patient-level workload. None of the included units used any specific patient

classification system. Patient-level workload therefore includes the HCP's perceptions of the overall patient-level workload based on the clinical condition and level of care needs among their patients. This information resulted in a data set of the working conditions for each participant.

Structured interviews

Structured interviews (132) were conducted with the respective FLMs in Study I and II. Questions were asked concerning the length of time they were managers, their professional degree and the unit's overall working conditions, e.g. staffing issues, unit layout and unit facilities. In Study I, the recorded interviews were conducted in person and then transcribed. In Study II, telephone interviews were performed, and notes were taken at the same time. In Study II, the first-line managers were not a part of the sample since the information was used only to describe the units. In Study I, by contrast, the information from the FLMs interviews was used in the analysis and the FLMs were therefore considered as a part of the sample.

Questionnaires

In Study II, a questionnaire was used. The questionnaires were sent to the HCP from April to December 2019. The HCP received the study material at their workplace, and according to the preferences of the FLMs either by regular post or email. When the material was sent digitally, it consisted of an informational letter, a link to the questionnaire that could be answered via computer or smart phone and a personal code to fill in at the beginning of the questionnaire if they agreed to participate. Included in the material sent by regular post was an informational letter, a pre-coded questionnaire with a stamped return envelope, and a web link/QR code so the questionnaire could be returned digitally. Two reminders were sent by email to non-responders. The questionnaire began with questions regarding demographic data such as age, education and professional characteristics that included years of work experience and length of time at the present unit. Additionally, three questions concerning the assessment of risks for organism transmission at work were included. Items were rated with a five-point scale from 1 (Low risk) to 5 (High risk) and consisted of the questions; A. How do you assess the risk for organism transmission is at your workplace? B. How do you assess the risk that you contribute to the spread of infection to patients during a work day? C. How do you assess your risk of getting infected during a work day?

The next part of the questionnaire contained the four working condition areas: Self-efficacy to medical asepsis in care situations, Structural empowerment, Work engagement and Work-related stress. The questionnaires had different scales as possible answers. There were no open questions. The six-page questionnaire consisted of 92 questions, nine of which were background questions.

Self-efficacy to medical asepsis in care situations

Self-efficacy to medical asepsis was assessed using the Infection Prevention Appraisal Scale (IPAS). According to Bandura, self-efficacy implies a person's beliefs in an ability to succeed in specified situations (119). Since no previous questionnaire existed that could measure self-efficacy to medical asepsis in care situations, Magnus Lindberg and Maria Lindberg developed a questionnaire using Bandura's self-efficacy theory (119) and its associated guide for instrument development (133). The questionnaire is preliminary confirmed as unidimensional (by using parallel analysis on unpublished data originating from RNs and ANs at medical units). It consists of 15 items regarding an individual's perception of self-efficacy to medical asepsis as well as general and specific hygiene principles covering the five aspects of work-clothes, disinfection, glove usage, aseptic technique and jewellery/nails. Responses are given on an eleven-point scale from 0 (not sure at all) to 10 (totally sure). The items are summed to generate a total score, where higher scores represent higher perceptions of self-efficacy to medical asepsis. Initially, face validity (132) was tested with a small group of RNs and ANs, which resulted in minor linguistic adjustments. Moreover, both item and scale content validity index was shown to be excellent (132) as rated by ten independent infection prevention nurses (Unpublished data).

Structural empowerment

To measure structural empowerment, The Conditions of Work Effectiveness Questionnaire-II (CWEQ-II) (45), which has been translated into Swedish (134) was used. The questionnaire has shown acceptable validity and reliability (45,134). It consists of 19 items measuring six factors of structural empowerment: access to opportunity, resources, information, support, formal power and informal power. In addition, two items measure "Global empowerment", which is a validation index (mean of the sum of the two items). Responses range from 1 (none) to 5 (a lot) on a Likert scale. Factor scores are averaged, and then the factors are summed to create a total score. The total score can be divided into three levels of empowerment. For cut-off limits, see Table 3. Cronbach's alpha ranged from 0.71 to 0.86 in Study II, and the total Cronbach's alpha score was 0.79.

Work engagement

To assess work engagement, the 9-item Utrecht Work Engagement Scale (UWES-9) (49) was used. The Swedish version has confirmed acceptable validity and reliability (135). The instrument includes the dimensions of vigour, dedication and absorption; and each factor has three items. Recent studies have revealed one factor to be appropriate (136,137) and one factor has therefore been used in this thesis. Items are rated on a 7–point scale from 0 (never) to 6 (always). Items are summed and divided by the number of items, where higher scores represent higher overall work engagement. Cronbach's alpha was 0.93.

Work-related stress

The United Kingdom Health & Safety Executive (HSE) Management Standards Indicator Tool (138) was used to measure work-related stress. The HSE is published by the British authority of health prevention and safety at work and consists of 35 items measuring six primary stressors: control, demands, roles, change, relationships and support (support is further divided into the subscales manager support and peer support). Responses are given on a five–point scale from 1 (poor) to 5 (desirable). In this questionnaire, factors are summed and divided by the number of factors (53) and then the participants' scores are compared to benchmark scores that are expressed in percentiles in different colours in order to simplify the interpretation of the results. Scores below the 20th percentile are marked in red, results below the 50th but above the 20th percentile in yellow, scores above the 50th and below the 80th percentile are in aqua and scores above the 80th percentile are in green (139). For cut-off limits in Study II and their meaning, see Table 3.

The Management Standards Indicator Tool is well-used and has confirmed acceptable validity and reliability (140). We obtained permission to translate the instrument, and it was translated into Swedish with a back-forward translation technique inspired by Beaton's guidelines (141). At first, a bilingual expert translated the instrument into Swedish. Then it was presented to a number of university staff that are RNs to control the items in terms of relevance, scorings, fluency and clarity. Based on their responses it was clear that the Swedish version was understandable, and no further suggestions arose for changing the wording or rephrasing any of the questions. A second bilingual expert obtained a blinded back-translation, and final agreement was achieved.

Table 3. Cut-off limits for included questionnaires/questions in Study II.

Questionnaires/questions	Scores	Implying
Structural empowerment	6-13	Low empowerment
	14-22	Moderate empowerment
	23-30	High empowerment (142)*
Work engagement	≤2.88	Low work engagement
	2.89-4.66	Average work engagement
	≥4.67	High work engagement (143)*
Work-related stress	≤3.24	Red - Urgent action required
	3.25-3.96	Yellow - Improvement needed
	3.97-4.49	Aqua - Good performance, potential improvement
	≥4.50	Green - Doing well, maintain performance (139)*
Assessment of general risk for organism transmission/own risk of contributing to organism transmission/risk for oneself becoming infected at work	1-2	Low risk
	3	Medium risk
	4-5	High risk

The numbers marked with * are the references to the respective questionnaire cut-off limits: see reference number 142 for Structural empowerment, number 143 for work engagement, and number 139 for work-related stress.

Data analysis

In Study I, with the mixed methods design, the quantitative and qualitative data were first analysed separately and later in the analysis, they were merged (Figure 2). In the first step, the transcribed field notes were divided into a total of 378 observation units, i.e. when one activity ended and another started. Additionally, data from the observation units were deductively categorised and quantified into risk behaviours regarding hand disinfection, placement of materials, work-clothes, glove usage, cleaning, aseptic technique, use of contaminated water and hand washing, as described by Lindberg et al. (2017) (117). To assess the consistency regarding the determination of risk behaviours, Lisa Arvidsson and Maria Lindberg, who were the first respective last author in the study, independently analysed risk behaviours from three randomly selected observation days. Inter-rater reliability for the 2–category classification (identifying no risk behaviour versus risk behaviour) was analysed with Kappa statistics (K) plus Gwet's agreement coefficient (AC1). The AC1 statistic is more robust than K statistics and has therefore been recommended as an alternative or complement to K (144). Additionally, since K statistics can sometimes be low despite high levels of agreement, we also calculated the prevalence-adjusted bias-adjusted kappa (PABAK) (145). The respective HCP observed and the perceived working conditions were linked with the observation units.

Study I's second step was to analyse the transcripts from the semi-structured interviews using qualitative content analysis (146). Qualitative content analysis can be either inductive or deductive (147), and in Study I, both approaches were used. Initially, the interviews were read through repeatedly to get an overall understanding and then more closely to deductively divide the text into the content areas: working conditions and reflections on risk behaviours. After that, the text within the content areas was inductively divided into meaning units, and when needed, condensed before being labelled with a code. The codes were compared based on their differences and similarities and sorted into categories and subcategories, which the qualitative results in Study I are based on. For the content area regarding reflections on risk behaviours, the text was deductively divided into the risk behaviours hand disinfection, placement of materials, work-clothes, glove usage, cleaning and aseptic technique. The participants did not mention the risk behaviours included in contaminated water or hand washing. The semi-structured interviews generated additional questions regarding the sources of the interruptions and working in pairs, which were later added to the quantitative data.

<table>
<tr><th></th><th>QUAL</th><th>QUAN</th><th>QUAL</th><th>QUAN</th></tr>
<tr><td>Data collection</td><td>Procedure
Focused observations of 79 healthcare personnel from eight units

Timing
Mornings at the units between February 28th to May 6th, 2019

Product*
Field notes</td><td>Procedure
Questions about background data + working conditions with the same 79 healthcare personnel

Timing
Prior to the observations

QUAN (structured data)

Product QUAN
Background data about healthcare personnel (Table 1)

Product*
Data set of working conditions for respective healthcare personnel</td><td>Procedure
Semi-structured interviews with the same 79 healthcare personnel

Timing
After the observations

QUAL (semi-structured data)

Product*
Transcripts</td><td>Procedure
Structured interviews with first-line managers from each respective unit (n=8)

Timing
Sometime during the observation days

Product QUAN
Background data regarding first-line managers and units (Table 1)

Product*
Data set of each unit’s overall
working conditions covering aspects of staffing, physical layout and facilities</td></tr>
<tr><td></td><td>QUAL → QUAN</td><td>QUAN</td><td>QUAL</td><td>QUAN</td></tr>
<tr><td>Data analysis</td><td>Procedure
Dividing field notes into observation units.

Categorisation of observation units into:
-Location of activity
-Colleagues working together
-Character of activity

Categorisation of interrupted activities into:
-Interruption requires changing location
-Source of interruption

Categorisation and quantification of:
-Risk behaviours

Product QUAN
-Observation units
-Description and distribution of healthcare personnel's working conditions (Table 2) and risk behaviours (Table 3) linked with each observation unit (Table 4)</td><td>Procedure
Linking healthcare personnel’s working conditions with observation units

Product QUAN
-Description and distribution of healthcare personnel’s working conditions
-Number of patients
-Estimated overall patient-level workload
-Staffing levels
-Bed occupancy (Table 2)
Linked with each observation unit (Table 4)</td><td>Procedure
Qualitative content analysis of transcripts

Product QUAL
Categories describing the content areas: working conditions (including interruptions) and Healthcare personnel’s reflections on risk behaviours (Table 5)</td><td>Procedure
Two-step cluster analysis based on information from all of the units overall working conditions

Product QUAN
Cluster solution</td></tr>
<tr><td></td><td colspan="4">Procedure
Statistical analysis of quantitative products: Pearsons’s chi-squared x^2, Kruskal-Wallis H, Mann-Whitney U

Product QUAN
Comparisons between working conditions and total respective risk behaviour category (Table 6)
Comparisons between clusters and total respective risk behaviour category (Table 7)</td></tr>
<tr><td>Results</td><td colspan="4">Merging of QUAL and QUAN results

Mixed methods Product
Integrated interpretation of healthcare personnel's working conditions and their relationship to risk behaviours for organism transmission</td></tr>
</table>

†: Products marked with * are used in additional analysis. When grey background, products are presented as results.

Figure 2. Procedural diagram of the convergent mixed-methods study design, with qualitative (QUAL) and quantitative (QUAN) data. This figure is reproduced from Study I in this thesis (Arvidsson L, Lindberg M, Skytt B, Lindberg M. Healthcare personnel' s working conditions in relation to risk behaviours for organism transmission : A mixed- methods study. Journal of Clinical Nursing, 00: 1– 17. https://doi.org/10.1111/jocn.15940). For references to Table 1–7 in this figure, please see the original article.

Cluster analysis is a method that can be used to determine which objects are similar to each other in a given set and to group similar objects into clusters (148). The third step in Study I was to classify the included units based on similarities and dissimilarities and create clusters with units having similar working conditions. Data sets of each unit's overall working conditions were used, and due to both hierarchical and non-hierarchical variables, a two-step cluster analysis with distance measure Log-likelihood was performed (148). First, variables with no differences between units were removed, and the remaining variables concerning working conditions were entered into the cluster analysis. The items covered aspects such as personnel situation, support staff and units facilities. During the first cluster analysis, no fixed number of clusters was predefined, and based on visual inspection of Akaike's Information Criterion (AIC), both three and four clusters were considered appropriate since they had good cluster quality measured by the Silhouette index (S.I.). The measure indicates how well objects lie within the cluster and validates the cluster outcomes. It ranges from -1 to1, and numbers ≥ to 0.5 indicate good clustering quality, where both 3 and 4 clusters showed good quality. Final determination based on clinical relevance resulted in three clusters. The stability and reliability of the cluster analysis was confirmed by repeating the clustering procedure, which resulted in the same cluster grouping and quality.

In the fourth step, the descriptive statistics regarding risk behaviours and working conditions were analysed. Due to the non-normal distributed data, Kruskal-Wallis H and Mann-Whitney U non-parametric tests were used to compare risk behaviours in relation to working conditions. Pearson's chi-squared x^2 test was used to compare the sources of the interruptions incurred by the RNs and ANs. Finally, the qualitative and quantitative findings were merged and presented together to achieve an integrated interpretation of the HCP's working conditions in relation to risk behaviours for organism transmission.

In Study II, descriptive statistics were used to present the participants' demographics. Then we tested whether the included variables were normally distributed, and since the majority were not, Spearman's rho for bivariate correlation was used to examine correlations between the variables. Missing values for items varied between 0.5 and 3%. Missing values were handled depending on the instrument; In IPAS, the median value of each item was calculated and replaced the missing value. In UWES, missing values were replaced with the mean value for each participant. In HSE and CWEQ, the participants had to answer all questions in one variable, or else there would be over 10% missing, and in these cases the factor was removed. In the analyses pairwise deletion was used, since this is recommended for correlational analyses (149). In regard to the interpretation of the correlational coefficients, we used Guilford's guidelines (150) reporting that values less than 0.20 have a slight; almost negligible relationship, 0.20-0.40 has a low correlation; definite but small relationship, 0.40-0.70 a moderate correlation; substantial relationship, 0.70-0.90 a high correlation; marked relationship and 0.90-1.00 a very high correlation; very

dependable relationship (150). Additionally, we used Kruskal-Wallis H non-parametric test to compare self-efficacy to medical asepsis in relation to the grouped working condition variables. Before the comparative analyses, the scores in UWES and the questions regarding risks for organism transmission (A–C) were grouped. The scores in UWES were grouped into three categories. Very low and Low were grouped into *Low* and Very high and High into *High*. The score *Average* was maintained. The assessed risks for organism transmission were also grouped into three scores. Low and Medium/low into *Low* and High and Medium/High intro *High*. Also here, *Medium* was maintained.

In both Study I and II, the significance level was set to $p < 0.05$. All statistical analyses were calculated in IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp. Armonk, NY, USA), except for the inter-rater reliability analysis in Study I, where WINPEPI Program Version 11.65 was used.

Ethical considerations

Both studies in the thesis were approved by The Swedish ethical review authority (reg. no. 2019-00530). The Swedish legislation on research involving human subjects (SFS 2003:460) (151) and ethical principles have been followed during the entire research process. Initially, the hospital managers approved the studies and subsequently also the FLMs for the respective units in Study I and II. When the FLMs from Study I and II had approved the study and had given their written informed consent, they informed the HCP about the studies. In Study I, LA informed the HCP about the study's aim and procedure before starting the data collection. The information was given verbally at some units and written at others. Every day before starting the observations, the HCP were personally informed, both written and verbally, about the aim and methods of the study. Confidentiality was assured to the participants and all data would be protected so that no unauthorised persons would have access to it. The participants were informed that their participation was voluntary, and they could withdraw at any time without giving any reason. They also received information that the observer would not participate in the caregiving as it would affect their working conditions. The observer would of course act in case of emergency, which the participants knew, but no such event occurred. All participants gave their informed consent, and before the observations started, all patients involved were asked for verbal approval of the observer's presence. The observations were conducted only when all persons involved had agreed to the observer's presence. No information about the patients was collected, which they were informed of.

After the observations in Study I, all participants were interviewed with questions regarding their reflections on the day's working conditions, how they perceived the working conditions in relation to their infection prevention behaviour and their reflections on risk behaviours that occurred during the observations. The interviews were conducted in a quiet room that the participants could choose located at or close to the unit. The interviews were conducted

using an empathic approach, and the researcher carefully described again that the aim was to study their infection prevention behaviour in relation to working conditions and not to judge or evaluate their behaviour. Participants were informed they could contact the researchers later if they had any concerns or questions, but none did. In Study II the HCP received written information about the study, as described in Study I when they received the questionnaires. Informed consent was considered given when they answered the questionnaire. They had the option to choose to fill in that they did not want to participate by marking so in the questionnaire, and no reminders were sent to them.

