Exploring the incidence and nature of nursing-sensitive orthopaedic adverse events: A multicenter cohort study using Global Trigger Tool

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A B S T R A C T

Background: For decades, patient safety has been recognized as a critical global healthcare issue. However, there is a gap of knowledge of all types of adverse events sensitive to nursing care within hospitals in general and within orthopaedic care specifically.

Objectives: The aim of this study is to explore the incidence and nature of nursing-sensitive adverse events following elective or acute hip arthroplasty at a national level.

Design: A retrospective multicenter cohort study.

Outcome variables: Nursing-sensitive adverse events, preventability, severity and length of stay.

Methods: All patients, 18 years or older, who had undergone an elective (degenerative joint disease) or acute (fractures) hemi or total hip arthroplasty surgery at 24 hospitals were eligible for inclusion. Retrospective reviews of weighted samples of 1998 randomly selected patient records were carried out using the Swedish version of the Global Trigger Tool. The patients were followed for readmissions up to 90 days postoperatively throughout the whole country regardless of index hospital.

Results: A total of 1150 nursing-sensitive adverse events were identified in 728 (36.4%) of patient records, and 943 (82.0%) of the adverse events were judged preventable in the study cohort. The adjusted cumulative incidence regarding nursing-sensitive adverse events for the study population was 18.8%. The most common nursing-sensitive adverse event types were different kinds of healthcare-associated infections (40.9%) and pressure ulcers (16.5%). Significantly higher proportions of nursing-sensitive adverse events were found among female patients compared to male, \( p < 0.001 \), and patients with acute admissions compared to elective patients, \( p < 0.001 \). Almost half (48.5%) of the adverse events were temporary and of a less severe nature. On the other hand, 592 adverse events were estimated to have contributed to 3351 extra hospital days.

Conclusions: This study shows the magnitude of nursing-sensitive adverse events. We found that nursing-sensitive adverse events were common, in most cases deemed preventable and were associated with different kinds of adverse events and levels of severity in orthopaedic care. Registered nurses play a vital role within the interdisciplinary team as they are the largest group of healthcare professionals, work 24/7 and spend much time at the bedside with patients. Therefore, nursing leadership at all hospital levels must assume responsibility for patient safety and authorize bedside registered nurses to deliver high-quality and sustainable care to patients.

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What is already known about the topic?

- Patient safety has been recognized as a critical global healthcare issue.
- Rates of adverse events are still high in in-hospital care, especially in the orthopaedic field.
- Professional nursing care is crucial to prevent patients from being affected by adverse events.

What this paper adds

- This study, with weighted samples, demonstrates that 36% of the patients with hip arthroplasty suffered at least one nursing-sensitive adverse event, and female patients and patients with acute admissions had higher proportions of nursing-sensitive adverse events.
- All types of nursing-sensitive adverse events were included and healthcare-associated infections, such as urinary tract infections and soft tissue infections, as well as pressure ulcers, were most common and a majority was assessed as preventable.
- Nursing-sensitive adverse events contributed to a substantial amount of extra in-patient days.

1. Background

For decades, patient safety has been recognized as a critical global healthcare issue. The World Health Organization defines patient safety as the absence of preventable harm to a patient and reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum (World Health Organization, 2006). Although most of the care given in hospitals is safe, hospital care nevertheless always involves the risk of an adverse event (AE). The presence of AEs reflects the gap between the actual care given and optimal safe care, and it always entails some form of suffering for the affected patient (Duarte et al., 2015). AEs have been shown to be common in in-hospital care (Hibbert et al., 2016; Schwendimann et al., 2018), especially in surgical specialties (Anderson et al., 2013) with orthopaedics having one of the highest AE rates, up to 30.0% (Merten et al., 2015; Rutberg et al., 2016; Unbeck et al., 2013). Pukk-Härenstam et al. (2008) found that surgical specialties accounted for 88% of patient claims to the County Councils Mutual Insurance Company, but for only 46% of hospital discharges. Orthopaedic and hand surgery care had the highest claims rate. A systematic review (Schwendimann et al., 2018) found that the most common AE types were related to operative/surgical procedures and accounted for a median of 40% of all AEs. Several systematic reviews (Anderson et al., 2013; Hibbert et al., 2016; Schwendimann et al., 2018; Vries et al., 2008) have reported on in-hospital AEs and the incidence differs both within and between specialties, ranging from 3% to 62%. One of those reviews (Vries et al., 2008) showed that different kinds of surgical specialities accounted for a median of 58.4% of the AEs, while the corresponding medicine specialities was 24.1%. The review by Hibbert et al. (2016) reported that general inpatients, including different specialities within both medical and surgical care, had an AE range of 7–40%.

