Home Care Nurses' Identification of Patients at Risk of Infection and their Risk Mitigation Strategies: A Qualitative Interview Study

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Home Care Nurses' Identification of Patients at Risk of Infection and their Risk Mitigation Strategies: A Qualitative Interview Study

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Abstract

Background

There is an increase in the number of individuals who receive care at home. A significant proportion of these patients acquire infections during their care episode. Whilst there has been significant focus on strategies for infection prevention and control in acute care environments, there is a lack of research into infection prevention in a home care setting.

Objectives

To understand 1) if and how home care nurses identify patients at high risk of infection and 2) the strategies they use to mitigate that risk.

Design

A qualitative descriptive study, using semi-structured interviews.

Setting

A large not for profit home care agency located in the New York region of the United States.

Participants

Fifty nurses with a range of experience in home care nursing.

Methods

Purposive and snowball sampling was used to recruit nurses from across the home care agency with varied years of work experience. Interviews were audio recorded and transcribed. The interviews explored how home care nurses evaluate their patients' risk of developing an infection and if/how they modify the plan of care based on that risk. Data were analysed using thematic analysis.

Results

Three themes were derived from the data; assessing a patient's risk of infection, the risk assessment process, and strategies for mitigating infection risk. Factors identified by nurses as putting a patient at higher risk of infection included being older, having diabetes,

inadequate nutrition; along with inadequate clinical information available at start of care. The patient's knowledge and understanding of infection prevention, and the availability and knowledge of caregivers were also important, as was the cleanliness of the home environment. Given the context of home care, where nurses have little control over the environment and care processes in-between visits, the main strategy for infection prevention was patient and caregiver education. Nurses also discussed the importance of their own infection prevention behaviours, and the ability to adjust a patient's plan of care according to their infection risk.

Conclusions

The study highlights the complexity of the risk assessment process in relation to infection. Existing guidelines for infection prevention and control do not adequately cover the home care environment and more research needs to determine which interventions (such as patient/caregiver education) would be most effective to prevent infections in the home care setting.

Key Words

Clinical Decision Making; Home Care Services; Home Health Nursing; Infection Control; Infection Prevention; Judgement; Qualitative Research;

Word Count: 6,359

What is already known about the topic?

- Infections are responsible for 17% of all unplanned hospitalizations among patients receiving home care in the USA.
- There is little evidence or guidance to support infection prevention and control interventions in a home care setting.

What this paper adds

- A detailed analysis of how home care nurses identify patients at higher risk of infection and the factors associated with that risk.
- Details the strategies that home care nurses use to mitigate infection risk in a non-hospital environment.
- Identifies priorities for future research on infection prevention strategies that are tailored to a home care environment.

1. Introduction and Background

Internationally there has been an expansion of health care in home or community settings (Van Eenoo et al., 2015). Community or home care can comprise of a variety of different types of service, which varies by individual countries. It has been defined as 'professional care provided at home to adult people with formally assessed needs', and can range from 24 hour support for individuals with complex needs to those who only need occasional help (Genet et al., 2011). Services provided in home care include nursing care, rehabilitation and personal care. Whilst a variety of professionals provide home care, overall nurses are the most frequent professional care provider (Van Eenoo et al., 2015). In 2015 nearly 4.5 million Americans received care from 12,200 home care agencies (Harris-Kojetin L et al., 2019); in the United Kingdom (UK) the Kings Fund suggest that community health services have up to 100 million contacts with patients a year and account for one-fifth of the total budget for the National Health Service (NHS) (Charles, 2019). A significant number of patients who receive home care are recently discharged from an acute care setting, with the re-admission of such patients being a key issue in terms of both quality of care, and the associated costs to both patients and the health care system (Berry et al., 2018, Friebel et al., 2018).

Infections acquired during health care (HAIs) are a preventable cause of patient harm in hospital settings (Panagioti et al., 2019) and are a significant factor in hospital readmission rates. Up to 1 in 5 individuals in the population of the USA and 3 European countries (the UK, Netherlands and Germany) are at increased risk of infection, due to factors such as increasing age and chronic illness (Bloomfield et al., 2007). A study of nearly 200,000 home care patients across the USA found that 17% of all unplanned hospitalizations were caused by four types of infection (Shang et al., 2015). In addition, there are specific environmental conditions in a home setting, which may also make individuals more vulnerable to infections,

