



Nurses' reports of staffing adequacy and surgical site infections: A cross-sectional multi-centre study



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ABSTRACT

Background: It is indicated that healthcare personnel's perceptions of the work environment may reflect the clinical outcomes for the patients they care for. However, the body of evidence is inconsistent when it comes to the association between work environment and surgical site infection.

Objectives: The aim of this study is to examine the associations between nurse-reported characteristics of the work environment and incidence of surgical site infections after total hip arthroplasty.

Design and settings: This is a cross-sectional multicentre study conducted in 16 Norwegian hospitals.

Participants: Clinical outcomes for 2885 patients > 18 years that underwent total hip arthroplasty are combined with work environment descriptions from 320 nurses.

Materials and methods: We combine data about surgical site infections from The Norwegian Surveillance System for Antibiotic Consumption and Healthcare-Associated Infections and hospital characteristics such as overall survival probability (from administrative patient data) and nurses' reports of characteristics of the work environment (from a multicentre survey among nurses in Norwegian hospitals). Stepwise mixed-effects logistic regression model was performed to examine the associations between characteristics of the work environment and surgical site infections.

Results: The incidence of surgical site infection among 2885 patients undergoing total hip arthroplasty in 16 Norwegian hospitals was 2.6%. Older age, elective procedures and high scores for staffing adequacy were associated with risk for surgical site infection. The association between high scores for adequate staffing and low risk for surgical site infections was present for patients that were admitted for an elective procedure, but not for patients admitted for a non-elective procedure.

Conclusion: Our results show that the risk of surgical site infections after elective total hip arthroplasty was lower in hospitals where nurses assessed staffing as adequate. Our findings add to the existing literature that examines the linkage between work environment and clinical outcomes.

What is already known about the topic?

- Healthcare associated infections are associated with understaffing, high bed occupancy and workload.
- The body of evidence is inconsistent when it comes to the association between work environment and surgical site infection.

What this paper adds

- Nurses' perceptions of staffing adequacy are associated with risk for surgical site infection after planned total hip arthroplasty.

- The interaction between staffing adequacy and procedure type emphasizes the complexity of healthcare organisation and evaluation of clinical outcomes.

1. Background

Surgical site infections are among the most common complications after orthopaedic surgery (Ohrn et al., 2012), and it is suggested that 55% of surgical site infections are preventable (Umscheid et al., 2011). In a systematic review the authors concluded that surgical site infections could be reduced to less than 1% after procedures classified as

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clean (Alexander et al., 2011). Total hip arthroplasty is a clean surgical procedure, yet, the incidence of surgical site infections after this procedure is normally higher than 1%, and this kind of complication exposes patients to serious consequences such as pain, disablement, and mortality (Gagliardi et al., 2009). Moreover, prolonged hospitalisation and readmissions due to surgical site infections lead to increased costs for the health care system (Alexander et al., 2011; Lasater and McHugh, 2016). Efforts to reduce the incidence of these infections have traditionally been targeted towards improvement of clinical processes related to the surgical procedure such as preoperative body hair removal by use of clippers (Kapadia et al., 2013) and patient preparation such as smoking cessation (Duchman et al., 2015; Gagliardi et al., 2009; Nessim et al., 2012). The inconsistent results of such interventions have been explained by lack of adherence to recommended guidelines. However, it is questioned whether a high adherence to guidelines is sufficient to reduce the incidence of surgical site infections (Gagliardi et al., 2009; Hawn et al., 2011). A qualitative study evaluating prevention practices for surgical site infections emphasized that organisational strategies such as enhancement of multidisciplinary teamwork are necessary to reduce infections (Nessim et al., 2012), and in a recent review, the authors address the hospital management and organisational features to identify crucial elements for prevention of healthcare associated infections (Zingg et al., 2015). The acknowledgement of an organisational approach towards quality and safety issues in healthcare has made the system perspective more influential during the last two decades. In research prompted by the recognition that errors occur in complex systems, it has been suggested that organisational transformation may be necessary to make sustainable quality improvements possible (Braithwaite et al., 2015; Leape et al., 2009).