To prevent patients from being affected by AEs, professional nursing care is crucial (Marques da Silva de Paiva et al., 2010). The registered nurses’ responsibility includes considering risk factors, taking relevant precautions in the planning of care, improving quality of care, and ensuring that all interventions are based on evidence (Smith et al., 2017). Despite this, the role nursing care can play in the prevention of patients’ suffering from AEs has not been given sufficient attention since many patients at risk do not receive adequate preventive care. For example, none of the studied patients at-risk of falling had adequate preventive interventions according to existing guidelines (Van Gaal et al., 2014). A national study (Bååth et al., 2014) including 39,271 inpatients concludes that, despite a pressure ulcer prevalence of 16%, the use of preventive interventions was not on an acceptable level.

There is a gap of knowledge of AEs sensitive to nursing care within hospitals in general and within orthopaedic care specifically, and we have been unable to identify AE studies sensitive to nursing care within this specialty. AE studies with a nursing focus have had different study designs and data collection methods such as interviews, observations, surveys, clinical incident reports and record reviews (Duarte et al., 2015), making comparison difficult. In some studies, which often use record review, the focus has been on predefined AEs, such as adverse drug events, medication administration errors, pressure ulcers, falls, urinary tract infections or in-hospital mortality (D’Amour et al., 2014; De Meester et al., 2013; Duarte et al., 2015; Van Gaal et al., 2014). Other studies have focused on, for example, staff perceptions of facing AEs, knowledge regarding AEs, and motivation to report AEs (Duarte et al., 2015). We conclude that there is a lack of knowledge regarding all types of AEs sensitive to nursing care in general, and also to patients operated with a hip arthroplasty. Patients who undergo hip arthroplasty, either elective due to osteoarthritis or acute due to a hip fracture, are a common patient group in orthopaedic departments. Therefore, this study aims to explore the incidence and nature of nursing-sensitive AEs following hip arthroplasty on a national level.

2. Methods

2.1. Study design

This sub-study is part of a retrospective multicenter cohort study (Magnéli et al., 2019), VARA (Validation of Register data after Hip Arthroplasty). The aim of the main study was to validate the ability of a set of predefined ICD-10 codes used on a national level to compare hospitals, detect AEs, and calculate the incidence of AEs following primary hip arthroplasties. The method and variables are the same for both the main study and this sub-study and are presented below.

2.2. Data sources

The study was based on three data sources: the Swedish Hip Arthroplasty Register, National Patient Register, and patient records.

All public and private orthopaedic units in Sweden performing hip arthroplasty report to the Swedish Hip Arthroplasty Register on a voluntary basis. The completeness of the register is about 98%. The participants in the study were recruited from the Swedish Hip Arthroplasty Register.

The National Patient Register includes data on all inpatient and outpatient care. Information is delivered to the register once a month from all regions in Sweden. The participants were identified by cross-linking data from the Swedish Hip Arthroplasty Register and the National Patient Register using the personal identification number and surgery date. Used for identifying each registered individual in Sweden, the personal identification number is a lifelong, unique 12-digit number consisting of the date of birth and four control digits. A statistician at the National Board of Health and Welfare performed the cross-linking.

Retrospective reviews of patient records were carried out using the Swedish version (SALAR, 2012) of the Global Trigger Tool (GTT) (Griffin and Resar, 2007) to identify AEs in the study cohort. The GTT is a two-stage retrospective record review process.
2.3. Variables from registers

From the Swedish Hip Arthroplasty Register, we collected the date and type of primary surgery. From the National Patient Register, the following variables were collected: ICD-codes, age, sex, admission type, dates for index admissions, readmissions, and acute outpatient visits, e.g. an unscheduled appointment in response to an acute or emergency health issue, at all Swedish hospitals up to 90 days postoperatively. With this data, we created a timeline for each primary surgery. This timeline was used as a template to know which admissions to review with the GTT. The variables collected in the review process are presented in Section 2.5.5.

2.4. Participants, setting and selection process

All patients older than 18 years of age who had undergone an elective (degenerative joint disease) or acute (fractures) hemi or total hip arthroplasty surgery between January 2009 and December 2011, and who had been reported to the Swedish Hip Arthroplasty Register, constituted the study population, and were eligible for inclusion in the study (N = 21,774 admissions with primary surgery). The study cohort consisted of 2000 primary surgery inpatients who had their index admission in 24 hospitals within four regions (Stockholm County Council, Region Västra Götaland, Region Skåne and Västerbotten County Council). The hospitals consisted of six university hospitals, five county council hospitals, seven local hospitals and six private hospitals that had agreements or contracts with the regions. All hospitals provided both acute and elective care except for five hospitals, which only conducted elective care.

The patients were followed for up to 90 days postoperatively for all inpatient and acute outpatient hospital care throughout the whole country, regardless of index hospital. The study cohort had a total of 5423 admissions in 16 regions out of 21 with 69 hospitals involved as the individual patients may have had multiple care episodes.