such as the presence of pets (Bloomfield et al., 2007). Whilst there has been a significant focus on interventions and strategies for infection prevention and control in acute care environments (Sydnor and Perl, 2011, World Health Organisation, 2016, World Health Organisation, 2010), there is a lack of data on the risks of infection for both patients and care workers in non-hospital settings (Maroldi et al., 2017, World Health Organisation, 2010). A systematic review of infection prevalence and risk factors for infection among adult patients receiving home health care services identified 25 studies internationally that had explored HAIs (Shang et al., 2014). Over half of the studies focused on patients receiving home parenteral nutrition, with the remaining studies exploring infection prevalence rates for patients on home infusion, with indwelling devices (such as a urinary catheter) and mechanical ventilators. Only 4 studies of the 25 focused on general home care patients. Overall it was difficult to estimate infection prevalence rates in the home care population, due to a lack of consistency in definitions. However, the infection rates highlighted in the review ranged from 10.04 infections per 1,000 device days for central-line associated bloodstream infections; 8.4 infections per 1,000 catheter days for self-reported urinary tract infections and a HAI rate of between 5.1% and 11.5% among all home care patients.

Identifying patients who are at risk of infection, is a key issue in community and home care settings (Department of Health and Social Care and England, 2013). However, there is little research on risk of infection development within this health care context despite the increasing population of vulnerable older adults. A recent study used routinely collected data from a large home health care agency in the USA to develop a predictive risk model to identify patients at risk of an infection related hospitalization or emergency room visit (Shang et al., 2019). The model that was developed was able to identify individuals at high or very high risk of developing an infection. Over 30 risk factors were identified from this study,

including receiving parenteral nutrition, having a urinary catheter, limited ambulation and skin ulcers (Shang et al., 2019). Uniquely to a home care setting, caregiver availability was a key risk factor; patients who did not have a caregiver at home, or whose caregiver was perceived as needing education were identified as being at a higher risk for infection development.

Unlike in hospital settings, there is little evidence or specific guidance to support infection prevention and control interventions in a home care setting. It is generally agreed that good hand hygiene practices, using both soap and water or alcohol-based hand sanitizer is the basis for standard infection control precautions in home care (Bloomfield et al., 2007, Embil et al., 2009). Use of Personal Protective Equipment, for more high risk patients or clinical procedures are also well established (Embil et al., 2009, Higginson, 2018, Rhinehart, 2001) . However, guidance from both acute and long term care settings related to issues such as environmental cleanliness (Centers for Disease Control and Prevention, 2016, Collins, 2008, Sydnor and Perl, 2011), and isolation of individuals with infections such as Methicillin-resistant Staphylococcus aureus (MRSA), need to be adapted for a home care setting (Embil et al., 2009). A survey of home care nurses also highlighted their risk of contracting an occupationally acquired infection, and that there is significant variation in infection prevention and control practices across different agencies (Kenneley, 2012). However, research into specific issues related to infection transmission in home care, for example the risks of infection from the nurses bag, is sparse (Kenneley, 2010).

The assessment of risk of infection, and subsequent decisions regarding infection prevention and control can be viewed in the context of a clinical judgement and decision-making framework (Figure 1). We have derived this framework for our study based on a linear

framework of hypothetico-deductive reasoning (Thompson and Dowding, 2009). The framework highlights the importance of collecting and evaluating information, to reach an assessment (judgement) about a patient's risk of infection. On the basis of that assessment, they then take decisions regarding the best approaches to reducing that risk, with the outcome of preventing or reducing the risk of a patient developing an infection.