Results

Study I

Qualitative findings

The HCP discussed staffing levels as an important working condition influencing their infection prevention behaviour. Some discussed how overstaffing could make the work unstructured and more complex, while most HCP described how being fully staffed made work and compliance with hygiene guidelines easier. Ancillary staff such as coordinators, receptionists, pharmacists, kitchen staff, and other support staff in the healthcare team who are not assigned to a particular patient or patients could help as an extra resource, and were reported to be beneficial and that they facilitated compliance with hygiene guidelines. Physical issues such as confined work areas, patients sharing rooms, toilets or equipment and the placement of disinfection agents were described as potential factors affecting their infection prevention behaviour. Patient-level workload was also an issue, and the HCP discussed the need to work together when caring for high-needs patients. Good cooperation and trust between colleagues were described as positive influences in the work environment that benefited hygiene practices, while communication shortcomings were said to do the opposite.

Interruptions were mentioned often, and the HCP emphasised how interruptions negatively influenced their working conditions and risk behaviours. The RNs and ANs had different perceptions regarding interruptions. ANs described how patients, including the nurse call button were the source of the interruptions, while the RNs described how the interruptions often came from colleagues and the work phone. In the interviews that followed the observations, the HCP were often from start unaware of the risk situations they had participated in, this despite the fact that all of the participants performed risk behaviours during the time they were being observed. As the interviews progressed, the most frequently occurring risk behaviours were discussed, often in relation to the HCP's working conditions. Stress, interruptions, lack of time and poorly placed or forgotten disinfection agents were described as reasons for risk behaviours. Risks for organism transmission were often associated with caring for patients with diarrhoea, vomiting, or multidrug-resistant bacteria. The participants mentioned quite often how colleagues sometimes perform risk behaviours and did not seem to care enough about hygiene guidelines.

Quantitative findings

The most frequent risk behaviours were related to missed hand disinfection (56.5%), inappropriate placement of contaminated materials (14.5%) and inappropriate use of protective clothing (10.5%). The cluster analysis based on the units' overall working conditions resulted in three cluster groups: 1 Lacking kitchen staff and a room for overflow of patients. 2 High-needs patients

throughout plus high staff turnover. 3 Only single patient rooms with accompanying disinfection room and linen cupboards for each room. The quantitative analysis revealed that all of the risk behaviour categories were significantly higher during interrupted activities compared to single and combined activities. When HCP had to change locations due to the interruption, risk behaviours concerning hand hygiene were significantly higher than interrupted activities that did not require the HCP to go to a different location. There were no differences in the frequency of risk behaviours related to staffing levels, patient ratios, bed occupancy or patient-level workload. However, when the HCP worked in pairs, all of the risk behaviour categories, except for risk behaviours involving glove usage, were significantly higher than when the HCP worked independently. In regard to the cluster comparisons, there were significantly more risk behaviours regarding work-clothes in clusters 1 and 2 compared to cluster 3.

Study II

Self-efficacy to medical asepsis in care situations

The total mean score for self-efficacy to medical asepsis in care situations among the HCP was 137.1 (SD=12.4, Min=82, Max=150), i.e. high confidence in medical asepsis. The HCP had the highest rated confidence scores regarding the item *Never forget to take off my wrist watch before starting work* (M=9.9, SD=0.2, Min=7, Max=10). The HCP rated lowest confidence scores in *Always use gloves when drawing blood* (M=8.1, SD=2.8, Min=1, Max=10).

Structural empowerment

Total rates of access to structural empowerment were moderate (M=20.4, SD=3.7, Min=8, Max=30). Spearman's rho correlational tests revealed low correlation and a definite, but small relationship between structural empowerment and self-efficacy to medical asepsis in care situations (r_s=0.255, p<0.001). *Access to opportunity* was the subscale with the highest rates (M=3.8, SD=0.7, Min=1, Max=5), and *Access to Information* was the lowest with the mean score of 3.1 (SD=0.9, Min=1, Max=5). After grouping structural empowerment, the results from the Kruskal-Wallis H test confirmed that HCP who rated high levels of structural empowerment had significantly higher levels of self-efficacy to medical asepsis compared to the group that rated average empowerment. No significant difference was found between average and low groups. Accordingly, the hypothesis that HCP who rate high levels of structural empowerment also rate high levels of self-efficacy to medical asepsis could be partially supported.

Work engagement

Work engagement was rated with a mean of 4.7 (SD=0.9, Min=1, Max=6), and a definite, but small positive relationship was found between work engagement and self-efficacy to medical asepsis (r_s=0.268, p<0.001). In the group comparisons, the results revealed that HCP had significantly higher self-efficacy to medical asepsis in the group that rated high compared to the group that rated

average work engagement. No statistically significant difference was found between the groups with low and average work engagement, and hypothesis 2 was accordingly partially supported.

Work-related stress

The HCPs overall work-related stress was rated with the mean 3.8 (SD=0.4, Min=2, Max=4.8). More than 65% of the HCP assessed values indicating that improvement is needed, and 13% of those required urgent action. In the correlational analysis, a definite, but small relationship between self-efficacy to medical asepsis and overall work-related stress was found (r_s=0.254, p<0.001). The HCP rated the highest scores in the subscales *Colleague support* and *Role* (M=4.2, SD=0.4, Min=2, Max=5), and lowest regarding *Demands* (M=3.1, SD=0.6, Min=1, Max=4.9). In the group comparisons, the Kruskal-Wallis H test revealed significant differences between the groups red and green, yellow and aqua and yellow and green (see Table 3 for a description of the meaning of the colours). Therefore, regarding work-related stress and self-efficacy to medical asepsis, this hypothesis was also partially supported.

Assessment of risks for organism transmission at work

The HCP assessed the general risk for organism transmission at work as medium-high (M=2.5, SD=1.1, Min=1, Max=5). The HCP assessed their own risk of contributing to organism transmission as lower, with a mean score of 1.9 (SD=0.9, Min=1, Max=5). The assessed risk for oneself becoming infected at work had the same rating (M=1.9, SD=0.9, Min=1, Max=5). A definite, but small negative relationship was found between self-efficacy to medical asepsis and the assessment of general risk for organism transmission (r_s=-0.195, p<0.001). Regarding the assessment of own risk of contributing to organism transmission at work, a definite, but small negative relationship was also found (r_s=-0.204, p<0.001). There was no correlation between self-efficacy to medical asepsis and assessed risk for oneself becoming infected at work (r_s=0.008). In the comparative analysis, significant values regarding the general risk for organism transmission and self-efficacy to medical asepsis were found between the groups high and low and medium and low. By contrast, regarding self-efficacy to medical asepsis and their own risk of contributing to organism transmission or oneself becoming infected at work, no significant relationships were revealed. To conclude, Hypothesis 4 was to some extent supported.

Discussion

Summary of main results

The overall aim of this thesis was to generate knowledge about HCP's working conditions relationship to risk behaviours for organism transmission in health care. The HCP rated high levels of self-efficacy to medical asepsis in care situations, but risk behaviours for organism transmission frequently occurred regardless of experienced and observed working conditions. Furthermore, the HCP were often, from the start, unaware of performed risk behaviours. Interruptions and activities in which the HCP worked together increased the frequencies of risk behaviours. In the group comparisons in Study II, it was found that HCP who rated high levels of structural empowerment had significantly higher levels of self-efficacy to medical asepsis compared to the group that assessed average structural empowerment. Likewise, the HCP with high work engagement also had higher self-efficacy to medical asepsis than the group with average work engagement. In the matter of work-related stress, several differences were found between the groups. Low correlations with a definite, but small relationship were found between self-efficacy to medical asepsis and the working condition variables. Furthermore, there were differences between assessments of risk for organism transmission at work and self-efficacy to medical asepsis in care situations.

Working conditions and behaviours from a theoretical and organisational point of view

The thesis showed variations in HCPs observed, experienced and assessed working conditions. In Study I, the HCP's observed working conditions were relatively adequate. For example, in 61% of the observation units the HCP cared for 2–4 patients (based on the 378 observation units, referring to when one activity ended and another started), the units were mostly overstaffed (63%) and had available patient beds (53%). On the other hand, in 42% of the observed activities, the HCP were interrupted, and the majority perceived that the patient-level workload was medium or high. In Study II, the HCP assessed structural empowerment with a mean of 20.4, which implies moderate access to empowerment (142), work engagement with a mean of 4.7, implying high engagement (143) and work-related stress with the mean of 3.8, which implies relatively high levels of work-related stress and that improvement is needed (139). In the Job Demands-Resources model, working conditions are divided into two aspects: job demands and job resources, which includes physical, psychological, social and organisational characteristics (126). In the expanded model, work engagement was added and explained as being predicted by job resources (127,128). In other words, work engagement was described as a result of working conditions and not a working condition per se. Despite this, work engagement was included in this thesis as a working condition since it refers to people's psychological state of mind at work, and we found it important to add this perspective. Work engagement was found to be connected

to self-efficacy to medical asepsis since a definite, but small positive relationship was found. Furthermore, in the comparative analysis, we found significantly higher assessment of self-efficacy to medical asepsis in the group rated high, compared to the group rated average in work engagement.

The JD-R model has frequently been used in research, and a comprehensive review of the model described several job demands and resource factors that can and have been used. Examples of these are: work pressure and work overload (which are connected to work-related stress), demands, feedback, job control, opportunities for professional development, information, knowledge, relationships between colleagues and managers, and support (152). Several of these factors can also be found in the tools that have been used in this thesis to assess structural empowerment and work-related stress (44,45,53). They all have one major aspect in common, and that is that structural empowerment, work engagement, job demands and resources, work-related stress, and self-efficacy are described as being able to influence people's performance and behaviours at work (46,50,111,119,120,122,125).

The employer is responsible for the employees' working environment and working conditions (153). In Study II in this thesis, more than 65% of the HCP had scores regarding work-related stress that indicated that improvement was needed, of which 13% required urgent action. Additionally, to some extent, work-related stress had a relationship to self-efficacy to medical asepsis in care situations. Work-related stress is a common concern among HCP (15,52), and in Sweden, sick leave caused by stress has increased in recent years. Most of the people on sick leave for stress are women (154). Women are also the majority of RNs and ANs (155). A comprehensive Cochrane review has determined that reducing work-related stress among HCP is not easy to manage (156). They found low evidence that cognitive-behavioural training, physical or psychological relaxation or schedule changes would reduce stress among HCP. Furthermore, the review indicated that interventions must concentrate on specific work stressors (156). According to the JD-R model, the managers are responsible for decreasing job demands and/or improving job resources so that employees can recover sufficiently (127). This is in line with the Swedish work environment laws that state that work content shall be designed so that the employee is not exposed to a physical or mental strain that may lead to illness or mental illness (153). Furthermore, it is stated that the employee shall be allowed to participate in the design of his or her work situation and in the change- and development of the work. Working conditions shall further provide opportunities for personal and professional development (153). Several of the working condition aspects included in this thesis are difficult for FLMs and the HCP to control, for example bed occupancy and patient-level workload. Other aspects however, can to some extent be managed within the organisation to improve the working conditions for the HCP. The employees can be included when designing the structure and arrangement of the work, and the FLMs

should include HCP in change- and development work. There are different origins of stress, and having too little to do at work is also undesirable in the long run, as that can lead to under-stimulation and poor performance (157). This is another reason why it is essential to have the HCP involved in the development at work. This is of importance for their well-being and for their ability to provide good patient care. Even though many of the HCP involved in this thesis had experienced high work-related stress, just as previous research has found (15,52), the HCP still experienced high levels of work engagement and moderate access to structural empowerment, which can be considered as encouraging.

Based on previously cited research that reported staffing levels, bed occupancy and patient-level workload affected the frequencies of HCIAs and other patient outcomes (12,27,159,62,73,103–105,108,109,158), we assumed these working conditions could also have a relationship to risk behaviours for organism transmission. The HCP did discuss these aspects in the interviews in relation to their infection prevention behaviour, but this could not be established in the statistical analyses. Despite adequate working conditions (measured objectively), risk behaviours still occurred. Based on the results in this thesis, it appears that risk behaviours for organism transmission are more closely associated with what is happening at the time than the HCP's overall working conditions, e.g. when interruptions occurred or when the HCP worked together. In a sense, HCP are in some way each other's working conditions. This can be seen as something positive since this is, unlike bed occupancy or patient-level workload, something that the FLM and HCP can influence. However, there are other aspects of working conditions beyond those included in this thesis that are of importance for the HCP, and that can influence risk behaviours. Further, risk behaviours can, of course, be influenced by aspects other than working conditions, e.g. knowledge, motivation, responsibility and social influence (8,92,160).

From a theoretical standpoint, people's behaviours (risk behaviours for organism transmission) should be related to the HCP's working conditions. However, this is a complex area, and we have not been able to fully understand our results found in this thesis using the theories discussed above. More knowledge is needed to understand these relationships.

Risk behaviours for organism transmission and self-efficacy to medical asepsis

In Study I, risk behaviours for organism transmission occurred frequently (approximately one risk behaviour every five minutes). In Study II, the HCP assessed high levels of self-efficacy to medical asepsis in care situations. In Study I, with the mixed methods design, there were no statistically significant differences regarding the frequencies of the risk behaviours related to the majority of the working conditions included. In other words, risk behaviours oc-

curred regardless of the staffing levels, bed occupancy, patient ratios and perceived patient-level workload. In the qualitative part, the HCP were often from start unaware of performed risk behaviours, and risks for organism transmission were commonly associated with care given to patients with certain conditions, e.g. vomiting or multidrug-resistant bacteria. This together may indicate a lack of understanding that a person's particular behaviour can constitute risks for organism transmission. According to Sandberg's theory about human competence at work, employees act according to their understanding of the work and the situation. Understanding is formed by personal, practical and emotional experiences; and by dialogue and reflection between colleagues. When developing understanding, the behaviour will subsequently be affected (161). Hence, an increased understanding of risk behaviours among HCP could possibly reduce risk behaviours for organism transmission.

The theory of understanding human competence at work is directed towards management and managers in organisations and emphasizes that competence does not only consist of knowledge and skills, but is based on the understanding of one's work. Accordingly, understanding is described as the basis for competence at work (161). Examples of results from this thesis that can be connected to this theory are that interruptions and working together during patient care activities was found to increase the frequencies of risk behaviours. On the premise of the theory of understanding human competence at work, the understanding that one's actions affect one's colleagues seems to be somewhat deficient. As previous research has reported (25–27), half of the interruptions are made by colleagues, which was also the case in this thesis. These interruptions, however, can be easier to prevent than interruptions from patients and relatives. Interruptions are described as being a part of health care, and they cannot be completely avoided (183), but reducing interruptions would benefit the HCP's working conditions and patient safety (39). In a previous ethnographic study, the authors emphasized that RNs would benefit from education to increase understanding and awareness of their contribution to interruptions (162). In order to increase the understanding of both risk behaviours for organism transmission and that a person's behaviours can have consequences for colleagues, HCP could use practical case scenarios. The epic3 guidelines emphasise that organisations must provide training and repetition for HCP performing medical asepsis (75). Since understanding according to the theory of understanding human competence at work is more related to practical experience than education alone (161), it could be a good idea for managers to present challenges in the form of vignettes or scenarios involving work problems to stimulate employees' reflections (163). HCP have described that discussing authentic vignettes with colleagues could be a suitable way to improve infection prevention behaviour (164). Feedback is a dimension in the JD-R model and in structural empowerment (53,150), and it is also one of the aspects presented in the World Health Organization's multimodal strategy to improve hand hygiene compliance (87). Therefore, feedback could preferably be incorporated in work problem scenarios to enrich HCP's reflections. Since more risk behaviours occurred when the HCP worked together, it would be preferable if

the HCP were allowed to practice in different group constellations. Understanding increases when people interact with each other, and the development of understanding is also a social process (163). When colleagues in a working group consolidate in a work task, everyone contributes with his or her skills and a shared understanding is developed (163). One example mentioned is that a newly graduated RN and an experienced RN understands care situations differently and will probably act in different ways based on their understanding of the situation (163). If FLMs want to increase understanding and change their employees' behaviour; it is not enough to only provide them with information. Employees need to understand the information and understand why things should be done a certain way (161). Another reason why HCP should be supported and encouraged to practice and reflect together is that it can increase their self-efficacy. According to the theory, self-efficacy is based on earlier performance outcomes (indicators of capability), vicarious experiences (observing others completing tasks successfully and transmission of skills) and verbal persuasion (being coached by others to believe in ability) (119). To conclude, if HCP practice and reflect together regularly, both self-efficacy to medical asepsis and the understanding of organism transmission can hopefully increase and lead to fewer risk behaviours, which can strengthen the HCP, enhance the organisation's effectiveness and promote patient safety.

There is definitely not a complete absence of understanding for risk behaviours for organism transmission. As the interviews progressed in Study I, the HCP often became aware of risk behaviours that had occurred during the observations, which were often discussed in relation to their working conditions. The participants sometimes even mentioned that they had noticed colleagues performing risk behaviours. In Study II, the HCP assessed the general risk for organism transmission higher than the risk of themselves contributing to organism transmission. This is in line with previous research showing HCP often assess their own ability and compliance to hygiene principles higher than their colleagues (165). This is another reason why increased understanding of risk behaviours for organism transmission is of importance and something that should be supported by the FLMs.