We used a weighted sample to optimize the selection of admissions with a possible AE and included a larger sample in the groups at high risk of AEs, such as long length of stay and readmissions. We, therefore, sampled from three groups of different percentiles of length of stay (0–55%, 56–80%, 81–100%) and more samples were drawn from the higher percentile groups. The three groups were divided in the cases of predefined ICD-10 codes (Appendix, Table A1) indicating an AE in the National Patient Register. More samples were drawn from the groups that had one of the predefined ICD-10 codes. Furthermore, we created two groups with readmissions within 30 and 31–90 days after surgery. These groups were also divided by ICD-10 codes and more samples were drawn from the groups with ICD-10 codes. This procedure was applied for both acute and elective patients, which resulted in 20 sampling groups in total. The different sampling groups and the proportion of the study cohort in relation to the study population is shown in Appendix, Table A2.

2.5. Record review process

2.5.1. Recruitment and education of reviewers

The recruitment of the ten reviewers (registered nurses, medical students and physicians) was based on previous experience with record review and/or convenience (Appendix, Table A3).

A study manual, as a complement to the Swedish GTT manual with trigger definitions and descriptions, was created to clarify the study-specific interpretations and applications of triggers, definitions and AE assessments. Some of the reviewers had been involved in the development of the study design and manual.

An obligatory education day in the GTT methodology was carried out for the reviewers, research group and panel of specialists in orthopaedic surgery or internal medicine (Appendix, Table A3). During the process of familiarization with the GTT method and the study manual, each reviewer independently read the two manuals and reviewed seven training records before the education day to make effective use of their time. The training records were chosen to highlight key learning points for AEs and for the study. During the education day, apart from a lesson in the GTT methodology, the training records, which included the interpretation and application of the triggers, study definitions, and other related matters, were thoroughly discussed among the participants to learn and reach consensus on how to assess AEs.

2.5.2. Definitions

In the review process, an AE was defined as suffering from physical harm or disease, as well as death, related to the orthopaedic index admission that was not an inevitable consequence of the patient’s underlying condition/disease or treatment.

Based on the terminology in the Swedish Patient Safety Act (Swedish Code of Statutes, 2010:659), a preventable AE was defined as an event that could have been prevented if adequate actions had been taken during the patient’s contact with healthcare professionals.

Inspired by a definition of nursing-sensitive performance measurements from National Quality Forum (2004), we defined a nursing-sensitive AE as an AE that is affected and/or influenced by nursing professionals, but for which nursing is not exclusively responsible and the relationship is not necessarily causal. Examples of AEs unlikely to be nursing-sensitive were foot drop, peripheral nerve lesions and fractures during surgery.

2.5.3. Inclusion and exclusion criteria

The record review and inclusion of an AE period covered the time frame from admission when the patient had the hip arthroplasty surgery to a maximum of 90 days postoperatively.

The AE must be related to acts of omission or commission originated from index admission. The AE could be identified in both inpatient and outpatient care, irrespectively of speciality, at any hospital within Sweden in the follow-up period.

An AE that occurred within 90 days postoperatively but was detected later was excluded; for example, infection symptoms starting within 90 days but the patient visited healthcare due to those after the 90 days. AEs that occurred before the index admission, but was detected during it, and AEs related to care within other specialties were also excluded. A second AE associated with a primary AE, such as a pressure ulcer developed at a readmission for a pulmonary embolism, was also excluded since the main study focused on AEs related to index admission. Furthermore, records from outpatient care outside the hospitals, such as from a general practitioner, were not included.

2.5.4. Review stage 1

Most records were available via the electronic patient record system used by the respective caregiver or institution. In some cases, the research group needed to request a paper copy from the individual caregiver, or travel to the caregiver to obtain copies of the records.

The reviews were carried out in a two-stage procedure. In most cases, the same person carried out both review stage 1 and 2. This same approach has been used, for example, in another multicenter study (Lindblad et al., 2018).

The national GTT manual (SALAR, 2012), with the associated trigger list, descriptions and study manual, was used as decision support in both review stages.

In the first review stage, all records were reviewed for up to 90 days postoperatively without any time restriction. All healthcare professionals’ notes were reviewed. The reviewers screened for
the presence of one or more of the 38 predefined triggers in five modules of the Swedish version of the GTT (Appendix, Table A4). The perinatal triggers were not used in this study. For each detected trigger the reviewer judged whether or not it reflected the presence of a potential AE. Only records with triggers indicating at least one potential AE went forward to review stage 2.

2.5.5. Review stage 2
Since the GTT methodology only includes a few variables in the classifications of an AE, we were inspired by the Harvard Medical Practice Study protocol with its subsequent modifications (Leape et al., 1991; Soop et al., 2009; Wilson et al., 1995) when creating a suitable classification scheme for review stage 2.