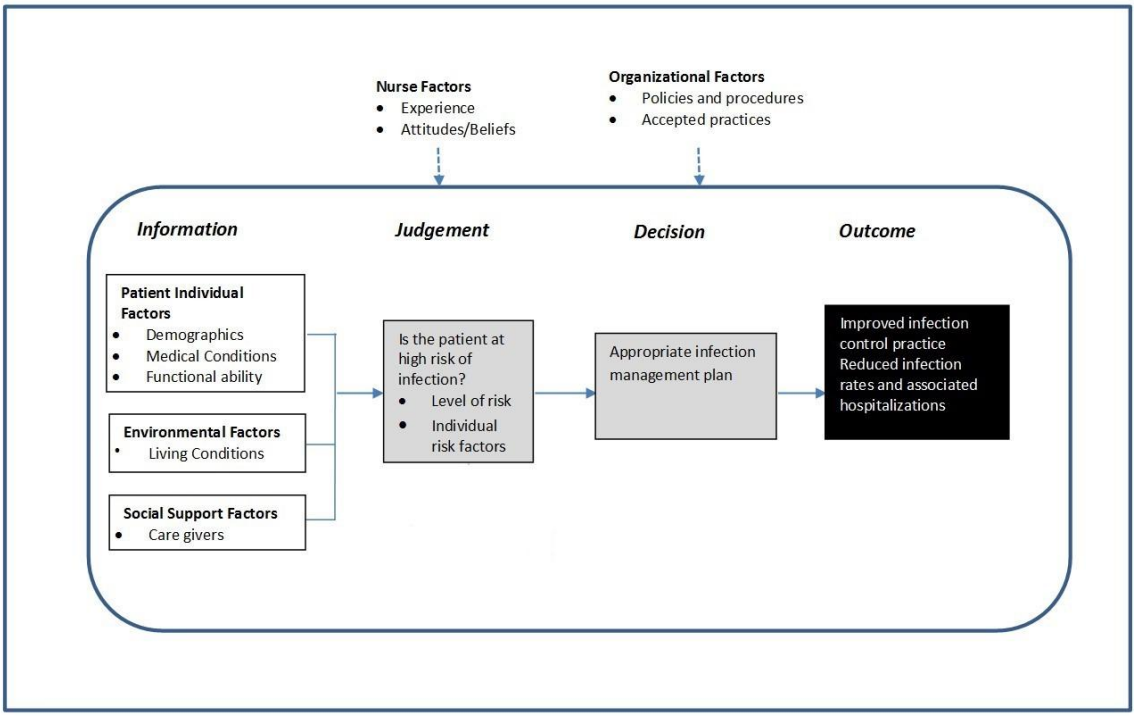

Figure 1: Conceptual Framework (adapted from hypothetico-deductive reasoning framework, Thompson and Dowding, 2009)

In this study we used the framework outlined in Figure 1 to inform our research exploring how nurses working in a large home care agency in the New York region of the United States assessed infection risk and developed interventions for infection prevention. This paper reports the findings of semi-structured interviews conducted with nurses, after they had been observed conducting patient visits (the results of the observations are being reported

elsewhere) and is part of a larger study examining the nature of infection prevention and control in home care. The wider study has previously reported the findings of XXXXXXXXXXXXX (detail removed for manuscript blinding purposes). The study outlined here aimed to understand 1) if and how home care nurses identify patients at high risk of infection and 2) the strategies they use to mitigate that risk.

2. Methods

This was a qualitative descriptive study, using semi-structured interviews. Using the conceptual framework described above, data were collected to shed light on nurses' judgement and decision processes surrounding infection risk and infection control practices. These data included information collected to inform risk judgements, the types of risk judgements they made, and decisions taken on the basis of this evaluation.

2.1 *Setting*

The study was conducted in a large not for profit home care agency located in the New York region of the United States. In 2018 the agency served nearly 119,000 patients, making 1.2 million clinical visits. It employed nearly 1,500 nurses (registered nurses and licensed practical nurses). As a Medicare-certified home health agency it provides skilled nursing and therapy services to patients who are deemed to be homebound and are eligible for Medicare benefits in the USA (i.e. persons age 65 or older, or younger people with disabilities), as well as patients covered by private insurance and other funding sources. When a patient is admitted to the agency, a home care nurse will conduct an admission visit and complete a formal assessment, known as the Outcome and Assessment Information Set (OASIS) (Centers for Medicare & Medicaid Services, 2019). This is a structured assessment that covers a patient's sociodemographic information, medical history, health status, functional

status, support system and environmental factors. This information, together with directions from a physician, inform a patient's plan of care, and is the basis for determining nursing interventions (including frequency of visits to the patient's home).

2.2. *Nurse recruitment and consent*

A combination of purposive and snowball sampling was used to recruit nurses from all neighbourhoods served by the home care agency and with varied years of work experience. All nurses providing direct in-home care at the participating agency were eligible to participate, including both registered nurses (RN) and licensed practical nurses (LPN) who work full-time, part-time, or per diem. Additional inclusion criteria were that the nurse agreed to be observed and interviewed. Nurses who did not meet these criteria, such as those who did not provide direct in-home care, were not eligible to take part in the study. A variety of recruitment strategies were used, including attending staff meetings to orientate the frontline staff to the research study; handing out flyers at these meetings and other agency gatherings to encourage nurses to contact the research team if they wanted to volunteer; emailing all nurses employed at the agency, as a group, to share information about the study, and hanging flyers near the supply rooms at each of the agency's regional offices. In addition, nurses who participated in the study were asked to refer a colleague, whom the researcher would then contact directly via telephone call. Once in contact with a nurse, the researcher would further explain the study and what was involved.

Fifty nurses were recruited to the study. This number was targeted to ensure adequate statistical power for estimating nurse adherence rates to hand hygiene, which was the focus of an observation study of nurses to be reported elsewhere. The nurses had a range of years of nursing experience (Table 1) from 1.5 to 44 years (mean 19 years) and 3 months to 26 years

in home care (mean 13 years). The nurse participants were also racially diverse, with 24 (48%) stating their race as Black/African American and the remaining participants identifying as White, Asian or other race. Two thirds of the participants had a Bachelor's Degree in Nursing (33 participants, 66%).