As previously noted, risk behaviours for organism transmission frequently occurred, even though self-efficacy to medical asepsis in care situations was assessed as high. However, there are two things that one must bear in mind. Firstly, self-efficacy to medical asepsis does not necessarily correspond to the actual performance and compliance to hygiene principles, and previous research has reported that HCP often overestimate compliance to hygiene principles in relation to observed behaviours (165,166). Bandura describes self-efficacy as a person's beliefs in their ability to succeed in specified situations (119), and the questionnaire used in this thesis is developed from the theory's associated guide for instrument development (133). Accordingly, the questions are not designed to apply performance/compliance, but beliefs in ability. To have a belief in ability is one thing, and performance is another. Self-efficacy

has however, been described as being able to influence people's performance and behaviours (119). Secondly, it is unlikely that those individuals who were observed in Study I and those who participated in the survey in Study II were the same individuals. It could be possible that some individuals participated in both studies since two of the units that were randomized to be asked to participate in Study II already had agreed to participate in Study I.

Due to the Swedish health and healthcare law (2017:30), all given care shall be given with good quality and hygiene standards (167). The managers' responsibility is to ensure that this is possible, e.g. the HCP should have access to work-clothes, disinfection, protective clothing and equipment (189), and also a reasonable workload (153). It goes without saying, that each individual working in health care is obliged to comply with valid hygiene principles to prevent organism transmission (75,76). This also requires knowledge and understanding. HCP's working conditions are, as delegated, the managers' responsibility (153), and increasing the employees' understanding is the managers' responsibility as well (161).

Methodological considerations

One of the key strengths in this thesis was that several approaches were used to investigate the relationships between HCP's working conditions and risk behaviours for organism transmission. Study I with the mixed-methods design made it possible to feature a multidimensional presentation of this complex topic. The use of a mixed-methods design can bring insight that goes beyond separate qualitative and quantitative results (129). When evaluating mixed-methods research, both qualitative and quantitative aspects must be taken into account (129). The design has to match the research question and the use of mixed-methods must be relevant for the research question. The convergent design of mixed-methods was considered suitable since the area of study was yet uncharted. It enabled us to obtain different, but complementary data on the same topic. The data was equally important and collected concurrently, yet separately, i.e. one data collection did not depend on the results of the other (129). The opportunity to move back and forth with the data enabled us to add further questions that could be answered. Results from the semi-structured interviews generated an additional question concerning the issue of working together. The HCP described how a consequence of caring for high-needs patients, was the need to work together. This question was added in the statistical analysis, which confirmed that the occurrences of risk behaviours were more frequent in situations where the HCP worked together during patient care activities than in situations where the HCP worked independently. This is an interesting and important result that had not been possible to ascertain without the mixed-methods approach. Likewise, the RNs and ANs described in the interviews that they experienced different sources for the interruptions, which was also confirmed in the analyses. Furthermore, the procedures must be transparent (129). To achieve this, a detailed procedural diagram of the convergent mixed-methods design was framed.

Trustworthiness in qualitative research consists of credibility, dependability and transferability (146). To ensure credibility, it is essential that the participants have various experiences that enable a variation of aspects, and that interpretations and results are truthful (132,146,168). In Study I, there was a large variation in terms of participants, e.g. age, profession and work experience. The units also varied, e.g. in terms of size, speciality and location in Sweden. In Study I, an example of the analysis of the field notes was presented, as well as a table with the content areas, categories and subcategories describing HCP's perceptions of working conditions in relation to risk behaviours for organism transmission. Additionally, several quotations from the categories were presented together with a rich presentation of the different data collection procedures and all of the steps involved in the data analysis. Dependability refers to data stability and the degree to which data change over time. If data collection extends over a long period of time, there is a risk that data collection could be inconsistent (146). In this thesis, the observational and interview data were collected by the same person. It is essential that all participants are questioned in the same content areas (146). An interview guide was therefore used to ensure that all topics were discussed, and to avoid the risk for inconsistency. While adhering to the aim of the interviews, adaptations were made to situations that had occurred during the observations. The first author conducted the analysis, and had open and reflective dialogue with the other authors during the process. Whether results can be transferable to other groups or settings is referred to as transferability, and to achieve transferability, the researchers should give a rich description of the characteristics of the context (132,146,168). Quotations from different participants strengthens the transferability, and a table with characteristics of both setting and sample are presented, so that the reader can determine whether the findings can be transferred to other contexts.

The observations performed in this thesis were collected qualitatively and subsequently quantified. Direct observations are accepted as the 'gold standard' when assessing hand hygiene compliance (169), but are unquestionably also associated with difficulties. A systematic review on the validity of hand hygiene compliance measured by observations has reported information, selection and confounding bias as the main types of potential bias (170). The Hawthorne effect means that people are modifying behaviours when they are aware of being observed. A newly published review discussed the importance of standardized methodologies to measure the Hawthorne effect when observing hand hygiene compliance (171). No measures to control for the Hawthorne effect were used in Study I, which is a potential risk for information bias (170). A common critique that can cause information bias is lack of observation training (170). Prior to the data collection, Lisa Arvidsson, who conducted the observations, practiced observation technique at a medical unit. Selection bias is possible when data collection is limited, for example in cases of a limited range of care settings, personnel or time periods (170). All observations were collected in the morning, which can make it difficult to apply the results to an entire 24–hour work day. It was an active choice to perform the observations

in the mornings since this is often the busiest time for patient-related activities. Working conditions for the HCP, e.g. staffing levels are usually not the same for the different shifts, and a potential selection bias is possible (170). No attempts to control for confounding bias were performed in Study I.

To assess consistency regarding the determination of risk behaviours in Study I, Lisa Arvidsson and Maria Lindberg independently analysed risk behaviours from three randomly selected observation days. The inter-rater reliability was analysed with both Kappa statistics and Gwet's agreement coefficient and their 95% confidence intervals (144). Moreover, since K statistics can be low despite high levels of agreement, we calculated the prevalence-adjusted bias-adjusted kappa (145). Absence of inter-rater reliability is a reoccurring critique in observational studies (170), and the performed inter-rater reliability is a great advantage in the study. Researchers need to reflect upon their role, and pre-understanding can make a difference when interpreting data (129). For the purpose of this thesis, pre-understanding was considered as positive. Both authors that conducted the inter-rater reliability have extensive experience in infection prevention, which was seen as appropriate and their substantial agreement gives additional strength to the results. Another strength was that several risk behaviours were studied, and not only hand disinfection.

All instruments in this thesis, except for IPAS, have confirmed acceptable validity and reliability (45,134,135,140). IPAS was developed since there was no previous questionnaire that measured self-efficacy to medical asepsis in care situations. As a first step, face validity was performed (132). Then, in not yet published data, both the item and scale content validity index was found to be excellent as rated by ten independent infection prevention RNs. It is not uncommon that generalized self-efficacy is used in research, but when it is used in a general sense, it is not in line with Bandura's theory, which emphasizes that self-efficacy refers to a person's beliefs in their ability to succeed in specified situations (119). IPAS was developed in line with the theory and its guide for instrument development (133), which is seen as a strength. One of the most frequently used statistics for the evaluation of internal consistency is Cronbach's Alpha (132). This was used in regard to the total scales, and the sub-scales in CWEQ-II and HSE. Coefficients $\geq$0.8 are described as particularly desirable (132) and all coefficients in Study II had desirable values. IPAS was 0.82, CWEQ ranged from 0.71 to 0.86 within the subscales and the total alpha score was 0.79. The UWES-9 was 0.93, and in HSE the Cronbach's alpha ranged from 0.78 to 0.91 within the subscales and the total alpha score was 0.82. External validity refers to generalizability (132). A strength in the survey study was that the units were randomized, and that there was a rich variation in the characteristics of the participants and the units that were from community, district, regional/university and private hospitals. An overall limitation in Study II was the cross-sectional design, which does not make it possible to find causal relationships. Additionally, it was unfortunate

that we could not perform regression analyses since the assumptions did not meet with the available data.

Conclusions

The HCP rated high levels of self-efficacy to medical asepsis, but on the other hand, risk behaviours frequently occurred regardless of perceived and observed working conditions. Healthcare managers are responsible for HCP's work environment and should continuously work to promote sufficient working conditions and to increase HCP's understanding of risk behaviours, which consequently promotes patient safety.

Clinical implications

This thesis has revealed that risk behaviours for organism transmission is common, this despite that the HCP themselves assess they have high levels of self-efficacy to medical asepsis. Additionally, the HCP were frequently unaware of performed risk behaviours. This can indicate a lack of understanding of how one's behaviour leads to risks for organism transmission. Increasing and retaining knowledge in infection prevention behaviour is a phenomenon that deserves to be prioritised in health care, especially since HCAIs are a global issue (3,4). HCP regularly practice cardiopulmonary resuscitation, which unquestionably is of great importance. FLMs should also promote recurring practice in medical asepsis in care situations in order to increase understanding and to prevent risk behaviours for organism transmission. Interruptions and care activities that the HCP performed together increased risk behaviours. These can and should not be avoided, but awareness of their possible repercussions can be improved. To improve awareness, healthcare organisations and FLMs should provide HCP opportunities to practice complex nursing situations with their colleagues and evaluate the situation together. This could increase HCP's understanding of risks for organism transmission, how their behaviour affects colleagues and consequently promote patient safety.

Suggestions for further research

Although the studies in this thesis have given us interesting and important results, it is clear that the relationship between risk behaviours and working conditions is a subject that needs to be studied further. In Study II, we investigated HCP's working conditions in relation to self-efficacy to medical asepsis in care situations, but not actual performance. In Study I, on the other hand, we did measure actual performance and got some answers. Knowing the fact that cooperation between colleagues and interruptions increased risk behaviours, it can be argued that risk behaviours for organism transmission are more closely associated with what is happening at the time than HCP's overall working conditions, and this needs to be studied further. In the interviews, the participants frequently discussed how interruptions negatively influenced their working conditions and infection prevention behaviour. They also emphasised the importance of the psychosocial work environment and that conflicts can arise between colleagues and that it matters who you work with. It would be of interest

to investigate if the frequencies of risk behaviours have a relationship to different constellations of HCP and if it could be a consequence of personal chemistry between collages. It is possible that if HCP have similar working methods, fewer risk behaviours occur, and/or when HCP work differently or are not accustomed to working together risk behaviours increase. It could also be the case that different work tasks affect the frequency of risk behaviours. Another possible explanation is that the increased frequencies of risk behaviours when HCP worked together may have a link to interruptions and difficulties foreseeing the colleague's next move. A suitable way to investigate this would be to continue to use the mixed-methods design using observations where consideration is given to the context and individuals involved combined with interviews to see if the HCP are aware of this and what they think it may be due to.

In Study II, the majority scored high levels of work-related stress and work-related stress among HCP is definitely a working condition that needs to be studied further. In Study I, work-related stress was commonly discussed in the interviews, but we were not able to perform any analysis regarding work-related stress and risk behaviours. Since a deeper understanding regarding HCP's experiences of work-related stress in relation to risk behaviours for organism transmission is lacking, a suitable way to begin could be to start qualitatively to generate hypotheses that can be later tested with appropriate quantitative analysis, such as regression analysis.

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ORIGINAL ARTICLE

Healthcare personnel's working conditions in relation to risk behaviours for organism transmission: A mixed-methods study

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Abstract

Aims and objectives: To investigate healthcare personnel's working conditions in relation to risk behaviours for organism transmission.

Background: Healthcare personnel's behaviour is often influenced by working conditions that in turn can impact the development of healthcare-associated infections. Observational studies are scarce, and further understanding of working conditions in relation to behaviour is essential for the benefit of the healthcare personnel and the safety of the patients.

Design: A mixed-methods convergent design.

Methods: Data were collected during 104 h of observation at eight hospital units. All 79 observed healthcare personnel were interviewed. Structured interviews covering aspects of working conditions were performed with the respective first-line manager. The qualitative and quantitative data were collected concurrently and given equal priority. Data were analysed separately and then merged. The study follows the GRAMMS guidelines for reporting mixed-methods research.

Results: Regardless of measurable and perceived working conditions, risk behaviours frequently occurred especially missed hand disinfection. Healthcare personnel described staffing levels, patient-level workload, physical factors and interruptions as important conditions that influence infection prevention behaviours. The statistical analyses confirmed that interruptions increase the frequency of risk behaviours. Significantly higher frequencies of risk behaviours also occurred in activities where healthcare personnel worked together, which in the interviews was described as a consequence of caring for high-need patients.

Conclusions: These mixed-methods findings illustrate that healthcare personnel's perceptions do not always correspond to the observed results since risk behaviours frequently occurred regardless of the observed and perceived working conditions. Facilitating the possibility for healthcare personnel to work undisturbed when needed is essential for their benefit and for patient safety.

Relevance for Clinical Practice: The results can be used to enlighten healthcare personnel and managers and when designing future infection prevention work.

KEYWORDS
healthcare personnel behaviour, healthcare-associated infections, infection prevention, interruptions, mixed methods, working conditions

1 | INTRODUCTION

Preventing organism transmission in healthcare delivery is a major global issue for patient safety, because healthcare-associated infections (HCAI) are the most common form of healthcare injury (Haque et al., 2018; World Health Organization, 2021). Healthcare personnel's (HCP) infection prevention behaviour is described as being a key factor in the prevention of HCAI (Allegranzi & Pittet, 2009; World Health Organization, 2009). Non-compliance with hand hygiene is widely regarded as the major risk behaviour for organism transmission (Allegranzi & Pittet, 2009; Haque et al., 2018). Interventions aiming to increase hand hygiene compliance among HCP are numerous, but accompanied by various difficulties (Gould et al., 2017; Price et al., 2018; Seo et al., 2019). Results in a comprehensive literature review by Gould et al., (2017)indicated that interventions gave a slight improvement in hand hygiene compliance and a low to moderate certainty of evidence was described. Long-term follow-up is uncommon, for example only three of 24 studies included in Seo et al., (2019) had measured long-term follow-up with maintained results. A systematic review of 19 systematic reviews by Price et al., (2018) found only one study with a low risk of bias. Even though non-compliance to hand hygiene is described as the major risk, several other risk behaviours that can lead to organism transmission have been described, for example inappropriate use of gloves (Lindberg et al., 2020) or protective clothing and uncleaned medical devices (Clack et al., 2018; Livshiz-Riven et al., 2015; Loveday et al., 2014). Despite numerous interventions aiming to decrease HCP risk behaviours, HCAI are still reported as a global problem (World Health Organization, 2021).

What does this paper contribute to the wider global clinical community?

- Interruptions and colleagues working together during patient care activities increase risk behaviours for organism transmission.
- Infection prevention work needs to include hand disinfection along with other risk behaviours, as only half of the problem is accessed when the focus is exclusively on hand disinfection.
- That mixed-methods research can be appropriate when investigating a complex relationship as between healthcare personnel's working conditions and infection prevention behaviours.

2 | BACKGROUND

Registered nurses (RNs) worldwide describe how they are experiencing undesirable working conditions (Goodare, 2017). Working conditions are described as a factor that influences the individual, and human risk behaviours are often a causal part of a sequence of events and not the origin (Rasmussen, 2003). For HCP, several working conditions have been identified as influencing the risk for HCAI. A systematic review found that bed occupancy, staffing, workload, use of pool or agency nurses and availability of materials play key roles in infection prevention. Outcomes were measured mainly by the frequency of HCAI or compliance with hand hygiene (Zingg et al., 2015). Virtanen et al., (2009) combined a personnel survey with infection prevalence and found that long work hours, low trust and poor collaboration between colleagues as well as high work stress increases HCAI (Virtanen et al., 2009). An early review investigated the relationship between RNs' working conditions and different patient outcomes, including HCAI. The results described how staffing levels have both a negative and positive impact on HCAI. Since working conditions were often measured by data from surveys and linked to quality indicators within nursing, the researcher described the results as ambiguous and suggested future research to measure observable working conditions and patient outcomes (Bae, 2011). RNs have described working conditions, for example heavy workloads, understaffing, lack of hand disinfection agents and improper placement of products or sinks to be reasons for non-compliance with hand hygiene. Other reasons not connected to working conditions, such as forgetfulness, skin irritation and difficulty putting on gloves after hand disinfection, were also described (Sadule-Rios & Aguilera, 2017).

Being interrupted is another working condition that can influence patient safety (Monteiro et al., 2015; Wagner et al., 2020). RNs are often interrupted in their work, and this phenomenon has been studied mainly in relation to medication safety (Hayes et al. 2015; Raban & Westbrook, 2014; Schroers, 2018; Thomas et al., 2017). Interruptions have been described as leading to increased cognitive loads and frustration among RNs (Thomas et al., 2017). Different sources for the interruptions besides self-interruptions are, for example, colleagues, patients, work phones and a lack of materials (Monteiro et al. 2020; Schroers, 2018). Interruptions have also been

found to influence the occurrence of HCP's risk behaviours for organism transmission (Lindberg et al., 2017, 2018). This issue would benefit from further study in regard to the sources of the interruptions and how the HCP perceive interruptions in relation to their infection prevention behaviours.

Human behaviour is influenced by the context of the work and the working conditions. Staffing, bed occupancy, workload and availability of materials have been reported as crucial factors in infection prevention. Despite this, observational studies that investigate HCP's observed and perceived working conditions in relation to HCP's observed behaviours are lacking. Studying this relationship is essential to increase the understanding of this complex subject. A mixed-methods study is one appropriate way to accomplish this. When the relationship is known, suitable improvements and measures can be implemented for the HCP that benefits them and patients safety.

3 | AIM

To investigate healthcare personnel's working conditions in relation to risk behaviours for organism transmission.