In review stage 2 the reviewers sorted the different triggers into potential AEs since several triggers can be involved in one AE. Every potential AE was then reviewed separately. To qualify as an AE, a score of three or higher on a 4-point Likert scale was required (1—the AE was not related to index admission, 2—the AE was probably not related to index admission, 3—the AE was probably related to index admission, and 4—the AE was related to index admission).

The reviewers assessed and documented each AE according to the following variables:

- Preventability was assessed using a similar 4-point scale (SALAR, 2012). An AE was judged to be preventable if it was classified as three or four.
- Severity was judged using a slightly modified version of the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) Index (www.nccmerp.org). NCC MERP Index categories E–I were included: E) contributed to or resulted in temporary harm; F) contributed to or resulted in temporary harm that prolonged hospitalization, required outpatient care or readmission; G) contributed to or resulted in permanent harm; H) required intervention necessary to sustain life within 60 min; or I) contributed or resulted in the patient’s death.
- Date of first AE symptom or detection date, if the date of symptom could not be determined.
- The type of AE classified by the kind of harm that affected the patient.
- If the AE had a correct ICD-10 code in the physician’s discharge summary.
- Location of occurrence.
- Estimated numbers of extra hospital days. AEs with a severity classified as NCC MERP categories F–I can generate extra hospital days. AEs classified as NCC MERP category F with 0 extra hospital days had extra outpatient care at a hospital. In the Swedish version (SALAR, 2012) of this NCC MERP category, the text “extra outpatient care” has been added since several AEs nowadays are mostly treated in outpatient care, such as deep vein thrombosis.
- Which work activities were present (commissions) or should have been present (omissions) when the AE occurred. Several work activities per AE could be chosen. The attribution to nursing care relates to the reviewers’assessments regarding the respective AE’s potential link to nursing care. This does not include work activities that were involved when the AE was detected/treated. In some other studies, the included items in this variable can be found among the following: types of AEs (Leape et al., 1991; Schwendimann et al., 2018); clinical categories (Wilson et al., 1995); types of errors (Leape et al., 1991); or causes of AEs (Anderson et al., 2013; Soop et al., 2009).
- If the AE occurred in the pre-, peri- or postoperative phase of care.
- Contributing potential causes to AEs.
- Triggers related to the AE.

All review data from review stages 1 and 2 were entered into a study database. During the review process, support was available via personal meetings, e-mail or telephone, primarily from one of the researchers (MJ). A panel of specialists was also available for consultation when needed by the reviewers (Appendix Table A3).

2.6. Reliability and validity
Inter-rater reliability was evaluated in review stage 1. Six percent of the records (n = 125 records including 151 potential AEs) were randomly selected and double-reviewed to assess agreement between the primary reviewers’ judgments concerning whether at least one trigger or potential AE was identified in the record if the record was to be forwarded to secondary review, if they found the same specific event and if this event was a potential AE. The reviewer pair comprised of one skilled and one less skilled in using structured record review.

The judgments in the double-reviewed records were discussed between reviewers to reach consensus and to form the basis for reviews in stage 2.

A record review expert (MU) monitored all reviews from stage 1 and 2 for completeness and adherence to the trigger definitions and study manual. The secondary reviewers’ outcomes were compared with the primary reviews, trigger definitions and descriptions, and the study manual and methodology. All questions or discrepancies were referred back to the reviewers for resolution. If discrepancies were found, clarifying discussions were held with the respective reviewer. No double review was performed in review stage 2 since this thorough monitoring process was used.

The inter-rater reliability of the primary reviewers’ judgments, concerning whether at least one trigger or potential AE was identified in the record, was κ = 0.828 (strong agreement) and 0.965 (almost perfect agreement), respectively. The inter-rater reliability, if the record was to be forwarded to secondary review, was κ = 0.965 (almost perfect agreement). The inter-rater reliability for the identification of a specific event, or if that event was a potential AE, was κ = 0.65 (moderate agreement) and 0.873 (strong agreement), respectively.

2.7. Statistics
In the analyses, we included all nursing-sensitive AEs classified in the variable work activities in review stage 2.

Data are presented as number (%) and median (range). We calculated the cumulative incidence of AEs over the review period.

The adjusted cumulative incidence of AEs in the population was calculated by dividing the number of patients with a nursing-sensitive AE in each sample group with the sample group size, generating a rate for the respective group. This rate was multiplied by the group proportion (population group/total population). The products of all groups were summed to provide the adjusted cumulative incidence (Appendix Table A2). The same method was used to calculate the adjusted cumulative incidence of preventable AEs.

Comparison of the difference between two independent proportions was tested using the Z test, and 95% CIs was calculated. A p-value <0.05 was considered to be statistically significant. Cohen’s Kappa (Cohen, 1960) was calculated for inter-rater reliability between the primary reviewers.

We used R v. 3.4.3 with the packages tidyverse, z.test, irr and htmlTable.