Nurse Demographics (N=50)	**% (n) or mean (range)**
Age	47.4 (25-69)
Gender	
Female	90% (45)
Male	10% (5)
Race	
Black or African American	48% (24)
White	26% (13)
Asian	18% (9)
Other	8% (4)
Qualifications	
LPN/LVN	8% (4)
Associate's Degree in Nursing	14% (7)
Bachelor's Degree in Nursing	66% (33)
Master's in Nursing	12% (6)
Years as a Nurse	19.3 (1.5-44)
Years as a Nurse in Home Care	12.9 (0.25-26)

Table 1: Nurse Participant Characteristics

2.3 *Data Collection*

Interview data were collected from December 2017 to September 2018. Two research fellows employed on the study conducted the interviews. One has an MA in ethnographic research and was employed by the research centre attached to the home care agency. The other research fellow was a PhD student, who was conducting research in the agency and had training in qualitative research techniques. Both researchers were female, received the same training (in terms of interview process), and had no established relationships with the nurse participants prior to the study. Each researcher conducted the interviews after they had observed the nurse visit 8 different patients, meaning that they had established some rapport with the participants.

Most of the interviews were completed over the phone, and lasted between 18 and 50 minutes (mean 31 minutes, median 29 minutes). Upon completion of the qualitative interview, the nurses were offered a $100 gift card as a thank you for their time. All interviews were audio recorded and later transcribed by a certified transcription service. The interview guide was developed based on the conceptual framework, to explore how home care nurses evaluate their patients' risk for developing an infection during the episode of care, whether or not (and how) nurses modify the plan of care and their infection prevention behaviours based on their patients' risk for infection (Table 2 provides an overview of the semi-structured interview guide). The interview guide was also designed to give the researchers the opportunity to ask nurses about their practice and behaviours observed in the home.

Interview Questions	**Link to Conceptual Framework**

1) What do you think puts people at risk for infections? a. Especially patients in the homecare setting? b. What environmental factors contribute to a patient's risk of developing an infection while in homecare? What things in the home have you observed that could contribute or may have contributed to a patient's risk of infection? c. What behaviors of the patient contribute? d. What behaviors of the home health team contribute? 2) What helps you perform infection prevention and control in the homecare setting? 3) What barriers are there to performing infection prevention and control in the homecare setting?	Information - Patient factors - Environmental factors - Social support factors Decisions Decisions
1) How do you currently evaluate a patient's risk for developing an infection while in homecare? a. What do you look for in the patient's record? b. What do you ask when you first evaluate the patient? 2) What do you do to prevent homecare associated infections? a. For yourself? b. For your patients? 3) What resources do you depend on to evaluate a patient's risk of infection before the first visit, during the first visit, and throughout the patient's length of stay? 4) Do you develop the plan of care differently for your patients who seem to be at an increased risk for developing an infection? How?	Information - Patient - Environment - Social Support Judgements – risk of infection Decisions; infection management plans Information Judgements Decisions – infection management plans

5) Can you tell me about an instance where you had a patient that you thought was at an increased risk for developing an infection? How did you develop the care plan differently?	Judgements Decisions
6) What do you do differently for patients who you know are at an increased risk for developing an infection? a. Probe for hand hygiene b. Probe for patient and caregiver education	Decisions

Table 2: Semi-structured Interview Guide

2.4 *Analysis*

All transcripts were imported into qualitative analysis software (NVivo 11). Three researchers from the study team (XX, YY and ZZ) undertook the analysis. The qualitative interview guide and three nurse interviews were used by the three researchers to independently identify initial thematic coding schemas. These coding schemes were synthesized into one thematic coding schema that was applied to three new interviews by all three researchers independently. After these interviews were coded, interrater reliability was calculated using the software's built-in coding comparison function, and a kappa coefficient was calculated to confirm agreement in coding (k=0.57, % agreement 95.9%). Areas of disagreement were discussed and the coding schema was modified to reflect the changes. This process was continued iteratively until a final coding schema and technique was agreed upon. The coding schema was then applied to all 50 interview transcripts in rounds of ten by the three members of the study team. All 50 transcripts were double-coded, with one researcher applying the schema to all 50 transcripts and the other two researchers applying the schema to 25 transcripts each. After a set of ten interviews was coded, the coding comparison function was again applied and kappa coefficients were calculated to ensure

continued agreement in coding (k=0.73, % agreement 92.4%). Because qualitative coding is an iterative process, codes were added, labels were changed, and transcripts were recoded as necessary. Finally, all three researchers synthesised key themes and issues arising from the data, to address the key aims of the study.

2.5 *Ethics*

All study activities were approved by both the home care agency's Institutional Review Board (IRB) (IRB#:E16-005) and the IRB for the collaborating researchers' institution (IRB#:AAAQ9226). Prior to the interview sessions, informed written consent was obtained from each nurse. Nurses were told that their participation in the study was voluntary and that they could stop or withdraw at any time.