4 | METHODS

4.1 | Design

A mixed-methods convergent design where qualitative and quantitative data were collected in parallel, given equal priority, analysed separately, and then merged was used (Creswell and Plano 2017). Collecting both quantitative and qualitative data can bring greater insight into the problem than either type of data alone could. A procedural diagram of the study design is provided in Figure 1. The Good Reporting of a Mixed Methods Study (GRAMMS) was used as a framework to report the study design and findings (O'Cathain et al., 2008: See File S1).

4.2 | Setting and sample

The study was conducted at eight conveniently chosen surgical and orthopaedic units in five Swedish hospitals. Participants were RNs, assistants nurses (ANs) and the unit's first-line managers (FLMs). No inclusion criteria were defined. The sample and settings are described in Table 1.

4.3 | Data collection

Data were collected through focussed mobile positioning observations (Spradley, 1980). The observer did not participate in the patient care to prevent alterations in the working conditions. Structured interviews with FLMs and semi-structured interviews (Polit & Beck, 2021) with RNs and NAs were collected concurrently. From 28 February to 6 May 2019, the first author spent three mornings at each of the eight included units. In total, 151 h were spent at the units. The total amount of hours performing the observations was 104. The remaining time was spent on the interviews and preparing for them. Prior to the observations, the HCP were asked to provide demographics about themselves. They were also asked to provide information about their present work conditions, for example number of patients they were responsible for, staffing level, bed occupancy as well as their perceptions of the general workload and patient-level workload that is based on clinical condition and level of care needs. This information resulted in a data set of the working conditions for the participant. During each observation, 2–4 HCP were shadowed while they performed different activities. When one activity was concluded, the observer either continued to follow the same participant or observed another. Field notes comprising all observed behaviours were written by hand during the observations. The field notes were written in a different colour for each participant to facilitate the preparations for the interviews and to enable the linking of the field notes to the HCP working conditions in the analyses. Locations of the performed activities were also noted. After the observations, the in person semi-structured interviews were held with all of the observed RNs and ANs. The majority were recorded and lasted between 5 and 27 min. Questions were asked regarding their reflections on the day's working conditions (including interruptions), how they perceived the working conditions in relation to their infection prevention behaviour and reflections on risk behaviours that occurred during the observations. When an opportunity arrived during a data collection day, a structured in person interview was conducted with each respective FLM. Questions were asked concerning the length of time they were managers, their professional degree and the unit's overall working conditions, for example staffing issues, unit layout and facilities.

4.4 | Data analysis

Initially, the quantitative and qualitative data were analysed separately (Figure 1). In the first step, the transcribed field notes were divided into a total of 378 observation units, that is when one activity ended and another started. HCP's working conditions were then categorised according to description and distribution (Table 2). Additionally, data from observation units were deductively categorised by the first author and quantified into different types of risk behaviours (Table 3) as described by Lindberg et al., (2017). To assess consistency regarding the determination of risk behaviours, the first and last authors independently analysed risk behaviours from three randomly selected observation days (42 observation units = 11% of the total 378). Inter-rater reliability for the 2-category classification (identifying no risk behaviour versus risk behaviour) was analysed with Kappa statistics (K) plus Gwet's agreement coefficient (AC1) and their 95% confidence intervals (95% CIs). The AC1 statistic is

	QUAL	QUAN	QUAL	QUAN
Data collection	**Procedure** Focused observations of 79 healthcare personnel from eight units **Timing** Mornings at the units between February 28th to May 6th, 2019 **Product*** Field notes	**Procedure** Questions about background data + working conditions with the same 79 healthcare personnel **Timing** Prior to the observations	**Procedure** Semi-structured interviews with the same 79 healthcare personnel **Timing** After the observations	**Procedure** Structured interviews with first-line managers from respective unit (n=8) **Timing** Sometime during the observation days **Product QUAN** Background data regarding first-line managers and units (Table 1) **Product*** Data set of each unit's overall working conditions covering aspects of staffing, physical layout and facilities
		QUAN (structured data) **Product QUAN** Background data about healthcare personnel (Table 1) **Product*** Data set of working conditions for respective healthcare personnel	**QUAL** (semi-structured data) **Product*** Transcripts	
	QUAL → QUAN	**QUAN**	**QUAL**	**QUAN**
Data analysis	**Procedure** Dividing field notes into observation units. Categorization of observation units into: -Location of activity -Colleagues working together -Character of activity Categorization of interrupted activities into: -Interruption requires changing location -Source of interruption Categorization and quantification of: -Risk behaviours **Product QUAN** -Observation units -Description and distribution of healthcare personnel's working conditions (Table 2) and risk behaviours (Table 3) linked with each observation unit (Table 4)	**Procedure** Linking healthcare personnel's working conditions with observation units **Product QUAN** -Description and distribution of healthcare personnel's working conditions -Number of patients -Estimated overall patient-level workload -Staffing levels -Bed occupancy (Table 2) Linked with each observation unit (Table 4)	**Procedure** Qualitative content analysis of transcripts **Product QUAL** Categories describing the content areas: working conditions (including interruptions) and Healthcare personnel's reflections on risk behaviours (Table 5)	**Procedure** Two-step cluster analysis based on information from all of the units' overall working conditions **Product QUAN** Cluster solution
	Procedure Statistical analysis of quantitative products: Pearsons's chi-squared $x^{2,}$ Kruskal-Wallis H, Mann-Whitney U **Product QUAN** Comparisons between working conditions and total respective risk behaviour category (Table 6) Comparisons between clusters and total respective risk behaviour category (Table 7)			
Results	**Merging of QUAL and QUAN results** **Mixed methods Product** Integrated interpretation of healthcare personnel's working conditions and their relationship to risk behaviours for organism transmission			

†: Products marked with * are used in additional analysis. When grey background, products are presented as results.

FIGURE 1 Procedural diagram of the convergent mixed-methods study design, with qualitative (QUAL) and quantitative (QUAN) data. †: Products marked with * are used in additional analysis. When grey background, products are presented as results

more robust than K statistics and has therefore been recommended as an alternative or complement to K (Wongpakaran et al. 2013). Additionally, since K statistics can sometimes be low despite high levels of agreement, we also calculated the prevalence-adjusted bias-adjusted kappa (PABAK) (Sim & Wright, 2005). The data set of working conditions for the respective HCP was linked to the observation

TABLE 1 Characteristics of settings and sample

SETTING	*n* = 8	SAMPLE	
Hospital units		**Healthcare Personnel**	***n* = 79**
Community hospital units	3	**Education**	
District hospital units	3	RN, number	37
Regional/university hospital units	2	AN, number	42
Unit specialty		**Sex**	
Surgical	4	Women, number	70
Orthopaedic	4	Men, number	9
Units' physical layout		**Age, years** mean (SD)	39.6 (12.8)
Square form	1	**Working experience, years** mean (SD)	11.6 (13.3)
Two parallel corridors	3	**Years at present unit,** mean (SD)	6.4 (8.4)
Long corridor	2		
T-formed	2	**First-line Managers**	***n* = 8**
Number of patient beds		**Number of subordinates**	
10–19	3	30–39	1
20–30	5	40–49	4
Work structure		50–59	2
Pair = RN & AN work together	2	60–69	1
Team = RN +2 or more ANs	3	**Professional degree**	
Mixed = pair/team	3	Registered nurse, number	8
Entire unit open		**Sex**	
Yes	4	Women, number	8
No (due to lack of personnel)	4	**Years as FLM,** mean (SD)	4.1 (7.7)
Type of patient rooms			
Only single patient rooms	2		
Single and double rooms	3		
Single/double/four beds per room	2		
Single/double/four/six beds per room	1		

Abbreviations: AN: Assistant nurse; FLM: First-line manager; RN: Registered nurse; SD: Standard deviation.

units and added to Table 2. An example of the field note analysis and linkages to HCP's working conditions is illustrated in Table 4.

In the second step, transcriptions from the semi-structured interviews were analysed using qualitative content analysis (Graneheim & Lundman, 2004). The interviews were read through repeatedly to get an overall understanding and then read closely to deductively divide the text into the content areas: working conditions (including interruptions) and reflections on risk behaviours. The text within the content areas was thereafter inductively divided into meaning units, and when needed condensed before being labelled with a code. The codes were compared based on their differences and similarities and sorted into categories and subcategories, which the qualitative results are based on. For the content area regarding reflections on risk behaviours, the text was deductively divided into risk behaviours that formed the categories. Presented in Table 5 are the content areas with their categories and subcategories that describe the HCP's perceptions of working conditions in relation to risk behaviours for organism transmission. The first author conducted the analysis and discussed it with the other authors until consensus was reached. Results from the semi-structured interviews generated questions that were clarified by statistical analyses.

Cluster analysis is a method that can be used to determine which objects are similar to each other in a given set and to group similar objects into clusters (Romesburg, 2004). The third step in this study's data analysis was to classify the units based on similarities and dissimilarities, and create clusters with units having similar working conditions. The data set of each unit's overall working conditions was used, and a two-step cluster analysis with distance measure log-likelihood was performed (Romesburg, 2004). Based on visual inspection of Akaike's information criterion (AIC), both three and four clusters were considered as appropriate since they had good cluster quality measured by the Silhouette index (SI). Final determination based on clinical relevance revealed three clusters. The stability and reliability of the cluster analysis was confirmed by

TABLE 2 Description and distribution of healthcare personnel's observed and perceived working conditions

Working conditions	Frequencies (%)
Location of activity, based on observation units (*n* = 378)	
Single patient room	187 (49.5)
Double room	86 (23)
Four-bed room	23 (6)
Six-bed room	25 (6.5)
Other location	57 (15)
Healthcare personnel (HCP) working together, based on observation units (*n* = 378)	
Yes (Two or more colleagues working together)	98 (26)
No (The HCP perform the care activity independently)	280 (74)
Character of activity, based on observation units (*n* = 378)	
Single (Containing one single activity)	77 (20.5)
Combined (Containing several subsequent activities)	142 (37.5)
Interrupted (The HCP was interrupted during the task)	159 (42)
Interruption requires change of location, based on interrupted activities (*n* = 159)	
Yes (The HCP has to change locations due to the interruption)	91 (57)
No (The HCP does not change location due to the interruption)	68 (43)
Source of interruption, based on interrupted activities (*n* = 159)	
Colleague (Including interruptions from other healthcare professionals/colleagues or work phone)	65 (41)
Patient (Including interruptions from patients, relatives and nurse call button)	72 (45)
Self-interruption (e.g. forgetting or misplacing equipment/supplies)	22 (14)
Number of patients, based on observation units (*n* = 378)	
Caring for 2–4 patients	231 (61)
Caring for 5–7 patients	120 (32)
Caring for 8–10 patients	27 (7)
Estimated overall patient-level workload, based on observation units (*n* = 378)	
Low-need (The HCP estimated overall patient-level workload to be low based on clinical condition of patients and level of care needs)	58 (16)
Medium-need (The HCP estimated overall patient-level workload to be medium based on clinical condition of patients and level of care needs)	183 (48)
High-need (The HCP estimated overall patient-level workload to be high based on clinical condition of patients and level of care needs)	137 (36)
Staffing levels, based on observation units (*n* = 378)	
Understaffed	96 (25.5)
Fully staffed	44 (11.5)
Overstaffed	238 (63)
Bed occupancy, based on observation units (*n* = 378)	
Patient beds available	200 (53)
At full capacity	146 (38.5)
Over full	32 (8.5)

repeating the clustering procedure, which resulted in the same cluster grouping and quality.

In the fourth step, the descriptive statistics regarding risk behaviours and working conditions were analysed. Due to the non-normal distributed data, Kruskal–Wallis H and Mann–Whitney U non-parametric tests were used to compare risk behaviours in relation to working conditions. Pearson's chi-squared test was used to compare the sources of the interruptions incurred by the RNs and ANs. Significance was set as $p \leq .05$. Statistical analyses were calculated in IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp. Armonk, NY, USA). WINPEPI Program Version 11.65 was used to calculate inter-rater reliability.

Finally, the qualitative and quantitative findings were merged and presented together in the results to achieve an integrated interpretation of HCP's working conditions in relation to risk behaviours for organism transmission.

4.5 | Ethical considerations

The Swedish ethical review authority approved the study protocol (reg. no. 2019-00530). Before data collection, information about the aim, methods and their right to withdraw at any time was given and written informed consent was obtained from all participants. All patients involved were asked for verbal approval of the observer's presence.

5 | RESULTS

The results start with descriptive statistics, and then, the integrated findings are illustrated. The integrated findings begin with descriptions from the qualitative material, including quotations, followed by the quantitative statistical analyses. A complete description of categories and subcategories generated from the content analysis is described in Table 5, and all of the statistical analyses are presented in Table 6. Finally, the healthcare personnel's reflections on observed risk behaviours are illustrated.

TABLE 3 Description and distribution of observed risk behaviours

Risk behaviour	Description	Frequencies (%)
Hand disinfection	Does not disinfect hands	721 (56.5)
Placement of materials	Inappropriate placement of contaminated material, returns dispensed material	184 (14.5)
Work-clothes	Contaminates clothing, inappropriate use of protective clothing, does not use apron, does not change apron	135 (10.5)
Glove usage	Does not use gloves, does not change gloves	113 (8.9)
Cleaning	Does not clean objects, does not clean with appropriate agent	76 (5.9)
Aseptic	Inappropriate aseptic technique	40 (3.2)
Contaminated water	Uses water that should be changed	4 (0.3)
Hand wash	Does not wash hands with soap and water when caring for patients experiencing vomiting or diarrhoea	2 (0.2)
		1275 (100%)

5.1 | Descriptive statistics of healthcare personnel's working conditions and risk behaviours for organism transmission

Almost half of the observed activities were conducted in single patient rooms, and in over 40% of the observed activities, the HCP were interrupted. The majority of units were overstaffed and had available patient beds. Descriptions and distribution of the HCP's observed and perceived working conditions are presented in Table 2. In total, 1275 risk behaviours for organism transmission were observed, which calculates to approximately one risk behaviour every five minutes. The most frequent risk behaviours were related to missed hand disinfection, inappropriate placement of contaminated materials and inappropriate use of protective clothing. Descriptions and distribution of observed risk behaviours are presented in Table 3. A substantial inter-rater reliability for the categorisation of risk behaviour was demonstrated since the Cohens kappa was 0.74, (SE = 0.051; 95% CI: 0.67–0.81), the adjusted kappa PABAK 0.75, and Gwet's AC1-statistic was 0.76 (SE = 0.033; 95% CI: 0.69–0.82).

5.2 | Working conditions in relation to risk behaviours for organism transmission

Staffing levels were described by the HCP in the interviews as being a crucial working condition when it comes to influencing their infection prevention behaviour. Some HCP discussed how overstaffing could make the work unstructured and create difficulties in knowing who does what, while most HCP described how being fully staffed made it easier to care for all of the patients and their needs. *When it is this well staffed, it is easier to have time for things and do them well and all the hygiene steps, but otherwise it gets a little trickier (RN).* Other members of the healthcare team, who are not assigned to a particular patient or patients and could help as an extra resource, were described as beneficial. Ancillary/auxiliary staff such as coordinators, receptionists, pharmacists and kitchen staff were highly appreciated and were described as facilitators that helped them follow hygiene guidelines. Less discussed were bed occupancy and number of patients. However, there were no significant differences when comparing the number of risk behaviours between staffing levels, bed occupancy or number of patients in the statistical analyses, see Table 6.

In the interviews, the HCP associated physical factors such as confined work areas, wheelchairs and other equipment that stood in the way and hindered the work flow with potential risk factors. Patients sharing rooms, toilets or equipment were also described as potential risks for organism transmission. Crucial working conditions described as influencing their infection prevention behaviour were the availability and placement of disinfection agents and protective equipment. When equipment and hand or surface disinfection agents were missing or poorly placed, for example it was not where it was supposed to be and the HCP had to look for it in another area, the HCP told how that could lead to decreased usage. There was an expressed disagreement between the HCP regarding an increased likelihood of risk behaviours in rooms with more than one patient, although the majority had the opinion that there was an increased risk. *When you're in a single patient room, the conditions are a little better. When you are in a large room with many patients, it's easy to be careless and go between patients. When you close the door and go in to a new patient, you think more about hygiene (RN).* In the comparative statistical analyses from the observations, there were significantly more risk behaviours involving work-clothes in a six-bed room compared to a single, double and four bed room. No additional significant differences were identified in the remaining risk behaviour categories when comparing patient rooms, Table 6.