2.8. Ethical approval
Ethical approval was provided by the Regional Ethics Committee of Gothenburg (516-13 and T732-13), and the study was carried
out in accordance with the guidelines set down in the Helsinki Declaration. The head of each respective hospital unit granted permission to access data for the reviewers. This is a register and record-based retrospective study with no patient involvement.

3. Results

Of the 2000 primary surgeries in our study cohort, two patients were excluded. The first had no available medical record and the second was a patient who had been incorrectly registered in the Swedish Hip Arthroplasty Register. After exclusion, 1 998 patients remained and were reviewed and included in the analysis. As shown in Table 1, the patients had a median age of 77 years, consisted of a majority of female patients (62.6%) and elective admissions (66.6%), and had a median length of stay of seven days at the index admission. The majority of the patients (71.2%) received a total arthroplasty.

Female patients had a significantly higher proportion of nursing-sensitive AEs compared to male patients, 38.3% vs. 33.3%, difference 5.0% (95% CI 0.6–9.4, p < 0.001). The same was found for patients with acute admissions compared to elective patients, 56.4% vs. 26.4%, difference 30.0% (95% CI 25.3–34.5, p < 0.001).

A total of 1150 nursing-sensitive AEs, 54.3% of all 2116 AEs in the study cohort, were identified in 728 (36.4%) patients with a median number of 1 (range 1–8) per affected patient. Of the 1150 nursing-sensitive AEs, 943 (82.0%) were deemed preventable (Table 2). When adjusted for the weighted sample selection design, the adjusted cumulative incidence regarding nursing-sensitive AEs for the study population was 18.8%, and the corresponding adjusted cumulative incidence for preventable nursing-sensitive AEs was 16.5% (Table 2).

The most common nursing-sensitive AE type was healthcare-associated infections (40.9%), followed by pressure ulcers (16.5%), skin, vessel and tissue harm (10.3%), dislocation of the prosthesis (8.0%), and urinary retention (7.3%). Of these five most common nursing-sensitive AEs, preventability ranged from 98.4% to 69.7% (Table 3).

Most nursing-sensitive AEs occurred in the postoperative phase of care (n = 1052, 91.5%). Seventy (6.1%) and 16 (1.4%) AEs occurred in the perioperative and preoperative phase, respectively. Twelve (1.0%) AEs were deemed not related to surgery.

Nearly half (n = 558, 48.5%) of the nursing-sensitive AEs were of a temporary and less severe nature and were deemed not to have affected the length of stay. AEs leading to temporary harm but increased length of stay, requiring hospital care or outpatient visits at a hospital, occurred in 35.6% of all AEs (Table 4). Five hundred and ninety-two nursing-sensitive AEs were estimated to have contributed to 3 351 extra hospital days with a median of three days (range 1–53) per AE and a cost of 15,123 063 SEK (close to 1.4 million EURO).

Of the 1150 nursing-sensitive AEs, 489 (42.5%) had an ICD-10 code for the respective AE in the discharge summary. For example, pressure ulcer had an ICD-10 code in 5.3% of the cases.

4. Discussion

This study aimed to explore the incidence and nature of nursing-sensitive AEs following hip arthroplasty on a national level. In this study cohort with weighted samples, 36.4% of the identified AEs were nursing-sensitive, and 82% of these were deemed preventable. The adjusted cumulative incidence regarding these AEs for the study population was 18.8%. Female patients and patients with acute admissions had higher proportions of nursing-sensitive AEs. Healthcare-associated infections and pressure ulcers were the most common nursing-sensitive AEs. Even though nearly half of the nursing-sensitive AEs was deemed not to have affected the length of stay, 592 nursing-sensitive AEs were estimated to have contributed to 3351 extra hospital days. Most of the nursing-sensitive AEs occurred in the postoperative phase of care, which is
not surprising since both the elective and most of the acute patients have surgery on day one or two.

It is difficult to compare our results because, to our best knowledge, there is no other study that has used retrospective record review and included all types of AEs. It is common with studies that include one nursing-sensitive AE at the time, for example, falls or pressure ulcers. D’Amour et al. (2014) included six predefined AEs and found that 15.3% of the patients were affected. Furthermore, 76.8% of the 568 identified AEs were deemed attributable to nursing care, of which 59.8% had a very high level of certainty compared to our results of 36.4%. Their high outcome may partly be because the six included AE types are previously known to be nursing-sensitive and our included AE types were not primarily chosen from that perspective.

It is difficult to compare systematic reviews (Anderson et al., 2013; Hibbert et al., 2016; Schwendimann et al., 2018; Vries et al., 2008) regarding AEs because the outcomes ranges from 3% to 62%. There are many factors that may affect the validity and reliability in record review studies. Reasons for variations in AE rates between studies may be related to different factors such as setting, AE definition, inclusion criteria, time frame for inclusion, inclusion of omissions, use of a review time limit, quality assurance strategies, case-mix of the patients, and documentation quality (Hibbert et al., 2016; Schwendimann et al., 2018; Vries et al., 2008). Factors related to variations in reviewer assessments, i.e. inter and intra reliability, include reviewer skills and experience, differing application and interpretations, hindsight bias, and training and education in the review method (Hibbert et al., 2016).