3. Findings

The thematic analysis identified a number of key issues related to the assessment of infection risk in home care settings, and the strategies nurses used to mitigate that risk. Quotations to support the themes are provided both in the text and in Supplementary Tables 3 (assessing a patient's risk of infection) and 4 (infection prevention strategies). In the text each quotation is referred to using a reference (e.g. Q1 relates to quotation 1 in the table) and the ID at the end of the quotation indicates the respondent's unique identification number.

3.1 *Assessing a patient's risk of infection*

3.1.1 *Sources of information for assessing risk*

Collecting information and evaluating the importance of that information in terms of its relationship to a patient's risk of infection is key for the assessment process. Nurses discussed how they were reliant on the quality of the information they could access, from patient discharge and referral documents and their medical notes to provide an initial indication of whether or not a patient had an existing infection they needed to be aware of (Q1). They supplemented this with further information collected during the process of formal assessment using the OASIS (Q2), as well as from directly asking patients and their families to provide further information (Q3). One nurse suggested that they were "*kind of playing detective. You're asking. And then if all else fails, you call the doctor to get info. You call family to get info."* [ID620]. Nurse observation and their experience was vital, in combination with the other information available to them, to make an accurate assessment of a patient and their risk factors (Q4).

3.1.2. Risk Factors for Infection

Nurses identified several factors that they felt put patients at a higher risk of infection. Key indicators included having a history of infections or a prescription for an antibiotic (Q5). Risk of infection was the result of a combination of factors that affected a patient's immune system such as older age, diabetes, dehydration or having inadequate nutrition (Q6 & Q7). Having particular points of entry for infection, such as IV lines, Foley catheters and wounds were identified as factors that automatically put a patient at a higher risk of infection.

"I think depending on if they have any open devices, like Foley catheters or any open devices that will put them at risk. That will automatically put them at risk. If they have an IV, a Foley, or anything that has an open orifice within the body, then that will first put them at risk." [ID206]

In addition to discussing general infection risk, nurses discussed infection risk related to specific types of infection, including urinary tract infections (UTIs), wounds and respiratory infections. The risks for UTI were complex with factors such as cognition, incontinence, availability of caregivers and environmental conditions all having a role to play (Q8 & Q9). Wounds were a key infection risk and their assessment and management are a large part of the nurses' work. Patients who also had a diagnosis of diabetes were at particular risk and nurses discussed in detail their process of wound assessment to ensure they detected any infections quickly (Q10 & Q11). A diagnosis of chronic obstructive pulmonary disease (COPD), and a history of smoking, were specific factors related to a risk of respiratory infections such as pneumonia (Q12).

3.1.3. Patient's knowledge, understanding and behaviour

Along with their medical or physical condition, nurses regarded patients' knowledge and understanding of their illness and factors associated with infection risk and infection prevention behaviours as being closely linked to their risk of infection. This included issues such as culture and beliefs, personal hygiene practices and their understanding of how infections were spread and could be prevented. Overall nurses felt their patients lacked basic knowledge about infection prevention, including basic health and hand hygiene, or held beliefs and attitudes towards infection control that nurses perceived were not at a "*high standard*".

"Lack of knowledge. Lack of education about infection control for one. Poor health hygiene. Sometimes even culture. Some people have certain beliefs about certain things, so they don't think infection control is-- they don't put it as a high standard." [ID200]

Patients' behaviours, in relation to general health promotion such as getting vaccinations, as well as behaviours related to personal hygiene and cleanliness impacted on their infection risk (Q13 & Q14). Adhering to treatment recommendations, such as following medication regimens (e.g. courses of antibiotics), managing their wounds, diabetes management and hand washing were important considerations for assessing infection risk:

"Not hand-washing. Not properly using universal precautions. Not taking their medications as prescribed." [ID380]

3.1.4. Environmental and social factors

One of the main factors discussed by nurses that was associated with infection risk was the patient's home environment. Nurses often discussed the relationship between a patient's personal hygiene and the condition of the patient's home. If patients lived in an environment that was unclean, then this increased the risk of a patient getting an infection.

"The cleanliness of their environment, if their homes are dirty, that's a big factor in the contribution to infection." [ID310]

Facilities for patients (and nurses) to carry out basic infection control such as handwashing was sometimes a challenge. Nurses reported patients living in apartments without running water, or a working sink (Q15). Nurses reported patient environments with clutter, trash and infestations of cockroaches and rodents. When patients lived with many family members in close proximity and their infection control practices were not thought to be of a high standard, this was also seen as a risk factor (Q16 & Q17). Environments where pets were present also put patients at higher risk of infection. Nurses viewed the mere presence of a pet as introducing an additional source of risk. However, they also highlighted how, for some patients, their general hygiene practices and how they cared for their pets increased their risk (Q18).