Patient-level workload based on the clinical condition and level of care needs of the patients was frequently discussed during the interviews and was associated with workload. Caring for patients with low-need levels was associated with good working conditions and adequate

TABLE 4 Example from analysis of field notes

Observation unit	Identified risk behaviour	Healthcare personnel (HCP) working conditions		Interruption in activity *(written in italics)*
Assistant nurse (AN) walks into the patient's room with a trolley for blood testing. Puts the trolley beside the bed. Opens[1] the trolley and gathers up a needle, a test tube, and some alcohol swabs. Gathers an alcohol swab and from a sealed box on the trolley some tape. Takes the tourniquet from the trolley and fastens it on the patient's arm. Leans[2] against the bed, looks and feels[3] for veins. Disinfects the patient's skin with the alcohol swab. Feels the vein once again. Takes[4] the needle and sticks[5] the patient. No blood returns. Loosens the tourniquet. Removes the needle, applies the needle safety shield and tapes a dry swab over the puncture site. Puts the needle in the patient's bed[6]. Opens[7] the trolley and gathers a new needle. *A colleague comes in and talks to the AN*. AN tightens the tourniquet again. Feels[8] another vein. Disinfects the skin. Sticks[9] the patient, fills up the test tube and puts it on the trolley. Releases the tourniquet. Removes the needle, applies the needle safety shield and tapes a new dry swab over the puncture site. Discards both needles in the needle safety box on the trolley. Verifies the patient's identity and marks the test tube. Hangs the tourniquet on the side of the trolley[10]. Discards the waste materials and disinfects hands. Takes the trolley and leaves it at its assigned place in the corridor[11]. Walks to the nurse's office and writes a nursing documentation[12].	Hand disinfection Work-clothes Hand disinfection Glove usage Aseptic Placement of material Hand disinfection Hand disinfection Glove usage Cleaning Cleaning Hand disinfection Numbers of risk behaviours: 12	Location of activity: Four-bed room HCP work in pairs: No Character of activity: Interrupted Numbers of patients AN responsible for: 8	Estimated patient-level workload: Low-need Unit's staffing levels: Fully staffed Unit's bed occupancy: Patient beds available	Interruption requires changing locations: No Source of interruption: Colleague
AN walks into patient's room with a bladder scanner. Puts on gloves[1]. Applies[2] gel on patient's abdomen over bladder. Takes the probe and scans the bladder. Disinfects the probe with an alcohol swab. Discards the swab. Wipes patient's skin. Removes and throws gloves away[3]. Walks out and places the bladder scan[4] in the corridor.	Hand disinfection Work-clothes Hand disinfection Cleaning Numbers of risk behaviours: 4	Location of activity: Six-bed room HCP work in pairs: No Character of activity: Single Numbers of patients AN responsible for: 7	Estimated patient-level workload: Medium-need Unit's staffing levels: Overstaffed Unit's bed occupancy: Patient beds available	-

TABLE 5 Content areas, categories and subcategories describing healthcare personnel's perceptions of working conditions in relation to risk behaviours for organism transmission

Content area: Working conditions (including interruptions)		
Staffing levels	Advantages with sufficient staffing levels	Sufficient staffing levels facilitate compliance with hygiene guidelines
		With good resources healthcare personnel can ask for help
		Extra staff resources and ancillary/auxiliary staff are facilitators that help healthcare personnel follow hygiene guidelines
	Difficulties due to overstaffing	Work can be unstructured
		Difficulties knowing who does what
Physical factors	Design of the premises	Small or crowed premises are difficult to work in and increase the risk for organism transmission
		Spacious premises facilitate work
	Access to and placement of disinfection agents and protective equipment affects healthcare personnel compliance with hygiene guidelines	Absence of protective equipment complicates compliance
		Having to go far or look for materials decreases compliance with hygiene guidelines
		Adequate availability of protective supplies/equipment facilitates compliance
		Convenient and easy access to hand and surface disinfection agents increases compliance
	Potential risks for organism transmission when patients sharing premises or equipment	Patients sharing room or toilet are risks for organism transmission
		No difficulties with hygiene guidelines despite patients sharing room
		Patients sharing aids or equipment are risks for organism transmission
Patient-level workload and workload	Factors contributing to adequate workload	Caring for low-need patients
		Adequate tempo with no stress facilitates work
	Factors contributing to heavy workload	High-need patients needing extensive care
		Sudden events
		Patients whose condition has declined
		Discharges
Psychosocial working environment	Interaction with colleagues important for work environment	Good cooperation between colleagues facilitates work
		Cooperation- and communication shortcomings complicates work
	Workplace culture and engagement influences infection prevention behaviour	The managers involvement in infection prevention affects the workplace culture
		Being each other's role model improves infection prevention practices
Interruptions	Experienced sources of interruptions	Colleagues
		Work phone
		Doctors' rounds
		Self-interruptions
		Patients
		Patients' relatives
	Interruptions as potential risk behaviours involving subcategories	Hand hygiene
		Work-clothes
		Glove usage
		Placement of materials
		Cleaning
		Aseptic technique
	Healthcare personnel who did not experience being interrupted/ interruptions	Being able to focus on the work task
		Being able to complete work tasks
		Working in peace and quiet

(Continues)

TABLE 5 (Continued)

Content area: Working conditions (including interruptions)	
Content area: Reflections on risk behaviours	
Risk behaviours	Reflections regarding hand disinfection
	Reflections regarding work-clothes
	Reflections regarding glove usage
	Reflections regarding placement of materials
	Reflections regarding cleaning
	Reflections regarding aseptic technique

tempo. In contrast, high-need patients requiring extensive care were said to increase workload and stress, which they associated with an increased risk for organism transmission. *Today it is rather extreme since none of the eight take care of themselves, not even those on the waiting list…//… that can affect hygiene (RN).* Unexpected events, patient's whose conditions had declined and discharges were also associated with a heavy workload. Since patient-level workload was emphasised in the qualitative data, a variable based on the overall clinical condition and level of care needs was developed. In the comparative statistical analyses, no significant differences could be seen in the number of risk behaviours when examining the low-, medium- and high-need patients (Table 6). A consequence of high-need patients according to the HCP was the need to work together when giving the care. Some described how this increased their workload further and negatively influenced infection prevention behaviours. In the statistical analysis, when comparing situations where the HCP worked together during patient care activities to situations where the HCP worked independently, this finding was confirmed in all of the risk behaviour categories except for risk behaviours involving glove usage (Table 6).

During the interviews, the HCP expressed how the psychosocial working environment played a crucial role in both the working conditions and their infection prevention behaviour. They emphasised that their colleagues and managers' involvement was crucial for the workplace culture regarding infection prevention and discussed how involvement, attitudes and behaviours are influenced by others. *Everyone is very careful and we remind each other 'you forgot your apron', sometimes you can do it without saying anything by taking an extra apron and giving it to the other person (AN).* Good cooperation and trust between colleagues were said to positively influence the work environment and benefit hygiene practices, while communication shortcomings were described to do the opposite. *It has been, what should I say, a crazy day with very little communication …//… it gets cramped, not literally, there are a lot of people talking, but there is no unity. A lot can fall between the cracks on a day like this (AN).*

The cluster analysis based on all of the units' overall working conditions resulted in three cluster groups with the following characteristics:

Cluster 1 = Lacking kitchen staff and a room for overflow of patients (2 units).

Cluster 2 = High-need patients throughout plus high staff turnover (4 units).

Cluster 3 = Only single patient rooms with accompanying disinfection room and linen cupboard for each room (2 units).

When comparing risk behaviours in relation to clusters, there were significantly more risk behaviours regarding work-clothes in cluster 1 and 2 compared to cluster 3. The remaining risk behaviours showed no significant differences (Table 7).

5.2.1 | Interruptions in relation to risk behaviours

The HCP told how interruptions were common and emphasised how interruptions negatively influenced their working conditions and infection prevention behaviour. This was confirmed in the statistical analyses where all of the risk behaviour categories had significantly higher numbers during interrupted activities compared to risk behaviours during single and combined activities. During those occasions when HCP had to change locations due to the interruption, the number of total risk behaviours and risk behaviours concerning hand hygiene was significantly higher than interrupted activities that did not require the HCP to go to a different location. The RNs frequently discussed how the majority of the interruptions were derived from colleagues and the work phone. In contrast, the ANs described how interruptions from patients, including nurse call button, were the major source of interruptions. *Especially evenings, weekends and when doctors are on-call you have more patients and you get disturbed by others, you have to check the calls …//… you can't really relax because you might have to go to the next one (AN).* The different sources of the interruptions described by the RNs and ANs were investigated and confirmed in the statistical analyses (Table 6). The HCP also discussed self-interruptions, for example forgotten supplies/equipment or a lack of concentration. Having sufficient time to think and prepare before different procedures was described as essential to avoid self-interruptions.

5.3 | Healthcare personnel's reflections on risk behaviours from the observations

During the interviews, the HCP were often, from the start, unaware of the risk situations they had participated in, this despite the fact that all of the participants performed risk behaviours at some time during the time they were being observed. However, as the

TABLE 6 Comparisons between working conditions, the total risk behaviours and each respective risk behaviour

	Total risk behaviours	Risk behaviours regarding hand disinfection	Risk behaviours regarding placement of materials	Risk behaviours regarding work-clothes	Risk behaviours regarding glove usage	Risk behaviours regarding cleaning	Risk behaviours regarding aseptic technique
Location of activity							
Single patient room mean (SD) IQR	4.1 (3.8) 3	2.0 (1.8) 2	0.6 (1.2) 1	0.4 (0.6) 1	0.4 (0.7) 1	0.3 (0.6) 0	0.1 (0.4) 0
Double room mean (SD) IQR	3.9 (3.0) 3	2.2 (1.8) 2	0.5 (0.8) 1	0.3 (0.6) 1	0.2 (0.6) 0	0.2 (0.4) 0	0.1 (0.4) 0
Four-bed room mean (SD) IQR	3.5 (3.0) 4	1.6 (1.7) 1	0.5 (0.7) 1	0.3 (0.5) 1	0.4 (0.8) 1	0.3 (0.5) 0	0.09 (0.3) 0
Six-bed room mean (SD) IQR	4.4 (3.0) 4	1.6 (1.1) 1	0.5 (0.9) 1	1.0 (1.0) 2	0.3 (0.8) 0	0.3 (0.5) 1	0.04 (0.2) 0
Test statistics H (df)	1.377 (3)	5.091 (3)	0.442 (3)	12.256 (3)	4.673 (3)	1.555 (3)	
p-Value	.711	.165	.931	**.007**	.197	.670	
Bonferroni Post hoc test				1–2 0.696 1–3 0.803 1–4 **0.001** 2–3 0.985 2–4 **0.001** 3–4 **0.009**			
Healthcare personnel work in pairs							
Yes mean (SD) IQR	4.4 (4.1) 3	2.4 (2.2) 2	0.8 (1.4) 1	0.3 (0.6) 0	0.4 (0.7) 1	0.3 (0.5) 1	0.2 (0.5) 0
No mean (SD) IQR	3.0 (2.6) 3	1.7 (1.4) 1	0.4 (0.8) 1	0.4 (0.6) 1	0.3 (0.6) 0	0.2 (0.5) 0	0.1 (0.3) 0
Test statistics U	16241.5	15943	15858	11974	14857	15289	14799
p-Value	**.006**	**.014**	**.004**	**.019**	.093	**.010**	**.018**
Character of activity							
Single mean (SD) IQR	1.4 (1.1) 1	0.9 (0.6) 1	0.1 (0.3) 0	0.3 (0.5) 0	0.1 (0.3) 0	0.03 (0.2) 0	0.03 (0.2) 0
Combined mean (SD) IQR	2.5 (1.8) 2	1.6 (1.1) 1	0.3 (0.6) 0	0.3 (0.5) 1	0.2 (0.4) 0	0.1 (0.4) 0	0.04 (0.2) 0
Interrupted mean (SD) IQR	5.1 (3.7) 5	2.7 (2.1) 3	0.9 (1.4) 1	0.5 (0.7) 1	0.5 (0.8) 1	0.4 (0.6) 1	0.2 (0.5) 0
Test statistics H (df)	1114.606 (2)	76.476 (2)	44.142 (2)	9.399 (2)	28.774 (2)	26.680 (2)	17.385 (2)
p-value	**<.001**	**<.001**	**<.001**	**.009**	**<.001**	**<.001**	**<.001**
Bonferroni Post hoc test	1–2 **<0.001** 1–3 **<0.001** 2–3 **<0.001**	1–2 **<0.001** 1–3 **<0.001** 2–3 **<0.001**	1–2 **0.017** 1–3 **<0.001** 2–3 **<0.001**	1–2 0.565 1–3 **0.008** 2–3 **0.014**	1–2 0.455 1–3 **<0.001** 2–3 **<0.001**	1–2 0.062 1–3 **<0.001** 2–3 **0.001**	1–2 0.690 1–3 **0.001** 2–3 **<0.001**
Interruption requires a change of location							
Yes	5.6 (3.8) 5	3.1 (2.3) 3	0.9 (1.4) 2	0.5 (0.8) 1	0.5 (0.7) 1	0.3 (0.6) 1	0.3 (0.5) 0

(Continues)

TABLE 6 (Continued)

	Total risk behaviours	Risk behaviours regarding hand disinfection	Risk behaviours regarding placement of materials	Risk behaviours regarding work-clothes	Risk behaviours regarding glove usage	Risk behaviours regarding cleaning	Risk behaviours regarding aseptic technique
No	4.6 (3.5) 4	2.2 (1.5) 2	0.7 (1.3) 1	0.4 (0.6) 1	0.5 (0.9) 1	0.4 (0.7) 1	0.1 (0.4) 0
Test statistics U	3804	3823	3362	3178	3235	3053	3429
p-Value	**.03**	**.024**	.476	.986	.806	.597	.173
Number of patients healthcare personnel are responsible for							
2–4 mean (SD) IQR	3.5 (3.5) 4	2.0 (1.9) 2	0.6 (1.2) 1	0.3 (0.6) 1	0.3 (0.7) 0	0.2 (0.5) 0	0.1 (0.4) 0
5–7 mean (SD) IQR	3.2 (2.4) 4	1.8 (1.3) 1	0.4 (0.8) 1	0.4 (0.6) 1	0.3 (0.6) 0	0.2 (0.6) 0	0.09 (0.3) 0
8–10 mean (SD) IQR	2.8 (1.9) 3	1.9 (1.4) 2	0.3 (0.4) 1	0.4 (0.5) 1	0.3 (0.5) 1	0.04 (0.2) 0	0.04 (0.2) 0
Test statistics H (df)	0.320 (2)	0.168 (2)	1.414 (2)	2.322 (2)	0.374 (2)	4.721 (2)	0.890 (2)
p-Value	.852	.920	.493	.313	.829	.094	.641
Patient-level workload							
Low-need mean (SD) IQR	3.0 (2.4) 2	1.7 (1.4) 1	0.3 (0.6) 0	0.3 (0.5) 1	0.3 (0.6) 0	0.2 (0.4) 0	0.09 (0.3) 0
Medium-need mean (SD) IQR	3.2 (2.5) 4	1.8 (1.4) 1	0.5 (0.9) 1	0.3 (0.6) 1	0.3 (0.6) 0	0.2 (0.6) 0	0.1 (0.3) 0
High-need mean (SD) IQR	3.8 (3.9) 4	2.2 (2.0) 2	0.6 (1.3) 1	0.4 (0.7) 1	0.3 (0.7) 1	0.2 (0.4) 0	0.1 (0.4) 0
Test statistics H (df)	0.734 (2)	1.933 (2)	3.939 (2)	0.762 (2)	0.664 (2)	0.522 (2)	0.193 (2)
p-Value	.693	.380	.140	.683	.717	.770	.908
Staffing levels							
Understaffed mean (SD) IQR	2.8 (2.1) 3	1.7 (1.3) 1	0.4 (0.9) 0	0.2 (0.5) 0	0.2 (0.5) 0	0.2 (0.4) 0	0.06 (0.3) 0
Fully staffed mean (SD) IQR	3.5 (3.2) 4	2.1 (2.1) 2	0.6 (1.0) 1	0.4 (0.5) 1	0.3 (0.5) 0	0.1 (0.4) 0	0.07 (0.3) 0
Overstaffed mean (SD) IQR	3.6 (3.4) 4	1.9 (1.8) 2	0.5 (1.0) 1	0.4 (0.7) 1	0.4 (0.7) 1	0.2 (0.6) 0	0.13 (0.4) 0
Test statistics H (df)	3.103 (2)	0.216 (2)	5.100 (2)	5.517 (2)	3.992 (2)	1.695 (2)	2.709 (2)
p-Value	.212	.898	.078	.063	.136	.429	.258
Bed occupancy							
Beds available mean (SD) IQR	3.4 (3.1) 4	2.0 (1.7) 2	0.5 (1.0) 1	0.4 (0.7) 1	0.2 (0.6) 0	0.2 (0.4) 0	0.1 (0.4) 0
At full capacity mean (SD) IQR	3.3 (3.0) 4	1.7 (1.5) 1	0.5 (1.0) 1	0.3 (0.5) 1	0.4 (0.7) 1	0.3 (0.6) 0	0.09 (0.3) 0
Over full mean (SD) IQR	3.5 (3.6) 4	2.1 (2.1) 2	0.4 (0.7) 1	0.2 (0.4) 0	0.4 (0.7) 1	0.2 (0.5) 0	0.2 (0.5) 0

(Continues)

TABLE 6 (Continued)

	Total risk behaviours	Risk behaviours regarding hand disinfection	Risk behaviours regarding placement of materials	Risk behaviours regarding work-clothes	Risk behaviours regarding glove usage	Risk behaviours regarding cleaning	Risk behaviours regarding aseptic technique
Test statistics H (df)	0.048 (2)	1.772 (2)	0.227 (2)	2.830 (2)	4.982 (2)	1.052 (2)	0.127 (2)
p-Value	.976	.412	.893	.243	.083	.591	.938

Source of the interruption	Registered nurses %	Assistant nurses %
Colleague	58.5	27
Patient	23.5	55
Self-interruption	18.0	18
Test statistics χ^2 *p*-value	**<.001**	

Abbreviations SD, Standard deviation; IQR, Interquartile range; df, Degrees of Freedom. H, Kruskal–Wallis; U, Mann–Whitney; x^2: Pearsons's chi-squared. Significant values in bold.

†Risk behaviours regarding contaminated water and hand washing were not analysed because too few observations occurred to be included in the analysis.