Whether AE related to surgical care is more common, compared to AEs affecting medical inpatients, or are simply more likely to be detected by patients and professionals is not well known (Gawande et al., 1999). Greater treatment complexity and invasiveness of

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Types of nursing-sensitive adverse events (AEs) and the proportion of preventable AEs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of nursing-sensitive AE</td>
<td>AEs, n (%)</td>
</tr>
<tr>
<td>Healthcare-associated infections</td>
<td>470 (40.9)</td>
</tr>
<tr>
<td>Kidney, urinary bladder</td>
<td>154 (32.8)</td>
</tr>
<tr>
<td>Skin, soft tissue</td>
<td>119 (25.3)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>95 (20.2)</td>
</tr>
<tr>
<td>Deep wound infection</td>
<td>46 (9.8)</td>
</tr>
<tr>
<td>Gastro intestinal</td>
<td>19 (4.6)</td>
</tr>
<tr>
<td>Septis</td>
<td>13 (2.8)</td>
</tr>
<tr>
<td>Unspecific infection</td>
<td>11 (2.3)</td>
</tr>
<tr>
<td>Oral</td>
<td>10 (2.1)</td>
</tr>
<tr>
<td>Genital</td>
<td>2 (0.4)</td>
</tr>
<tr>
<td>Eye</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Pressure ulcers</td>
<td>190 (16.5)</td>
</tr>
<tr>
<td>Category 1</td>
<td>86 (45.3)</td>
</tr>
<tr>
<td>Category 2</td>
<td>77 (40.5)</td>
</tr>
<tr>
<td>Category 3</td>
<td>18 (9.5)</td>
</tr>
<tr>
<td>Category 4</td>
<td>2 (1.1)</td>
</tr>
<tr>
<td>Category, unknown</td>
<td>7 (3.7)</td>
</tr>
<tr>
<td>Skin, vessel or tissue harm</td>
<td>119 (10.3)</td>
</tr>
<tr>
<td>Skin harm</td>
<td>81 (68.1)</td>
</tr>
<tr>
<td>Infiltration/extravasation</td>
<td>31 (26.1)</td>
</tr>
<tr>
<td>Thrombophlebitis</td>
<td>7 (5.9)</td>
</tr>
<tr>
<td>Dislocation of the prosthesis incl. re-operation</td>
<td>92 (8.0)</td>
</tr>
<tr>
<td>Distended urinary bladder</td>
<td>84 (7.3)</td>
</tr>
<tr>
<td>Deterioration of vital signs</td>
<td>49 (4.3)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>20 (40.8)</td>
</tr>
<tr>
<td>Central nervous system, e.g. acute confusion</td>
<td>16 (32.7)</td>
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<tr>
<td>Cardiovascular, e.g. cardiac arrest, heart failure</td>
<td>11 (22.4)</td>
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<tr>
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<tr>
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<tr>
<td>Leg</td>
<td>5 (26.3)</td>
</tr>
<tr>
<td>Heart</td>
<td>2 (10.5)</td>
</tr>
<tr>
<td>Brain</td>
<td>1 (5.3)</td>
</tr>
<tr>
<td>Pain</td>
<td>13 (1.1)</td>
</tr>
<tr>
<td>Severe obstipation</td>
<td>11 (1.0)</td>
</tr>
<tr>
<td>Allergic reaction</td>
<td>8 (0.7)</td>
</tr>
<tr>
<td>Skin harm</td>
<td>7 (87.5)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (12.5)</td>
</tr>
<tr>
<td>Ileus</td>
<td>7 (0.6)</td>
</tr>
<tr>
<td>Ulcer</td>
<td>7 (0.6)</td>
</tr>
<tr>
<td>Haemorrhage/haematoma</td>
<td>6 (0.5)</td>
</tr>
<tr>
<td>Neurological harm</td>
<td>5 (0.4)</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>2 (0.2)</td>
</tr>
<tr>
<td>Severe nausea and/or vomiting</td>
<td>5 (0.4)</td>
</tr>
<tr>
<td>Affected electrolytes</td>
<td>2 (0.2)</td>
</tr>
<tr>
<td>Dehydration</td>
<td>2 (0.2)</td>
</tr>
<tr>
<td>Other</td>
<td>12 (1.0)</td>
</tr>
<tr>
<td>Total</td>
<td>1150</td>
</tr>
</tbody>
</table>
Table 4