Related to the different factors that affect a patient's risk of infection was the availability of caregivers in the home. When a patient wasn't able to look after themselves, having an involved caregiver who was able to follow advice to reduce the risk of infections, was important. Patients who had caregivers or family that were not following advice or being involved in care were seen to be at an increased risk of developing infection.

> *"Well, things like sometimes they'll have a family member doing the wound care or they might be doing it. They're not wearing gloves. A lot of times, family members don't wear gloves."* [ID205]

3.2. The risk assessment process

Many of the nurses interviewed highlighted the interrelationship between medical diagnoses, patient conditions, environmental conditions and other factors. The overall picture is not one where nurses were looking for patients at risk of infection at the start of their assessment of a

patient. Rather, as they combined information and identified numerous issues, together they may suggest that a patient is at an increased risk of infection. One nurse highlighted how it was only at the end of the process of assessment, once they have collected all relevant information, that they would reach a judgement about a patient's risk of infection. This is evaluated in the context of the patient's overall disease condition, and the focus of the home care episode. Overall, there has to be an underlying reason why an individual is at risk of infection:

> *"Well, I mean,* ***it's just a combination of everything that you're doing around assessment. It's nothing specific just for infection****. So you're looking at diagnosis. You're looking at age. You're looking at medication. You're looking at skin wounds. You do an assessment. So then at the end of the assessment, then you put everything together and you see if somebody's a higher risk of infection."* [ID620]

> *"there is a risk for every person and every patient. But* ***there also has to be certain comorbidities to go along with risk of infection****. It's not that you walk into every home and you kind of suspect, "Oh, this person is at risk for--" there has to be some sort of underlying condition."* [ID490]

The process of assessment isn't a 'one-off' activity but continues across home care visits, with nurses monitoring a patient for changes in signs and symptoms of infection at every visit:

> *"And that's at each visit.* ***I do an assessment at each visit*** *because conditions can change."* [ID215]

3.3. Strategies for mitigating infection risk

The strategies nurses put in place to manage or mitigate a patient's risk of infection should be seen in the context of clinical practice in home care. There is no universal best practice because the nurse lacks control over the clinical setting, the patient's home, so they must be prepared to work with whatever conditions they may encounter. The "best" a home care nurse can do is be flexible (Q19). In the context of homecare practice in the USA, nurses must adjust their level of care to what is covered by the patient's insurance, which may require some patients to monitor their own clinical status more than they would in other clinical settings (Q20).

3.3.1. Patient and caregiver education

According to the participants in this study, patient and caregiver education is one of the most important infection prevention and control methods in homecare. Because the clinical setting is the home and clinical surveillance is only occurring when the nurse visits, the nurse must educate the patient and caregivers in infection prevention and control methods to ensure they are following infection prevention and control guidelines in the nurse's absence (Q21). A focus of patient and caregiver education is hand hygiene, alongside other hygienic practices such as properly cleaning a patient who is bed-bound and incontinent to prevent sacral wound infections and UTIs, correctly positioning, moving, and turning the patient, and regularly cleaning supplies such as catheter drainage bags (Q22; Q23; Q24). Participants also emphasized the importance of nutritional education and argued that proper nutrition not only strengthens the immune system to fight infection, but sufficient protein intake and controlled sugar levels can help heal wounds and other infections (Q25). Recognizing and reporting signs and symptoms of infection was an additional focus of patient and caregiver education.

Whilst wounds were the type of infection discussed most frequently this also included signs of respiratory infections and UTIs (Q26 & 27).

Nurses faced particular challenges when talking to a patient about cleaning up their home to avoid infection (Q28), and often patients did not have a suitable family caregiver to support the nurse's attempts at reducing infection risk. Both patients and caregivers may show a resistance to change, may have low health literacy, and may be cognitively impaired. Mental health – especially stress –also presented a challenge to patient and caregiver education (Q29 & Q30). Assessing the caregivers' capacity for following advice and retaining information was key to ensuring patients were cared for in-between nursing visits. They highlighted how they may alter their plan of care depending on this assessment (Q31).

3.3.2. Practitioner Behaviour

Nurses described how home care presents a unique set of challenges to infection control practices. Nurses were aware of the differences between home and hospital settings. While the hospital was described as a sterile and tightly controlled environment with supervisory staff monitoring their actions, the home was seen as one where nurses were practicing by themselves. Nurses voiced a sole responsibility for preventing the spread of infection to their patients (Q32). Nurses also discussed how they practiced good hand hygiene, using universal precautions for all their patients. They also reported taking specific precautions if patients had certain types of infection. This was particularly the case with patients who had MRSA, who required a specific kit in their home to prevent the transmission of infection (Q33).