TABLE 7 Comparisons between clusters, the total risk behaviours and each respective risk behaviour

	Cluster 1 (*n* = 2)			Cluster 2 (*n* = 4)			Cluster 3 (*n* = 2)			Test statistics			Bonferroni post hoc test
Risk behaviour	Mean	SD	IQR	Mean	SD	IQR	Mean	SD	IQR	Kruskal–Wallis H	df	*p*-value	*p*-value
Total risk behaviours†	3.6	3.2	4	3.3	3.1	3	2.9	2.6	4	3.217	2	.2	
Hand disinfection	2.0	1.6	2	1.9	1.9	12	1.7	1.5	2	1.721	2	.423	
Placement of materials	0.5	1.1	1	0.6	1.0	1	0.4	0.7	1	1.437	2	.487	
Work-clothes	0.5	0.7	1	0.3	0.5	1	0.1	0.3	0	15.184	2	**.001**	1–2 0.197 1–3 <0.**001** 2–3 0.**009**
Glove usage	0.3	0.6	0	0.4	0.7	1	0.3	0.6	0	3.368	2	.186	
Cleaning	0.2	0.6	0	0.2	0.4	0	0.2	0.5	0	0.516	2	.773	
Aseptic technique	0.1	0.4	0	0.1	0.3	0	0.1	0.4	0	0.789	2	.674	

Abbreviations SD, Standard deviation; IQR, Interquartile range. Significant values in bold.

†Risk behaviours regarding contaminated water and hand washing were not analysed because too few observations occurred to be included in the analysis.

interviews progressed and they discussed situations that had occurred during the day, the HCP often became aware of situations. The most frequently occurring risk behaviours were discussed in the interviews, which often occurred in relation to their working conditions. The HCP mentioned stress and interruptions as reasons for missed hand disinfection. They were aware that hand disinfection sometimes was neglected before putting on and after removing gloves. Some expressed uncertainty on when to wear gloves. The majority of the HCP were aware they sometimes used gloves inappropriately, for example did not change gloves between moments or that they were overusing gloves more for self-protection rather than hygiene. Not wearing an apron was considered to be a risk for organism transmission, and several participants were aware that they had sometimes missed wearing an apron during the observations. Most often when aprons were missed, the HCP described how the original intention was not to have close patient contact, for example only dispense medication. Other reasons discussed by the HCP for not wearing an apron were that it was time-consuming and plastic was bad for the environment. *I had just entered the room when I realized I had forgotten something. I put the apron in my pocket because I hadn't used it yet. Then, when I came back, I took it out and used it. I think of it as recycling (AN).* When the disinfectant to clean surfaces and equipment was missing or hard to reach, it was considered less important and not used to save time. However, the HCP described missed disinfection or inadequate placement of materials or equipment as being risks for organism transmission. Another situation mentioned as a risk was the lack of aseptic technique during intravenous medication administration. The major reasons for this according to the RNs were stress and forgotten materials. Risks for organism transmission were often associated with caring for patients that had diarrhoea, vomiting or multidrug-resistant bacteria. Some HCP had not perceived that they had been at risk for organism transmission that particular day because they had not cared for patients with any of those conditions.

6 | DISCUSSION

Regardless of the HCP's observed and perceived working conditions, risk behaviours for organism transmission frequently occurred during care activities. In our mixed-methods study, HCP described several working conditions such as staffing levels, patient-level workload, physical factors and interruptions as important aspects that influenced their infection prevention behaviour. However, in the comparative statistical analysis from the observation data, the risk behaviours were mostly related to situations where the HCP worked together during patient care activities and interrupted activities. Interruptions had a significant association with several risk behaviour categories that have also been described in previously published studies on HCP's risk behaviours for organism transmission (Lindberg et al., 2017, 2018).

In the qualitative part of our study, the HCP did emphasise how interruptions influenced their working conditions and their infection prevention behaviour. However, half of the interruptions were made by colleagues. This is in line with several previous studies that found the majority of interruptions to be made by colleagues (Monteiro et al. 2020; Schroers, 2018; Wagner et al., 2020). Interruptions are well researched in relation to medication safety. In a mixed-method before and after study, significant reductions in both interruptions and medication errors occurred when RNs used do-not-disturb vests while preparing and administering medications. However, the RNs raised some concerns about this approach. Since the RNs perceived the interruptions as mainly coming from other colleagues, they felt the vests would attract attention. There was also the issue of hygiene because several colleagues shared the same vest (Verweij et al., 2014). Our study's results revealed that the RNs were interrupted by colleagues significantly more than the ANs were. The ANs were interrupted primarily by the patients. Interruptions are described to be part of health care and something that cannot be completely avoided (Hopkinson & Wiegand, 2017), but reducing interruptions would benefit the HCP's working conditions as well as patient safety (Monteiro et al., 2015). Hopkinson and Wiegand (2017) concluded that RNs would benefit from education to increase further understanding and awareness of their contribution to interruptions and how they interact in a complex system. However, based on our study's results, we can conclude that it can be more challenging to decrease interruptions among ANs than RNs. This is valuable knowledge when designing future interventions aiming to reduce interruptions in order to prevent risk behaviours for organism transmission. Future interventions could benefit from strategies designed collectively with RNs, ANs and FLMs together to reduce unnecessary interruptions from colleagues and patients. In a newly published observational study, the RNs were found to continue with the primary task they had started half the time and did not change to a secondary task caused by the interruption (Wagner et al., 2020). In our study, 43% of the interruptions led to the HCP having to go to a different location, and among these there were significantly more risk behaviours regarding hand hygiene. These results also emphasise the importance of preventing interruptions. An observational study found interruptions to be most frequent during the mornings between the hours of 7 and 11 (Yen et al., 2018). In our study, data were collected during the mornings, and interruptions occurred frequently. ANs described the patients' use of the nurse call button to be a common source of interruptions. In a qualitative study, some patients told how they were willing to receive attention from different RNs and thought it was more important to receive attention quickly. In contrast, some patients expressed difficulties in having to relate to different personnel (Klemets & Evjemo, 2014). However, it is not the patients' use of call buttons per se that is the issue, but how they are handled by the HCP. Klemets and Evjemo (2014) discussed technical aids that could be used by the HCP to change and review each other's availability status and prevent unwanted interruptions.

An interesting result in our study was the increased frequency of risk behaviours when the HCP worked together during patient care activities. Reasons for these results are yet to be answered. It may have links to interruptions and difficulties foreseeing the colleague's

next move. A consequence of personal chemistry or communication shortcomings are also possibilities. Information is lacking regarding any differences between the different constellations of HCP. When studying human behaviours, social interactions must be considered since the context influences the individual (Rasmussen, 2003). Earlier research has described communication and teamwork failures as contributing factors to adverse events. Two newly published systematic reviews found that team training could improve teamwork skills such as situational awareness, communication and safety attitudes (Costar & Hall, 2020; Wu et al., 2020). Some studies in a review by Costar and Hall (2020) also measured patient outcomes. A reduction of HCAI were obtained in intervention studies that used team training, such as role-play and simulation exercises (Costar & Hall, 2020). This phenomenon needs to be studied in more detail to investigate possible reasons for the increased frequencies of risk behaviours when HCP work together.

In our study's results, ~50% of the total risk behaviours comprised missed hand hygiene, which has long been known as the major risk for organism transmission in health care (Allegranzi & Pittet, 2009). Additionally, the majority of interventions aiming to reduce the risks for HCAI have concentrated on hand hygiene (Price et al., 2018). However, we cannot access all risk behaviours for organism transmission by focussing exclusively on hand disinfection. Our results from the statistical analyses pointed out risk behaviours involving protective work-clothes to be related to the HCP's working conditions. This was evident in the cluster comparisons and patient rooms, where there were significantly more risks observed in the six-bed patient rooms. These results are congruent since the cluster group with the fewest risk behaviours involving work-clothes was characterised by their single bed occupancy. In the qualitative results, the HCP were partly aware of these risks and they discussed the inadequate usages of protective work-clothes as being risk filled and that such risks can occur when patients share a room, which is common in health care.

Even though working conditions considered to be acceptable existed, for example fully staffed and a sufficient availability of patient beds was common, risk behaviours for organism transmission occurred frequently anyway. In our study, it is difficult to explain if overstaffing was a coincidence or it was possibly due to a heavy workload. This question is something that can be taken into account when designing future studies. HCP risk behaviours can be influenced by several aspects and must be taken into account as potential confounders in this study. Knowledge, motivation, responsibility, attitudes and resources are all described as being able to influence HCP's infection prevention behaviours (Seo et al., 2019; Smiddy et al., 2015). Social influence and organisational culture have also been described as essential in infection prevention (Zingg et al., 2015). In our study's qualitative results, the HCP described how the psychosocial working environment influenced their behaviour, but no quantitative data were collected making statistical analyses impossible, which is another factor to consider when planning further studies.

6.1 | Strengths and limitations

The mixed-methods design of this study has contributed to a multifaceted understanding of this complex subject. The possibility of moving back and forth in the data enabled a great number of findings to emerge and has contributed to nuanced results. Direct observations are acknowledged as the 'gold standard' when measuring hand hygiene compliance (Haas & Larson, 2007). However, observations are allied with difficulties. An extensive systematic review by Jeanes et al., (2019) concerning the validity of hand hygiene compliance measured by observations described information bias, selection bias and confounding bias as potential threats to validity (Jeanes et al., 2019). The Hawthorne effect involves individuals modifying behaviours when they are aware of being observed (Purssell et al., 2020). No attempts to control the Hawthorne effect were assessed in this study, but despite the potential risk for information bias related to the Hawthorne effect, risk behaviours frequently occurred during the observations. Absence of inter-rater reliability is a common critique in observational studies (Jeanes et al., 2019). The performed inter-rater reliability is a strength in this study, and the substantial agreement (Landis & Koch, 1977) strengthens the results additionally. The first and last authors, who conducted the analysis of risk behaviours, have extensive experience in infection prevention and control and are trained in observation techniques and the analysation of these types of data. It was considered appropriate to conduct the observations in the mornings, which are often the busiest time for patient-related activities. Working conditions can differ between the day, evening and night shifts, which can be a potential selection bias (Jeanes et al., 2019). Spradley (1980) described how focussed observations are to observe carefully selected events based on the study's aim, which facilitates the observer's ability to stay focussed during the observations. Mobile positioning that follows one participant throughout the activity (Spradley, 1980) was considered appropriate since it enables the observer to see the relationship between the HCP's working conditions and risk behaviours. Data were collected in surgical and orthopaedic units with rich setting and sample variations, for example age and working experiences that increase the generalisability of this study results. The interviews were conducted not long after the observations, and the majority were audio recorded. An interview guide was used to ensure that the main topics were covered, but at the same time, the interviews were adapted to the situations that occurred during the observations. Quotations from all categories are presented in the results to facilitate transferability (Graneheim & Lundman, 2004).

7 | CONCLUSION

These mixed-methods findings illustrate that HCP's perceptions do not always correspond to the observed results since the risk behaviours occurred frequently regardless of the observed and perceived working conditions. Interruptions and working together during

patient care activities were shown to be highly associated with risk behaviours, and from this, we can assume HCP's infection prevention behaviours are more closely associated with what is happening in the moment than to their overall working conditions. Facilitating the possibility for healthcare personnel to work undisturbed when needed is essential for their benefit and patient safety.

8 | RELEVANCE FOR CLINICAL PRACTICE

The relationship between interruptions and infection prevention behaviour is important knowledge for both HCP and FLMs. Highlighting and preventing interruptions can improve working conditions. Interventions aimed at reducing interruptions could benefit from strategies designed collectively by the HCP and FLMs together. By reducing interruptions, working conditions can be improved and risk behaviours for organism transmission reduced.

The increased frequency of risk behaviours when the HCP worked together during patient care activities has not been described previously. These findings need to be made known in healthcare settings and considered in regard to infection prevention. Further research is needed in this area.

Furthermore, infection prevention work needs to include both hand disinfection along with other risk behaviours, as only half of the problem is accessed if the focus is directed exclusively on hand disinfection.

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CONFLICT OF INTERESTS

The authors declare they have no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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Paper II

Healthcare personnel assessed self-efficacy levels to medical asepsis and their relationship to structural empowerment, work engagement and work-related stress

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Conflict of Interest
The authors declare they have no conflict of interests.

Abstract

BACKGROUND: Healthcare personnel's working conditions are important for their well-being at work and for their ability to provide patients with safe care. Self-efficacy can influence employees' behaviour at work. Therefore, it is valuable to study self-efficacy levels to medical asepsis in relation to working conditions.

OBJECTIVE: To investigate the relationship between healthcare personnel assessed self-efficacy levels to medical asepsis in care situations and structural empowerment, work engagement and work-related stress.

METHODS: A cross-sectional study with a correlational design was conducted. A total of 417 registered nurses and nursing assistants at surgical and orthopaedic units responded to a questionnaire containing: Infection Prevention Appraisal Scale, Conditions of Work Effectiveness Questionnaire-II, Utrecht Work Engagement Scale and HSE Management Standards Indicator Tool. Correlational analysis and group comparisons were performed.

RESULTS: Healthcare personnel rated high levels of self-efficacy to medical asepsis in care situations. Low correlations with a definite, but small relationship were found between structural empowerment, work engagement, work-related stress and self-efficacy to medical asepsis. The comparative analysis revealed significant differences between some of the groups within the questionnaires. There were also differences between assessments of risk for organism transmission at work and self-efficacy.

CONCLUSIONS: This study revealed that HCP rated high levels of self-efficacy to medical asepsis, and to some extent, it seems to have a relationship to structural empowerment, work engagement and work-related stress. It is valuable knowledge that it would be possible to make improvements at the managerial and organisational level that benefit both HCP and patients in the long run.

Keywords: Infection prevention, working conditions, registered nurses, assistant nurses

1. Introduction

The working conditions of healthcare personnel (HCP) are related to their well-being and satisfaction at work, and undesirable working conditions lead to a higher risk of dissatisfaction and intention to leave the profession (1–4). Working conditions such as structural empowerment, work engagement and low work-related stress are also important to enable HCP to provide good and safe care to patients (5–7). Medical asepsis in care situations involves procedures that reduce micro-organisms and prevent the risk for organism transmission in health care (8). Self-efficacy is described as a person's belief in their ability to succeed in specified situations which consequently affects behaviour (9). Human behaviour is known to be a consequence of a causal part of a sequence of events, affected by the context in which individuals are operating (10). Accordingly, it is valuable to study the relation between the assessed working conditions of HCP and self-efficacy to medical asepsis in care situations.

1.1. Self-efficacy

Self-efficacy means people's beliefs in their ability to succeed in specified situations. People with high grades of self-efficacy are more able to take action and are more likely to view challenges as something to be handled rather than problems and things to avoid (9). Individuals with high self-efficacy are more prone to making effort to complete tasks and are more productive and creative than individuals with lower levels of self-efficacy (11,12). Bandura (1997) described self-efficacy as based on four essential elements; 1, Earlier performance outcomes, which are indicators of capability. 2, Vicarious experiences including observing others completing tasks successfully and the transmission of competencies. 3, Verbal persuasion, meaning that people are coached by others to believe they can complete tasks successfully. 4, Psychological/affective states which influence peoples beliefs in their capability (9). Self-efficacy has been found to influence employees motivation, perception, and performance at work (11). In a systematic review of systematic reviews, Price et al. (2018) investigated interventions to improve the hand hygiene behaviour of HCP and concluded that self-efficacy and social influence may enhance the effectiveness of interventions, but that the literature regarding this is rather scarce and more research is needed (13). In previous educational research, it has been found that people modify their behaviours by the actions of others and the social environment in which the individual acts, i.e., self-efficacy has a social influence on people (14). Therefore, we can assume it is important for HCP to have high grades

of self-efficacy to medical asepsis in order to promote safe care and reduce the risk for organism transmission.

1.2. Working conditions

1.2.1. Structural empowerment

According to Kanter (1993), a work environment that provides employees with access to information, resource, support and opportunities is empowering. Good structural empowerment leads to organisational effectiveness and people feeling in control at work (15). Access to *information* refers to people knowing the work and the organisation. *Resources* involve employees' ability to access sufficient time, materials and resources to achieve organisational goals. Access to *opportunity* means opportunities of professional development within the organisation. *Support* refers to obtaining guidance and feedback from managers, subordinates as well as peers. Access to these structures depends on perceptions of formal and informal power, where formal power means having a visible and central job that contributes to achieving organisational goals, and informal power is described to be developed through work-related alliances (15,16). A scoping review found structural empowerment, especially sufficient access to support and resources, positively influenced work and unit effectiveness and affected the quality of care and patient safety climate (5). It has also been found to increase psychological empowerment and job satisfaction and decrease job strain for HCP (3,17). An empowered workplace for HCP can also result in better health outcomes for patients (18). A systematic review of qualitative literature found two core concepts that influence HCP compliance with hand hygiene guidelines – motivational factors and perceptions of the work environment (19). Perceptions of the work environment included resources, knowledge, information, and organisational culture, which Smiddy et al. (2015) concluded were closely connected to Kanter's theory of structural empowerment. Resources such as time, workload, staffing and access to equipment and materials were important for compliance with hand hygiene, as well as information and continuous education to develop and retain knowledge (19).