<table>
<thead>
<tr>
<th>Severity category according to NCC MERP index</th>
<th>AEs, n (%)</th>
<th>Preventable AEs, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E Contributed to or resulted in temporary harm</td>
<td>558 (48.5)</td>
<td>453 (81.2)</td>
</tr>
<tr>
<td>F Contributed to or resulted in temporary harm to the patient and required outpatient visit, hospital care, or prolonged hospitalization</td>
<td>409 (35.6)</td>
<td>322 (78.7)</td>
</tr>
<tr>
<td>G Contributed to or resulted in permanent patient harm</td>
<td>154 (13.4)</td>
<td>146 (94.8)</td>
</tr>
<tr>
<td>H Lifesaving intervention required within 60 min</td>
<td>7 (0.6)</td>
<td>6 (85.7)</td>
</tr>
<tr>
<td>I Contributed to patient's death</td>
<td>22 (1.9)</td>
<td>16 (72.7)</td>
</tr>
<tr>
<td>Total</td>
<td>1 150 (100)</td>
<td>943 (82.0)</td>
</tr>
</tbody>
</table>


care, compared to medical specialties, may increase the risk of an AE as AEs related to surgery have been found to be common (Schwendimann et al., 2018). In surgical care there are many work activities, pre-, peri- or postoperatively, that can lead to AEs. The types of AEs may vary between specialties. Some AEs, for example, postoperative infections, can never occur in specialties that do not carry out surgical procedures. Commissions or omissions in one specialty or procedure may lead to a minor AE, whereas a similar one in another specialty can lead to permanent disability (Leape et al., 1991). This makes it difficult to compare specialties and their impact on patients and severity. A study (Zegers et al., 2011) showed that AEs varied between hospitals and departments but that preventability only varied between departments. The authors state that interventions to improve patient safety should, therefore, be tailored to specialties and local contexts.

The findings reported here are particularly concerning concerning a national patient safety program launched in 2007 by the Swedish Association of Local Authorities and Regions. This program included areas of prioritized safety areas that targeted common AEs, such as pressure ulcers, fall-related injuries, urinary tract infections and surgical site infections. Evidence-based clinical guidelines to be used by the interdisciplinary team were developed. Despite having these guidelines and annual nationwide prevalence studies, findings from this study showed a relatively high number of nursing-sensitive AEs. Registered nurses’ clinical interventions play an important role in the quality of patient care, and the act of omitting nursing care can increase AEs as observed by Lucero and colleagues (Lucero et al., 2010).

Healthcare-associated infections were the most common nursing-sensitive AEs in this study. Of these infections, urinary tract infections, soft tissue infections, and pneumonia were most common, and most of them were assessed as preventable. These findings are consistent with a study (Rutberg et al., 2016) based on 38,566 admissions including both orthopaedic AEs and AEs from other specialties. During the time period from when this study sample derived, a common routine in Sweden was that patients undergoing hip surgery had an indwelling urinary catheter inserted before the surgery and the catheter was often not removed within 24 h as recommended by Swedish Association of Local Authorities and Regions. It is also essential that an aseptic technique be used when inserting the urinary catheter as well as when changing wound dressings. Pneumonia might be an indicator of either the patient’s oral hygiene, that the patient is laying in bed waiting for surgery, or that the patient is not receiving effective mobility training after surgery. A meta-analysis (Nordstrom et al., 2018) showed that rehabilitation by geriatric interdisciplinary teams increases physical function and mobility after hip fracture significantly compared to conventional care.

Pressure ulcers, an internationally accepted nursing-sensitive measurement, were the second most common, comprising 16.5% of all AEs. Studies from hospital settings in different countries report prevalence from 0% to 46% (NPUAP, 2014). Most common in this study were pressure ulcers category 1 (45%). One study (Cunningberg et al., 2015) showed that there is a shortfall in pressure ulcer prevention knowledge among nursing professionals in Sweden, concluding that a major educational campaign needs to be undertaken in both hospitals and nursing educations. The result of our study also supports that conclusion. The review by Niederhauser et al. (2012) concluded that an interdisciplinary intervention can be successful in reducing pressure ulcers. Therefore, all professionals must work as a team to implement sustainable prevention strategies.

Dislocation of the prosthesis (8.0%) might not be seen as a typical nursing-sensitive AE; however, educating the patient on what exercises he/she can do without risk of dislocation is important for all professionals in the interdisciplinary team. Helping the patient out of bed the first time after surgery should not be delayed while awaiting arrival of a physiotherapist. Ensuring patients are mobilized safely and often is critically important and the primary responsibility of nursing. However, preserving physical function is a responsibility of every member of the healthcare team. All care givers must have the appropriate knowledge and skill to safely mobilize and educate patients to mobilize safely.