Nurses were very aware of the risks of transmitting infection between homes. They discussed the strategies they put in place when visiting a home to reduce the risk of infection

transmission. This included the use of barriers before they placed their bag or supplies on a surface to reduce the risk of them becoming contaminated and spreading infection or standing up so that they didn't sit on a patient's couch. One nurse discussed her '*made-up rules*' to try and prevent contaminating her bag or possessions and transmitting infections between houses.

> *"Sometimes I don't feel safe putting my bag down. There's nowhere to put my coat. You know what I'm saying? If I put it down, I'm taking a risk that I'm going to take something home with me or to another patient's home.* ***So I try to follow all these made-up rules****: find a door knob, find a hook, to hang things around my neck, balance the computer on my lap, put a drape or paper towels down before I take my stuff out of my bag."* [ID216]

They also discussed the importance of cleaning equipment in between patients and modelling behaviour as a way of reinforcing good infection control practices in their patients. The nurses viewed their computer/tablet as a potential vector for infection, particularly as patients were meant to use their finger or a stylus provided by the nurse to sign the tablet as a record of their care provided during the home visit (Q34 & Q35).

3.3.3. Care planning

In home care practice, universal precautions are not the only component of infection prevention and control. The plan of care is tailored to the patient's needs and differential risk for infection. Nurses use protocols to meet the needs of recently hospitalized patients with specific conditions such as heart failure or wound care, with plans varying in the number and type of visits a patient receives. In addition, there are limits to the number of visits paid for by

Medicare and private insurances. The most common change or addition to the plan of care, when a patient appears to be at increased risk of infection, is patient and caregiver education (Q36 & Q37). During home visits, nurses would reinforce hand hygiene and other infection control practices to patients with higher risk of infection, their family members, and paraprofessional caregivers (aides).

Nurses reported adjusting their plan of care according to the patient's infection risk, taking into account a patient's medical diagnosis and their ability to manage their condition. Patients believed to be at a higher risk for re-hospitalization (or infection) are frontloaded, where nurses choose to see them more frequently at the beginning of their home care episode (Q38 & Q39). In addition, nurses were cognizant of factors that affected their patients' infection risk and would plan or time their visits accordingly, to reduce the probability of transmitting infection between patients. For example, one nurse reported organising her visits so that she would visit a patient with MRSA after visiting an elderly patient with a catheter she judged as being at a high risk of infection, to try and reduce the risk of infection transmission:

> *"And what I would always try to do is I would try to see the 106-year-old patient first and then I would go to the MRSA patient. ...because I felt that even as much as you try to be careful with hand washing and stuff, I didn't want to run the risk of potentially infecting that patient."* [ID206]

Nurses were very aware of the limits of what they could do, particularly related to a patient's home environment and general levels of cleanliness. They discussed being able to '*do the best you can'* given that they are in someone else's home environment. One nurse discussed the limitations of their ability to change a patient's environment, focusing on educating them

about their behaviour (something they could impact) rather than tackling wider environmental issues. They discussed strategies they used in home environments to ensure that they minimised contamination and transfer of infection between houses (Q40).

4. Discussion

The aim of this study was to identify if, and how, home care nurses identify patients at high risk of infection, and the infection prevention and control strategies they use to prevent or reduce that risk. Our analysis established the importance of the clinical context of infection control practice in a home care environment, where environmental risks are prevalent and best practice depends on the patient's specific clinical situation (e.g., MRSA). Many of the interviewed nurses highlighted how they did not explicitly assess patients for their risk of infection. However, nurses may identify a combination of factors during their comprehensive assessment of the patients that would signal to nurses that patients may be at a higher risk.

The process of assessment is one of collecting and evaluating information to reach judgements about a patient's condition (Lamond et al., 1996). Nurses in this study reported collecting information from a variety of sources (referral notes, discharge notes, verbal reports from patients and their families, verbal reports from other clinicians and the nurse's own observation) to inform their judgements. The quality and accuracy of these sources was often questionable, meaning nurses used a triangulation approach to try to collect the information they needed. In addition, the assessment process was complex, involving the evaluation of a variety of different types of information regarding patients' medical history (including history of infection), any co-morbidities, their physical and mental status, their social support network and home environment. Although there were some commonly identified factors that place patients at increased risk (e.g. increased age, presence of diabetes

or other conditions where the individual was immunosuppressed), there were also specific factors for particular types of infection. For example, a profile for a patient seen to be at risk for a UTI was different to a patient at risk of a respiratory infection.