According to James Reason's theory of human error, a complex organisation possesses different defensive layers to prevent the occurrence of errors (Reason, 2000). Some of these layers are related to the physical environment, for example by having a safe and appropriate laminar air flow system in the operation theatre. Other layers rely on people, for example by the skills of members of the operating team to avoid contamination of the sterile field. Procedures and administrative controls are layers that protect against process failures, for example double checking administration of antibiotic prophylaxis. However, the defensive layers may have lapses that compromise the protection against accidents. The double check of antibiotic prophylaxis may for example be missed if the ward personnel is uninformed about when the patient is scheduled for surgery. Latent conditions of the layers may protect against or provoke errors through conditions within the local workplace (for example by prolonged preoperative waiting time, understaffing and problems with communication) (Reason, 2000). In an adaptation of Reason's model for use in healthcare, error producing conditions are classified in seven levels of safety: patient factors, task and technology factors, individual staff factors, team factors, working conditions, organisational environment and the wider institutional context (Vincent, 2003).

Research showing that healthcare personnel's perceptions of their work environment are associated with clinical outcomes, supports this framework. Nurses constitute a large proportion of healthcare personnel, and hold key roles in the healthcare delivery. They spend more time close to the patients than other healthcare professionals and collaborate with all providers of care in the hospital. Their assessments of the work environment are therefore considered important indicators for organisational characteristics that have been associated with quality of care (Stalpers et al., 2015). Nurses' evaluations of teamwork, work pressure and leadership are associated with patient outcomes such as mortality, failure to rescue, length of stay and health status after discharge (Aiken et al., 2008; Bae, 2011; Kee et al., 2005; Shang et al., 2012; Smeds-Alenius et al., 2016; Stone et al., 2007). Moreover, associations between nurses' work environment and clinical outcomes such as mortality and readmissions has been addressed by several researchers (Cho et al., 2016; Ma et al., 2015; McHugh and Ma, 2013;

McHugh et al., 2016; Stalpers et al., 2015; Tvedt et al., 2014). However, we were not able to find studies that described the relationship between work environment and healthcare associated infections, even though healthcare associated infections are associated with nurse staffing, high occupancy and high workload (Hugonnet et al., 2004; Stone et al., 2008; Zingg et al., 2015). In previous research, we showed that hospital mortality was associated with nurses' assessment of staffing adequacy, but not with the nurse-patient ratio (Tvedt et al., 2014). We therefore assume that nurses' assessments of the work environment represent characteristics of the organization that is relevant for performance and quality of care of the hospitals. To our knowledge, the relationship between work environment and surgical site infections has not previously been studied. The objective of the present study is to examine the associations between work environment and surgical site infections after total hip arthroplasty. Total hip replacement is a clean procedure, and it is anticipated that the infection rates are low. However, the incidence of surgical site infections varies between hospitals, and organisational characteristics such as nurses' work environment may be indicators for hospital performance and consequently the infections rates.

2. Objectives

The aim of this study is to examine the associations between nurse-reported characteristics of the work environment and incidence of surgical site infections after total hip arthroplasty.

3. Methods

3.1. Design

In this cross-sectional multicentre study, we combined variables from three sources:

1) Descriptions of nurse-reported characteristics of the work environment from a cross-sectional survey (2009).

- Staffing adequacy
- Nurse-physician relationship
- Quality system
- Patient safety management
- Quality of nursing

2) Probabilities of being alive within 30 days after hospital admission reported for patients discharged from Norwegian hospitals, i.e. for diagnoses included in the group of diagnoses causing 80% of hospital deaths (2005–2009).

- Overall survival

3) Data from The Norwegian Surveillance System for Antibiotic Consumption and Healthcare-Associated Infections (NOIS) to determine the incidence of surgical site infections after total hip arthroplasty (2005–2009).

- Age
- Gender
- Procedure type (elective/non-elective)
- Surgical site infection status after total hip arthroplasty (dependent variable)

3.2. Settings

The present study included patients from 16 Norwegian hospitals with 20 wards specialized in orthopaedic care. The included hospitals make up 46% of the 35 Norwegian hospitals that had more than 90 beds in 2009.

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