We found that distended urinary bladder also was a common nursing-sensitive AE. It is well known that orthopaedic patients operated for total joint arthroplasty postoperatively have an increased risk of urinary retention (Balderi et al., 2011; Izard et al., 2006) compared to other surgical patients. Registered nurses should be aware of the risk and initiate prevention interventions both preoperatively and postoperatively to avoid urinary bladder distention. Ensuring adequate pain relief and providing assistance with toileting are strategies that can reduce the risk of urinary retention.

In total, 728 patients were affected by nursing-sensitive AEs, with female patients more common than male patients. Furthermore, the proportion of patients with nursing-sensitive AEs was much higher in the group of hip fracture patients compared to the elective group. This might reflect the fact that patients with hip fractures are often older, female, frail and with pre-existing health issues and, therefore, more prone to developing complications leading to AEs. However, risk factors are modifiable (Chang et al., 2018).

In the hip fracture group, AEs in the postoperative period have been shown as a major challenge both in patient outcomes and healthcare costs (Khasraghi et al., 2003). The suffering and economic burden of patients, relatives, staff, healthcare and society because of preventable AEs is substantial (Nilsson et al., 2018) and, therefore, the nursing society needs, in interdisciplinary collaboration, to take action to prevent these.

Another perspective of nursing-sensitive AEs is that of the workload experienced by registered nurses, often reported as patients/registered nurse ratios or care left undone (Ball et al., 2016; 2018; Lake et al., 2017). In this study, we did not have access to such data, but it cannot be ruled out that patients/registered nurse ratios or care left undone is a potential explanation for the differences among the groups or as a contributing cause to the AEs. It is also imperative that nursing professionals evaluate care delivery in order to increase understanding of what facilitates or hinders patient care so that AEs can be prevented. In addition to nurse/patient ratios and care left undone, perspectives to consider include, but are not limited to, how nursing teams are organized to enable registered nurses to identify and address subtle patient
changes, optimal skill mix for nursing teams, and how interdisciplinary teams work together.

The identified AEs in this study are within the area of responsibility of nursing professionals, but for which nursing is not exclusively responsible and the relationship is not necessarily causal. Registered nurses play a vital role in the interdisciplinary team since they are a large group of healthcare professionals, work 24/7 and spend much time directly at the bedside with patients. Ensuring patient safety requires registered nurses who are aware of risk factors and are vigilant to subtle changes that signal an AE. Therefore, even though, it can be demanding for nurse leaders, trying to meet organizational demands and priorities while also managing a high turnover of all members in the team, the nursing leadership on all hospital levels must associate responsibility for patient safety. Nursing leaders must support registered nurses, in collaboration with other professionals, to deliver high-quality, sustainable care patients. Leadership is a core element for well-coordinated and integrated provision of care (Sfantou et al., 2017) and leadership styles are strongly correlated with quality care and associated measures.

4.1. Strengths and limitations

One strength of the study was that it contains a large study population, including all types of AEs and patients both with acute hip fracture due to osteoporosis, as well as elective surgery due to osteoarthritis, and thereby including both total and hemi hip arthroplasties. Another strength of the study was the multi-center design with a wide range of patients of all ages and from different types of hospitals. The 90-day follow-up is long enough to detect different kinds of acute and subacute AEs. On the other hand, AEs that develop after this time frame will be missed as well as second AEs associated with primary AEs since that was an exclusion criterion. The GTI method used is well established. However, one limitation is that the retrospective record review has limitations since the review process relies on the judgments of the reviewers and they can only use the information that is available in the record. Therefore, AEs might be missed since it is known that the registered nurses often do ‘not make and record observations of symptoms, such as delirium or pressure ulcers, as it is assigned a low priority and often delegated to junior workers or support workers who might not have the requested expertise. It might also be considered a limitation that parts of the two-stage review were conducted by the same person.

5. Conclusions

Despite the fact that patient safety has been recognized as a critical global healthcare issue for decades, we are still facing safety challenges. Our findings demonstrate the magnitude of nursing-sensitive AEs, including all types of AEs, since other record review studies within the nursing field only include a predefined set of a few AEs. We found that these AEs were common, highly preventable and were associated with different kinds of AEs and levels of severity in orthopaedic care. The identified AEs in this study are within the area of responsibility of registered nurses who play a vital role in the interdisciplinary team. Therefore, the nursing leadership on all hospital levels must assume responsibility for patient safety and authorize registered nurses, in collaboration with other professionals, to deliver high-quality and sustainable care to patients.

Conflict of interest

None.

Credit authorship contribution statement

Ami Hommel: Data curation, Formal analysis, Writing - original draft. Martin Magnéli: Data curation, Formal analysis, Writing - review & editing. Bodil Samuelsson: Data curation, Writing - review & editing. Kristina Schildmeijer: Data curation, Writing - review & editing. Desirée Sjöstrand: Data curation, Writing - review & editing. Katarina E. Göransson: Formal analysis, Writing - original draft. Maria Unbeck: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Validation, Writing - original draft.

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Supplementary materials


References