Existing research examining risk of infection in home care patients is sparse. However, the nurses in our study did identify risk factors that have been associated with an increased risk of infection, such as the presence of a Foley catheter or IV line (Shang et al., 2014). They also listed many of the predictors for infection identified in previous research that developed a prediction model using OASIS data (Shang et al., 2019) such as problems with mobility, the presence of wounds/skin ulcers and having a caregiver who needs education in the home. The results of our study suggest that future research should focus on developing risk prediction models for patients at risk of different types of infection (such as a UTI or wound infection). This would potentially enable further targeting of resources to ensure infection prevention focuses on the specific areas of risk for different groups of patients.

Nurses in home care operate in a very different clinical setting to nurses working in acute care environments, and this means that the intervention strategies developed for acute care may not meet all the needs to prevent infections in the home environment. Good hand hygiene is key for infection prevention in all settings including home care (Bloomfield et al., 2007, Embil et al., 2009), and the nurses in our study discussed this as a way of preventing infections in their practice. Overall the nurses interviewed in our study demonstrated good knowledge and understanding of infection prevention and control policies and procedures, echoing findings of a survey of home care nurses knowledge, attitudes and self-reported infection control behaviours (Russell et al., 2018). However, in contrast to an acute care setting, patients in home care may be managing their own condition (for example changing

their own dressing) or have family members or other caregivers carrying out care activities, in-between nurse visits. This means that home care nurses are reliant on patients and informal caregivers to practice good infection prevention interventions; the assessment of an individuals' ability to learn/practice such behaviours, and the provision of education and training, were reported by nurses in this study as a large part of their practice. Existing guidelines highlight the importance of training staff in infection prevention policies and practices (Centers for Disease Control and Prevention, 2016), and educating patients about the importance of hand hygiene in acute care settings (Loveday et al., 2014). There are a few studies that have examined the effectiveness of education programs for patients in inpatient settings to improve their hand hygiene (Srigley et al., 2016), which suggest that they may reduce HAIs. However, the quality of existing studies is low, and it is unclear what elements of an intervention, including the provision of education to patients and/or staff members, lead to hand hygiene improvements (Srigley et al., 2016). There is a significant gap in the evidence to assist home care nurses identify the best ways of educating their patients about good hygiene practices.

Cleanliness of the environment (Collins, 2008) and the isolation of individuals with drug resistant organisms such as MRSA (Smith et al., 2008), as well as ensuring basic washing facilities (World Health Organisation, 2010), are all discussed as factors to ensure infection prevention in acute and long term care settings. In home care, these issues are out of the control of the nurse, who can only provide guidance to patients on what they may need to do to keep their home clean, or in some circumstances (e.g. for severe hoarding) refer the patient to a social worker. They reported developing practices to reduce the risk of transmission between patient visits, including 'making up' rules (developing strategies) for where to sit/stand and put their equipment. Having to discuss cleanliness and sanitation with patients

was seen as challenging by nurses in the study; they had to take into account the patient and/or family's ability to understand information, cultural beliefs that affect behaviour and the resources of the patient/family to be able to act on their advice (Shim, 2010). These cultural factors may have important implications for patient-provider interaction dynamics. Future research should explore in greater detail how the social and environmental context in which patients live relates to their infection control beliefs and practices—and by extension their risk of developing infection. In circumstances where nurses felt patients or their family were at extreme risk, they altered their care plans accordingly. One strategy they reported using was that of 'frontloading' (organising one's schedule to see patients more frequently earlier in their home care service period), an intervention that (together with physician visits) reduces the risk of hospitalisation in home care patients (Deb et al., 2019, Murtaugh et al., 2017). It is unclear however if this is a useful intervention specifically for patients judged by a nurse to be at increased risk of infection. In addition, they also discussed managing the timing of their visits, to ensure that they reduced the risk of transmission of infection between patients, if one was identified as having an infection and the other at a higher risk of getting infections. The ability to have flexible work schedules and self-scheduling of appointments is highly valued by home care nurses (Irani et al., 2018), and this aspect of their work to reduce infection risk also requires further research.

4.1 Study Limitations

This study was conducted in one home care agency in the north eastern region of the USA, which serves an ethnically diverse and largely urban population. Whilst we have provided details on the context and setting of the study it is possible our findings may not be transferable to other home care agencies and settings. Overall the nurse participants in the study were experienced home care nurses. A previous survey highlighted potential

differences in compliance with infection control practices depending on nurses' age and experience (Russell et al., 2018), and further research would need to explore if and how this impacts on nurses infection risk judgements and infection control practices.

4.2 Conclusion

This study used semi-structured interviews to explore home care nurses' identification of patients at risk of developing infections and strategies they used to reduce or prevent infections. It highlights the complexity of the risk assessment process, and the importance of having reliable and accurate information available to nurses at the time of admission to home care, to enable them to plan their care effectively. Existing guidelines for infection prevention and control do not adequately cover the home care environment and more research needs to be conducted into interventions (such as patient/carer education) to prevent infections in the home care setting.

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