1.2.2. Work engagement

Work engagement is described as "a positive, fulfilling work-related state of mind that is characterised by vigour, dedication and absorption" (20 p 74). Engagement is characterised as a persistent cognitive state not focusing on a particular object or event. Vigour means high levels of energy while working and the willingness to invest effort in work. Absorption is

described as being fully concentrated and happily engrossed in work, leading to time passing quickly, and dedication is characterised by a sense of enthusiasm, meaning, pride and inspiration (21). The construct of work engagement is used as an indicator of a healthy workplace (20), and high levels of work engagement has been reported to increase job satisfaction and the intention to remain in the profession (22). An association between work engagement and patient outcomes, such as hospital mortality, has been found (23). A relationship between employees' recovery levels and work-related stress and work engagement has also been described (24).

1.2.3. Work-related stress

Work-related stress have been found to be a common concern among healthcare personnel worldwide (25,26), and work stress, e.g. time pressure, concentration demands and uncertainty have been found to make cognitive failures more likely and affect patient safety (27,28). Work-related stress can consist of different stressor areas, such as demand, control, support, relationships, role and change (29). Demands relate to workload, work patterns and working environment. Control refers to employees' autonomy and how much say people have in their work. Support includes encouragement, and the dimension is further divided into two subscales: 'Management Support' and 'Colleague Support'. Relationships involve how conflicts and unacceptable behaviour are addressed and how a positive working environment is promoted. Role refers to how well people understand their role within the organisation and whether the organisation ensures the person does not have conflicting roles. Change measures how organisational changes are managed and communicated within the organisation (29).

In light of the above, working conditions for HCP are important for their well-being at work (1–3). Structural empowerment, work engagement and low levels of work-related stress have also been found as working conditions that are essential for enabling HCP's provision of safe care for patients (5–7). Nevertheless, working conditions for HCP are often reported as strained (4). Self-efficacy refers to people's beliefs in their ability to succeed in specified situations and has been found to influence employees' performance, i.e., behaviour, at work (11). Therefore, it is valuable to study HCP assessed self-efficacy levels to medical asepsis in relation to structural empowerment, work engagement, and work-related stress to enable appropriate implementation measures for HCP. To our knowledge, there are no previous studies investigating self-efficacy to medical asepsis in care situations in relation to different working condition measurements, neither in correlational analyses nor in group comparisons.

1.4. Objective and hypothesis

The study aimed to investigate the relationship between healthcare personnel assessed self-efficacy levels to medical asepsis in care situations and structural empowerment, work engagement and work-related stress.

In this study, we hypothesised: **H1** Healthcare personnel who rate high levels of structural empowerment also rate high levels of self-efficacy to medical asepsis. **H2** Healthcare personnel who rate high levels of work engagement also rate high levels of self-efficacy to medical asepsis. **H3** Healthcare personnel who rate low levels of work-related stress rate high levels of self-efficacy to medical asepsis. We were also interested in if the assessment of risk for organism transmission at work was related to self-efficacy to medical asepsis and therefore an additional hypothesis was generated. **H4** Healthcare personnel who assess a low risk for organism transmission either in general on the unit, own risk of contributing to organism transmission or risk for oneself becoming infected at work; rate high levels of self-efficacy to medical asepsis.

2. Methods

2.1. Study design and setting

This study was cross-sectional and used a correlational design (30). Data was collected from April to December 2019. A list including all surgical and orthopaedic units providing 24h care in (blinded for review) was established. The list consisted of 207 units, of which 42 units were randomised with the ambition to ask approximately 1000 HCP for participation. From the randomised units, 25 units located in 22 hospitals accepted participation. A comprehensive description of the units' characteristics is presented in Table 1.

2.2. Sample and procedure

After the respective first-line manager (FLM) had accepted the unit's participation, they shared a list, including email addresses, with HCP, i.e. RNs and assistant nurses (ANs) who met the inclusion criteria: they had to be working presently, have permanent employment or by paid hourly, the HCP could work either full time or part-time. HCP who were not working at the time, e.g. because of parental leave or long-term sick leave, were excluded. The HCP received the study material at their workplace, either by regular post or email, as desired by the FLM.

For those who received the study material by regular post, this consisted of an informational letter, a coded questionnaire and a stamped return envelope, and they could choose between returning the questionnaire by post or via the web link or QR code in the informational letter. Where the FLMs preferred the HCP to receive the study material by email, this consisted of an informational letter, a link to the questionnaire and a personal code. Two reminders were sent by email to non-responders. In total, we asked 985 HCP to respond to the questionnaire, of which 417 responded, giving a response rate of 42%. Participation was voluntary, participants could withdraw at any time, and confidentiality was assured. Structured telephone interviews were performed with respective FLM to provide information about the unit's characteristics, e.g. managers' span of control, number of patient beds and type of patient rooms.

2.3. Measures

The questionnaire began with demographic questions (e.g. age, gender and education) and professional characteristics (e.g. years of work experience and work time). Additionally, three questions (A–C) concerning assessment of risks for organism transmission at work were included: A. How do you assess the risk for organism transmission is at your workplace? B. How do you assess the risk that you contribute to the spread of infection to patients during a work day? C. How do you assess your risk of getting infected during a work day? Items were rated with a five-point scale from 1 (Low risk) to 5 (High risk). This was followed by the four questionnaires described below.

2.3.1. Self-efficacy to medical asepsis in care situations

Self-efficacy to medical asepsis in care situations was assessed using the Infection Prevention Appraisal Scale (IPAS). The questionnaire consists of 15 items regarding individual's perception of self-efficacy to medical asepsis and general and specific hygiene principles. The principles covered five aspects: work-clothes (3 items), disinfection (4 items), glove usage (3 items), aseptic technique (3 items) and jewellery/nails (2 items). It is preliminary confirmed as unidimensional (by using parallel analysis on unpublished data from RNs and ANs at medical units). The questionnaire has been developed based on Bandura's self-efficacy theory (9) and its associated guide for instrument development (31). Responses are given on an eleven-point scale from 0 (not sure at all) to 10 (totally sure). The items are summed to generate a total score. Face validity (30) was assessed with ten RNs and ANs, and minor linguistic adjustments were made. Their responses were not included in further analyses. Item and scale content validity

index (30) has been shown to be excellent as rated by ten independent infection prevention nurses (unpublished data). Cronbach's alpha was 0.82 in the present study.

2.3.2. Structural empowerment

Structural empowerment was measured using the Conditions of Work Effectiveness Questionnaire-II (CWEQ-II) (16), which has been translated into (blinded for review) (32). The CWEQ-II consists of 19 items measuring six factors of structural empowerment: access to opportunity, resources, information, support, formal power and informal power. Items are rated on a five-point scale from 1 (none) to 5 (a lot). Higher scores represent stronger perceptions of working in an empowered environment. In addition, two items measure 'Global empowerment', which is a validation index (mean of the sum of the two items). Factor scores are averaged, and then the factors are summed to give a total score. The total score of empowerment can be calculated by summing either the first four subscales or all six subscales. The six-subscale version was used in this study. A total score of 6–13 implies low levels, 14–22 moderate levels and 23–30 high levels of empowerment (33). In this study, Cronbach's alpha ranged from 0.71 to 0.86 within the subscales and the total Cronbach's alpha score was 0.79, which is similar to previous studies (34,35).

2.3.3. Work engagement

Work engagement was assessed using the 9-item Utrecht Work Engagement Scale (UWES-9) (36). The (blinded for review) version was used and has confirmed acceptable validity and reliability (37). The instrument includes the three dimensions vigour, dedication and absorption, with three items each. Recent studies have revealed one factor to be appropriate (38,39) and this has therefore been used in this study. Items are rated on a seven-point scale from 0 (never) to 6 (always). Items were summed and divided by the number of items. Higher scores represent higher overall work engagement. A total mean score $\leq$1.77 represents very low work engagement, 1.78–2.88 low, 2.89–4.66 average, 4.67–5.50 high and $\geq$5.51 represent very high work engagement (40). Cronbach's alpha in this study was 0.93.

2.3.4. Work-related stress

Work-related stress was measured using the United Kingdom Health & Safety Executive (HSE) Management Standards Indicator Tool (41). The tool is published by the British authority of health prevention and safety at work and consists of 35 items measuring six primary stressors: control, demands, role, change, relationships and support (which is further divided into the subscales manager support and colleague support). Responses are given on a five-point scale

from 1 (poor) to 5 (desirable), measuring how well the employer is performing in managing each of the six work-related stressors in relation to the management standards (29). The instrument is well-used and has confirmed acceptable validity and reliability (42). Permission was obtained to translate the instrument, and it was translated into (blinded for review) using a back-forward translation technique, inspired by Beaton's guidelines (43). In the first step, a bilingual expert translated the instrument to (blinded for review). Then it was presented to a small group (n=5) of academy staff/RNs to control items in terms of relevance, the scoring of each question, and clarity and fluency. It was apparent from their responses that the (blinded for review) version was understandable, and there were no further suggestions for changing the wording or rephrasing any of the questions. A second bilingual expert obtained a blinded back-translation, and a final agreement was achieved. The answers from the academy staff/RNs in the face validity were not included in further analyses. Factors were summed and divided by the number of factors. Participants' scores are compared to benchmark scores that are expressed in percentiles in different colours to facilitate interpretation of the results. Results below the 20^{th} percentile are marked red and indicate that urgent action is needed. Scores below the 50^{th} but above the 20^{th} percentile are yellow, representing that improvements are needed. Results above the 50^{th} and below the 80^{th} percentile are aqua, meaning the performance is good but with potential for improvement, and finally scores above the 80^{th} percentile are green, indicating good results with the need to maintain performance (44). Cronbach's alpha ranged from 0.78 to 0.91 in this study and the total Cronbach's alpha value was 0.82.

2.4. Data analysis

Data analysis was performed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp. Armonk, NY, USA). Descriptive statistics were calculated. As a precondition for the correlation analyses, we tested whether the variables were normally distributed and the majority were not, and therefore Spearman's rho for bivariate correlation was calculated to examine correlations between variables. Missing values for items varied from 0.5 to 3%, and they were handled depending on the instrument. In IPAS, missing values were replaced with the median value of each item. In UWES, the mean value for each participant was calculated and replaced the missing value. In HSE and CWEQ, the participants had to answer all the questions in one variable, otherwise there would be over 10% missing. In these cases the factor was removed, and in the analyses we used pairwise deletion, since this is recommended for correlational analyses (45). Concerning the interpretation of correlational coefficients, we used Guilford (1956), who describes values less than 0.20 as slight; almost negligible relationship; 0.20–0.40

low correlation, a definite, but small relationship; 0.40–0.70 moderate correlation, a substantial relationship; 0.70–0.90 high correlation, a marked relationship; and 0.90–1.00 very high correlation, a very dependable relationship (46).

The Kruskal-Wallis H non-parametric test was used to compare self-efficacy to medical asepsis in relation to the working condition variables. Before the analyses, we grouped UWES scores into three categories: Low (which includes Very low and Low) and High (including Very high and High); the score Average was maintained. We also grouped the scores from the answers concerning Assessed risks for organism transmission (questions A–C), resulting in three groups: Low (which includes (Low and Medium/low) and High (including Medium/high and high); the score Medium was maintained. In all analyses, p-values below 0.05 (two-tailed) were regarded as statistically significant. Internal consistency was measured with Cronbach's alpha, which demonstrated acceptable values ($\alpha > 0.70$) for all study questionnaires.

2.5 Ethical considerations

This study was conducted in accordance with applicable ethical rules. Participation was strictly voluntary, and participants could withdraw at any time without giving a reason. Confidentiality was assured, and informed consent was obtained from all participants. The (blinded for review) ethical review authority approved the study protocol (blinded for review).

3. Results

3.1. Sample characteristics

Within the sample of HCP, 9 out of 10 were women. The mean age of participants was 40.5 (SD=13.9, range 19–67), and there was an equal distribution between RNs and ANs. The mean years of work experience in the current work role was 13.5 years (SD 12.9), and time at the present unit was 7.8 years (SD 9.0). The majority had their education in (blinded for review), and nine participants were educated in another country (Finland, Poland, Uganda, Bosnia, United States, Lithuania, Croatia, Philippines, and the Netherlands). A comprehensive description of the HCP is presented in Table 2.

3.2. Self-efficacy to medical asepsis in care situations

The HCP rated high levels of self-efficacy to medical asepsis in care situations, with a total mean score of 137.1 (SD=12.4, Min=82, Max=150); see Table 3. The HCP scored lowest confidence regarding the item *Always use gloves when drawing blood* (M=8.1, SD=2.8, Min=1,

Max=10). The item with highest confidence (M=9.9, SD=0.2, Min=7, Max=10) was *Never forget to take off my wrist watch before starting work.*

3.3. Structural empowerment

Total rates of structural empowerment were moderate (M=20.4, SD=3.7, Min=8, Max=30). The subscale with the highest scores was Access to opportunity (M=3.8, SD=0.7, Min=1, Max=5), and the lowest was Access to Information (M=3.1, SD=0.9, Min=1, Max=5). As a general empowerment measure, Global empowerment had a mean score of 3.3 (SD=0.9, Min=1, Max=5), which is in line with the other subscales (Table 4). Correlational tests used the mean scores of the six subscales of CWEQ-II and revealed low correlation and a definite, but small relationship between structural empowerment and self-efficacy to medical asepsis (r_s=0.255, p<0.001), see Table 3. The highest correlation for the subscales in CWEQ-II and self-efficacy to medical asepsis was Access to support (r_s=0.295, p<0.001); see Table 4. Within the sample, 8 HCP rated low levels of total structural empowerment, 258 moderate and 113 high levels of structural empowerment (percentages are presented in Table 5). The results from the Kruskal-Wallis H test confirmed that HCP who rated high levels of structural empowerment had significantly higher levels of self-efficacy to medical asepsis compared to the group with average structural empowerment. No statistically significant difference was found between the low and average groups. All results from the comparative analysis are found in Table 5.

3.4. Work engagement

Work engagement was rated relatively high (M=4.7, SD=0.9, Min=1, Max=6), and a definite, but small positive relationship was found between self-efficacy to medical asepsis in care situations and work engagement (r_s=0.268, p<0.001; see Table 3. After grouping participants into low, average and high work engagement, we found that within the sample, 12 HCP rated low work engagement, 147 average and 258 rated high levels of work engagement. When comparing groups, the results revealed significantly higher self-efficacy to medical asepsis in the group rated high compared to the group rated average work engagement. The results revealed no significant difference between the low and average groups (Table 5).

3.5. Work-related stress

Perceived overall work-related stress was rated as (M=3.8, SD=0.4, Min=2, Max=4.8), category Yellow, i.e. improvement needed. The highest scores were in the subscales Colleague support and Role (M=4.2, SD=0.4, Min=2, Max=5) for each, which ended up in the category Aqua, i.e. good performance with potential for improvement). The lowest score was on the subscale

Demands (M=3.1, SD=0.6, Min=1, Max=4.9), ending up in the category Red, i.e. urgent action required; see Tables 4 and 5. The correlational test revealed a definite, but small relationship between overall work-related stress and self-efficacy to medical asepsis in care situations (r_s=0.254, p<0.001); see Table 3. The highest correlation for the subscales in HSE and self-efficacy to medical asepsis was Change (r_s=0.232, p<0.001). No correlation was found between self-efficacy to medical asepsis and the subscale Relationships (r_s=0.003); see Table 4. Regarding total work-related stress, 46 HCP in the sample scored red, 192 yellow, 101 aqua and 15 green. The Kruskal-Wallis H test revealed significant differences between the groups red and green, yellow and aqua as well as yellow and green; see Table 5.

3.6. Assessment of risks for organism transmission at work

The results showed that the HCP assessed the General risk for organism transmission at work as medium–high (M=2.5, SD=1.1, Min=1, Max=5); see Risk-A in table 3. The mean score for own risk of contributing to organism transmission (Risk-B in Table 3) as well as the risk for oneself becoming infected at work (Risk-C in Table 3) was (M=1.9, SD=0.9, Min=1, Max=5) for the respective items. A definite, but small negative relationship was found between self-efficacy to medical asepsis in care situations and the assessment of general risk for organism transmission (r_s=-0.195, p<0.001) and the assessment of own risk of contributing to organism transmission at the workplace (r_s=-0.204, p<0.001). There was no correlation between risk assessments for becoming infected oneself and self-efficacy to medical asepsis (r=0.008); see Table 3. When grouping the variables into low, medium and high, 191 HCP rated low, 161 medium and 61 rated a high general risk for organism transmission at work. Regarding their own risk of contributing to organism transmission, 316 HCP rated low, 74 medium, and 23 HCP rated high risk. The risk of becoming infected oneself was rated low by 301 of HCP, 83 rated medium, and 26 rated high within the sample. The comparative analysis revealed significant values regarding general risk and self-efficacy to medical asepsis in care situations between the groups high–low and medium–low. No significant relationships were found between self-efficacy to medical asepsis and the assessed own risk of contributing to organism transmission or becoming infected at work (see Table 5).

4. Discussion

This study revealed that HCP rated high levels of self-efficacy to medical asepsis in care situations and a definite, but small relationship was found between the working conditions of HCP and self-efficacy to medical asepsis. Self-efficacy is described as people's belief in their ability to succeed in different situations (9) and has been found to influence employees'

performance at work (11). RNs worldwide describe how they are experiencing undesirable working conditions (4), and the association between HCP's working conditions and patient safety is well known (47). Previous research has shown that insufficient staffing levels, high workload, high grades of work-related stress, long work hours, and deficient access to materials and equipment are associated with several patient safety outcomes, e.g, patient mortality, the risk of patient falls, pressure ulcers, information loss, and healthcare-associated infections (HCAI) (48–51). Moreover, HCAIs can be the consequence of deficient medical asepsis in care situations and non-compliance with hygiene principles. Even though our results revealed that HCP rated high levels of self-efficacy to medical asepsis in care situations, it does not necessarily correspond to the actual performance of medical asepsis and compliance with hygiene principles. Earlier research has found that HCP often overestimate their hand hygiene performance in relation to observed behaviour (52–54) and that HCP are often unaware of performed risk behaviours for organism transmission (54).

HCAI also include occupational infections (55). There was no relationship between assessment of risk for oneself becoming infected at work and self-efficacy to medical asepsis in this study. This could imply that HCP primarily associate medical asepsis and compliance to hygiene principles with patient safety rather than occupational infections. The fact that HCP assessed the risk for oneself becoming infected at work as low can also imply that HCP use hygiene principles, such as protective clothing and gloves, to protect themselves rather than the patients, which has also been found in previous research (52,56). Furthermore, HCP assessed the general risk for organism transmission as higher than the risk of contributing to organism transmission themselves at work. This is also in line with previous research, showing HCP often rate their own ability and compliance with hygiene principles more highly than that of colleagues (52). To conclude, the hypothesis that HCP who assess the risk for organism transmission at work as low also rate high levels of self-efficacy to medical asepsis could only partly be supported.

Concerning structural empowerment, most HCP rated moderate levels, and the hypothesis that HCP who rate high levels of structural empowerment also rate high levels of self-efficacy to medical asepsis could partly be supported. There was a significant difference in self-efficacy between HCP who rated high structural empowerment compared to those who rated moderate levels, and the correlational analysis revealed a definite, but small relationship. Structural empowerment has in previous studies been found to positively influence work effectiveness as well as patient safety (5,18). Structural empowerment implies, among other

things, having access to information and resources (15). In a systematic qualitative literature review by Smiddy et al. (2015), they found HCP's perceptions of the work environment, e.g. access to resources and information, to influence compliance with hygiene principles. Furthermore, they concluded that HCP's perceptions of work environment were closely connected to Kanter's theory of structural empowerment. Accordingly, when employees are empowered in their job, it increases their compliance with hand hygiene guidelines (19), and thus performance of medical asepsis in care situations.

In this study, the majority of HCP rated a high level of work engagement. The hypothesis that proposed HCP who rate high levels of work engagement also rate high levels of self-efficacy to medical asepsis was partly supported, with significant differences between HCP who rated high versus average work engagement. HCP have expressed that psychosocial working environments, such as colleagues and managers' engagement and the workplace culture regarding infection prevention, influence their infection prevention behaviour (54). Since employees with a high level of work engagement often experience more positive emotions and enthusiasm and have the ability to transfer their engagement to others (57), it is important to create a workplace that increases and maintains work engagement among HCP, both for the psychosocial work environment and to promote patient safety (23).

Concerning work-related stress, more than 65% of the HCP in this study gave answers indicating that improvement is needed, of which 13% required urgent action. Significant differences were found between self-efficacy to medical asepsis in care situations and several groups regarding work-related stress. Consequently, the hypothesis proposing that HCP who rate low levels of work-related stress rate high levels of self-efficacy to medical asepsis was supported. Work-related stress is a common difficulty for HCP (7,26), and high levels of work-related stress have been found to increase the risk for HCAI (64) and negatively impact HCP's compliance with medical asepsis routines (58). Work-related stress has also been discussed by HCP as reasons for non-compliance with hygiene guidelines (54). However, qualitative studies investigating HCP's experiences of reasons for work-related stress are scarce, and this phenomenon would benefit from being studied in more detail and should be taken into account when designing future qualitative studies aiming to investigate this topic further.

This study's results confirmed that HCP experiencing high access to structural empowerment, high work engagement, and low levels of work-related stress assess higher grades of self-efficacy to medical asepsis in care situations, as definite but small relations

between variables were found. Still, it is difficult to conclude to what extent self-efficacy to medical asepsis is related to HCP's working conditions. The HCP in this study rated highest and the most positive scores concerning work-related stress in the subscale Colleague support. Colleague support can be connected to element number 3 in Bandura's theory of self-efficacy. This element concerns verbal persuasion and implies that people are coached by others to strengthen belief in their personal capacity. It can also be connected to element number 4, that psychological states influence belief in capability (9). Regarding structural empowerment, the highest correlation to self-efficacy was found in the subscale Access to support, which further strengthens this connection.

According to the theory, self-efficacy relates to people's belief in their ability and consequently this affects human behaviour (9). Earlier research has pronounced that self-efficacy appears to impact the infection prevention behaviour of HCP to some extent but that more research is needed (13), and from our results we agree that further investigations are required to determine potential relationships and to what extent they intertwine. As a suggestion, this can be done by including other working condition instruments such as working climate, but also from a qualitative perspective as proposed earlier. This would make it possible to study the beliefs and experiences of HCP more deeply in order to access structures that cannot be measured quantitatively. One must also bear in mind that this study has investigated an assessment of self-efficacy by HCP regarding medical asepsis and not actual performance of medical asepsis in care situations and as previously noted, HCP tend to overestimate hygiene compliance in relation to actual performance (52–54). However, since self-efficacy has an impact on people's perceptions and performance at work (11), and moreover has a social influence within a group of people (14), we can conclude it is somehow essential to foster a positive culture regarding medical asepsis in care situations from an organisational perspective, since it is beneficial for the HCP and in the long run also for their patients.

4.1 Methodological considerations

An overall limitation was the cross-sectional design, which does not make it possible to find causal relationships between outcomes. In the correlational analysis, we found a low correlation and a definite, but small relationship between HCP's working conditions and self-efficacy to medical asepsis. However, from these results, we cannot conclude which variables affect what. The assumptions for multiple linear regression analyses were not met, since this was not possible with our available data, which is another limitation. Instead, we conducted the group

comparisons because all questionnaires in the study have confirmed cut off-limits, which could increase the understanding and applicability of this study's results.

A strength of this study is that participants were randomised and recruited from several hospitals and units of different sizes from all over the country, making it easier to draw more general conclusions from the results. Since the FLMs could choose how the participants would receive the questionnaire and since we did not request a response confirmation, we cannot guarantee that all potential participants received the information, which could have affected the response rate. However, we find the FLMs' opportunity to choose how to receive the study material as positive. Much existing research focuses exclusively on RNs in survey studies, and the inclusion of both RNs and ANs is a strength in this study. RNs and ANs work together in nursing care, and ANs are equally important in the caring process in hospitals units.

The Conditions of Work Effectiveness Questionnaire-II, Utrecht Work Engagement Scale and HSE Management Standards Indicator Tool are validated and frequently used instruments. The Infection Prevention Appraisal Scale is new and was developed since there was no previous questionnaire that measured self-efficacy to medical asepsis in care situations. However, the questionnaire is subject-specific in line with the theory and its associated guide for instrument development and, in not yet published data, both the item and scale content validity index was excellent as rated by ten independent infection prevention RNs.

5. Conclusions

This study revealed that HCP rated high levels of self-efficacy to medical asepsis in care situations, and to some extent, it seems to have a relationship to structural empowerment, work engagement and work-related stress. It is valuable knowledge that it would be possible to make improvements at the managerial and organisational level to benefit both HCP and patients in the long run. However, since the results are not distinct, these relations need further investigation to improve understanding.

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Table 1. Characteristics of included units

Hospital units	**n=25**
Community hospital units	5
District hospital units	10
Regional/university hospital units	9
Private hospital units	1
Unit speciality	
Surgical	15
Orthopaedic	10
Number of patient beds	
10–19	5
20–29	17
30–39	2
40–29	1
Entire unit open	
Yes	13
No (due to lack of personnel)	12
Type of patient rooms	
Only single patient rooms	1
Single and double rooms	8
Single/double/three beds per room	3
Single/double/four beds per room	13
Education for personnel in hygiene guidelines	
Continuously/annually	15
At the beginning of the employment	8
No	2
FLMs' estimation of levels of personnel turnover	
Low	15
High	10
FLMs' estimation of levels of patient overcrowding	
Low	13
High	12
Placement of overcrowded patients	
In patient rooms	18
In the corridor	7
FLMs' estimation of overall patient-level workload	
Low need	4
Medium need	12
High need	9
FLMs' span of control	
20–39	7
40–59	12
60–79	6
FLMs' perceived conditions for the HCP to be able to follow hygiene guidelines	
Good conditions	19
Poor conditions	6
Number of patient beds	
10–19	5
20–29	17
30–39	2
40–29	1

Abbreviations: FLM First-line manager. HCP Healthcare personnel.

Table 2. Healthcare personnel characteristics

Healthcare personnel	**n=417 (%)**
Age years, mean (SD)	40.5 (13.9)
Years of work experience, mean (SD)	13.5 (12.9)
Years at present unit, mean (SD)	7.8 (9.0)
Gender	
Woman	378 (91.1)
Men	37 (8.9)
Education	
Assistant nurse	197 (47.2)
Registered nurse	204 (48.9)
Specialised nurse	16 (3.8)
Country of education	
(blinded for review)	402 (97.8)
Other country	9 (2.2)
Work time	
Full time	307 (75.2)
Part time	101 (24.8)
Working shift	
Daytime	32 (7.7)
Day/evening shift	246 (59.7)
Night shift	51 (12.3)
Rotational work	84 (20.3)

Abbreviations: SD standard deviation. When totals do not add up to 417 there is missing internal data.

Table 3. Descriptive statistics and bivariate correlations (Spearman's rho) between study variables

Variable	Scale range	Min–Max	Mean	SD	Median	IQR	Skewness	Kurtosis	1. Sum IPAS	2. Mean UWES	3. Sum CWEQ	4. Mean HSE	5. Risk-A	6. Risk-B
1. IPAS (sum)	0–150	82–150	137.1	12.4	140	13	-1.801	3.975						
2. UWES (mean)	0–6	1–6	4.7	0.9	4.9	1.2	-1.045	1.446	0.268**					
3. CWEQ (sum)	6–30	8–30	20.4	3.7	20.1	5	-0.045	0.092	0.255**	0.546**				
4. HSE (mean)	1–5	2.0–4.8	3.8	0.4	3.8	0.6	-0.463	0.999	0.254**	0.457**	0.692**			
5. Risk-A	1–5	1–5	2.6	1.1	3	1	0.443	-0.048	-0.195**	-0.232**	-0.220**	-0.240**		
6. Risk-B	1–5	1–5	1.9	0.9	2	1	0.896	0.654	-0.204**	-0.224**	-0.130*	-0.210**	0.578**	
7. Risk-C	1–5	1–5	1.9	0.9	2	1	0.757	-0.011	0.008	-0.207**	-0.190**	-0.279**	0.558**	0.583**

Abbreviations: SD Standard deviation, IQR Interquartile range. Risk-A. How do you assess the risk for organism transmission is at your workplace? Risk-B. How do you assess the risk that you contribute to the spread of infection to patients during a work day? Risk-C. How do you assess your risk of getting infected during a work day? **Correlation is significant at the level of 0.01 (2-tailed).

Table 4. Descriptive statistics and bivariate correlations (Spearman's rho) between IPAS and respective factor in CWEQ and HSE

Factor	**Scale range**	**Min–Max**	**Mean**	**SD**	**IPAS**	**CWEQ**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**HSE**	**8**	**9**	**10**	**11**	**12**	**13**
IPAS (sum)	0–150	82–150	137.1	12.4																
CWEQ (sum)	6–30	8–30	20.4	3.7	0.255**															
1 Opportunity	1–5	1–5	3.8	0.7	0.144**	0.566**														
2 Information	1–5	1–5	3.1	0.9	0.179**	0.635**	0.236**													
3 Support	1–5	1–5	3.3	0.9	0.295**	0.756**	0.381**	0.381**												
4 Resources	1–5	1.33–5	3.4	0.8	0.200**	0.669**	0.200**	0.366**	0.443**											
5 Formal Power	1–5	1–5	3.2	0.9	0.163**	0.814**	0.367**	0.480**	0.549**	0.506**										
6 Informal Power	1–5	1–5	3.7	0.8	0.100*	0.612**	0.382**	0.196**	0.352**	0.272**	0.434**									
7 Global empowerment	1–5	1–5	3.3	0.9	0.195**	0.624**	0.304**	0.334**	0.377**	0.564**	0.618**	0.419**								
HSE (mean)	1–5	2–4.8	3.8	0.4	0.254**	0.692**	0.313**	0.368**	0.569**	0.607**	0.588**	0.352**	0.646**							
8 Demands	1–5	1–4.88	3.1	0.6	0.134**	0.247**	-0.34	0.189**	0.195**	0.536**	0.166**	-0.054	0.369**	0.576**						
9 Control	1–5	1.17–5	3.2	0.6	0.171**	0.509**	0.224**	0.293**	0.315**	0.945**	0.502**	0.273**	0.556**	0.636**	0.349**					
10 Manager support	1–5	1–5	3.8	0.8	0.217**	0.363**	0.347**	0.320**	0.580**	0.480**	0.556**	0.371**	0.498**	0.810**	0.312**	0.419**				
11 Colleague support	1–5	2–5	4.2	0.5	0.114*	0.408**	0.194**	0.208**	0.361**	0.381**	0.352**	0.326**	0.417**	0.700**	0.312**	0.361**	0.565**			
12 Relationships	1–5	1–5	4.1	0.6	0.003	0.327**	0.219**	0.126*	0.289**	0.286**	0.223**	0.167**	0.363**	0.578**	0.392**	0.174**	0.404**	0.434**		
13 Role	1–5	2.2–5	4.2	0.5	0.217**	0.485**	0.305**	0.387**	0.390**	0.417**	0.394**	0.234**	0.425**	0.627**	0.298**	0.360**	0.452**	0.492**	0.257**	
14 Change	1–5	1–5	3.4	0.8	0.232**	0.608**	0.316**	0.395**	0.485**	0.471**	0.545**	0.336**	0.512**	0.773**	0.239**	0.502**	0.659**	0.431**	0.308**	0.446**

Abbreviations: SD Standard deviation. **Correlation is significant at the level of 0.01 (2-tailed). *Correlation is significant at the level of 0.05 (2-tailed).

Table 5. Comparisons between self-efficacy to medical asepsis and grouped working condition variables

Working condition variables	Self-efficacy to medical asepsis	Percentage within the sample
Structural empowerment		
Scores: 6–13 Low empowerment, mean (SD) IQR	138.5 (7.3) 13	2.1
Scores: 14–22 Moderate empowerment, mean (SD) IQR	135.4 (13.6) 15	68.1
Scores: 23–30 High empowerment, mean (SD) IQR	140.4 (9.4) 10	29.8
Test statistics H (df)	12.136 (2)	
p-value	**0.002**	
Bonferroni post hoc test	Moderate–low 1.000 **Moderate–high 0.002** Low–high 0.943	
Work engagement		
Scores: ≤2.88 Low work engagement, mean (SD) IQR	133 (13.3) 23	2.9
Scores: 2.89–4.66 Average work engagement, mean (SD) IQR	134.1 (14.4) 14	35.2
Scores: ≥4.67 High work engagement, mean (SD) IQR	138.9 (10.8) 13	61.9
Test statistics H (df)	16.249 (2)	
p-value	**<0,000**	
Bonferroni post hoc test	Low–average 1.000 Low–high 0.237 **Average–high <0.000**	
Work-related stress		
Scores: <3.24 Red - Urgent action required mean (SD) IQR	132.9 (16.7) 17	13
Scores: 3.25–3.96 Yellow - Improvement needed mean (SD) IQR	135.8 (12.4) 14	54.2
Scores: 3.97–4.49 Aqua - Good performance, potential improvement mean (SD) IQR	139.8 (10.8) 12	28.6
Scores: >4.50 Green - Doing well, maintain performance mean (SD) IQR	143.5 (6.5) 7	4.2
Test statistics H (df)	16.895 (3)	
p-value	**0.001**	
Bonferroni post hoc test	Red–yellow 1.000 red–aqua 0.062 **Red–green 0.029 Yellow–aqua 0.017 Yellow–green 0.031** Aqua–green 1.000	
General risk for organism transmission at work		
Scores: 1–2 Low risk, mean (SD) IQR	139.9 (9.3) 11	46.2
Scores: 3 Medium risk, mean (SD) IQR	135.4 (12.5) 16	39
Scores: 4–5 High risk, mean (SD) IQR	132.3 (17.9) 23	14.8
Test statistics H (df)	14.093 (2)	
p-value	**0.001**	
Bonferroni post hoc test	High–medium 1.000 **High–low 0.027 Medium–low 0.002**	
Own risk of contributing to organism transmission at work		
Scores: 1–2 Low risk, mean (SD) IQR	138.2 (10.9) 13	76.5
Scores: 3 Medium risk, mean (SD) IQR	133.7 (14.9) 22	17.9
Scores: 4–5 High risk, mean (SD) IQR	130.7 (19.1) 22	5.6
Test statistics H (df)	6.591 (2)	
p-value	**0.037**	
Bonferroni post hoc test	High–medium 1.000 High–low 0.302 Medium–low 0.095	
Risk for oneself becoming infected at work		
Scores: 1–2 Low risk, mean (SD) IQR	137.0 (11.7) 13	73.5
Scores: 3 Medium risk, mean (SD) IQR	136.9 (15.2) 15	20.2
Scores: 4–5 High risk, mean (SD) IQR	137.6 (12.7) 20	6.3
Test statistics H (df)	1.962 (2)	
p-value	0.375	

Abbreviations: SD Standard deviation. IQR: Interquartile range. df: Degrees of freedom. H: Kruskal-Wallis test. Significant values in bold.