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Identifying Populations at Risk For Infection After Knee Arthroplasty: An Integrated Literature Review

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IDENTIFYING POPULATIONS AT RISK FOR INFECTION AFTER KNEE

ARTHROPLASTY: AN INTEGRATED LITERATURE REVIEW

by

CHRISTIAN E. COKER

A thesis submitted in partial fulfillment of the requirements

for the Honors in the Major Program in Nursing

in the College of Nursing

and in The Burnett Honors College

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Thesis Chair: Dr. Angeline Bushy, Ph.D., RN, FAAN, PHCNS-BC

Abstract

The purpose of this integrated review of the literature was to explore the postsurgical infection complications commonly occurring in individuals undergoing total knee replacement surgery, and the relationship of co-morbidities, lifestyle choices, and genetics on the risk for complication. A comprehensive search of the literature focusing on the patient surgical site infection and total knee replacement surgery using the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Medical Literature On-line (MEDLINE). Initial searches revealed 80 results. Upon closer scrutiny, duplicates were removed, as well as those not relevant to infection in total knee arthroplasty. This resulted in a review of 6 articles that fit the inclusion criteria. Inclusion criteria were articles written in the English language and published in scholarly, peer-reviewed, journals from 2009 to present. In addition to published articles, pertinent material from current nursing textbooks was evaluated and chosen to further substantiate the literature results. In cases of knee arthroplasty, diagnoses of obesity and diabetes were discovered to be risk factors for postsurgical infection. The findings of this thesis offer interpretation for nursing practice, research, education, and policy. Implications for nursing research, policy, education and practice are highlighted along with limitations of this integrative review.

Dedications

To my parents, Beth and Dwain, who have supported me throughout my life,

especially in my educational endeavors.

To my Grandparents, who have encouraged me, supported me, believed in me

and always reminded me to dream big.

I am grateful to my entire family, for the love, support, and encouragement

that has sustained me throughout this experience.

Acknowledgements

I would like to thank the members of my committee, Dr. Angeline Bushy, Mrs. Peggy Hill, and Dr. H. Edward Fouty, who have provided me with guidance throughout this project. Thank you for all of your hard work and time you took to assist me with this thesis. Without your numerous hours of direction, discussion, and revision, my research experience would not have been possible.

I would especially like to thank Dr. Angeline Bushy, and Mrs. Peggy Hill for sharing their wealth of knowledge and expertise in the field of nursing with me so that I could complete this thesis. I would also like to thank Dr. Leslee D'Amato-Kubiet, my instructor at the College of Nursing, who recommended I participate in Honors in the Major. I appreciate the support, guidance, and encouragement I received from you throughout this program.

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Introduction

Knee replacement surgery is one of the most common orthopedic procedures in the United States, with over 600,000 performed each year (Weinstein, et al., 2013). Estimates predict that by 2030, there will be approximately 3.48 million total knee arthroplasty (TKA) procedures performed annually (Garvin & Konigsberg, 2012).

Osteoarthritis

Osteoarthritis (OA), known also as degenerative joint disease, is the most prevalent joint disease. This disease is generally found in individuals over 40 years old, and women appear to be more affected than men. Weinstein et al. (2013), found that the lifetime risk of being diagnosed with knee osteoarthritis was 18.8% for males and 13.3% for females. Individuals who have been very active or have a history of unusual and exceptional stress on joints, such as those who working laying carpet and crawling on knees, experience the onset of osteoarthritis at a much earlier age. A torn anterior cruciate ligament (ACL) or meniscectomy is sometimes the cause for early accelerated osteoarthritis of the knee.

Pain is usually the first sign of OA, especially on weight or load bearing joints, particularly the knee. Other signs and symptoms of OA include stiffness, swelling or enlargement, limited range of motion, tenderness, muscle wasting, partial dislocation and deformity (Huether & McCance, 2008).

Nonsurgical treatments for knee pain and osteoarthritis (OA) are initiated first, and may include pharmacological therapies, exercise, weight loss, and minimally invasive procedures (Kon et al., 2011). Pharmacologic therapies include analgesics, opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), and systematic slow-acting drugs. Strength training and aerobic

activities, and range of motion (ROM) exercise therapies have shown at least a short-term beneficial effect in pain reduction, prevention of disease progression, and improvement in physical function (Kon et al., 2011). Minimally invasive procedures include injective treatments, most commonly corticosteroids. After non-surgical options are no longer helpful to control pain, the individual may be considered a candidate for total knee replacement surgery.

Knee Replacement Surgery

In a total knee arthroplasty (aka, TKA), the surgeon removes the damaged cartilage and bone from the ends of the femur and tibia. Subsequently, the surface of the joint is recreated with implanted prosthetic components made of metal, plastic, or both (American Academy of Orthopedic Surgeons, 2011). The newly implanted prosthetic joint is usually comprised of three components: a) the femoral component to resurface the end of the femur, also called the thigh bone; b) the tibial component to resurface the top of the tibia, also called the shin bone; and c) the patellar component to resurface the part of the kneecap that rubs against the femur (Johns Hopkins Medicine, n.d.). There are two surgical methods by which implants can be attached to the bone. The first is to use bone cement, which is referred to as a cemented implant. Second, the implant can be referred to as uncemented, which is made of a porous surface onto which the bone adheres to over time (Johns Hopkins Medicine, n.d.). General or nerve block anesthesias are the most commonly used methods for orthopedic surgical procedures. The surgical procedure typically takes approximately one to two hours (American Academy of Orthopedic Surgeons, 2011). Outcomes vary; however individuals with severe osteoarthritis of the knee have reported improved quality of life post operatively (Papakostidou et al., 2012).

Increased obesity and aging of the population contribute to a higher prevalence of osteoarthritis, therefore increasing the need for total knee replacements (Ruiz, 2013). In the past decade, the number of patients undergoing total knee replacement surgery has doubled (Weinstein et al., 2013). Recent studies show that adults aged 45 to 64 years of age have experienced the most rapid increase in TKA surgeries. From 1997 to 2010, the percentage of knee replacements performed in this age range increased from 26% to 42% (Ruiz, 2013). Several factors can be attributed to the growing utilization of total knee replacements such as safety and effectiveness of the procedure, increased prevalence of obesity, and aging of the general population. As a result of technologic advances, the American Academy of Orthopedic Surgeons (AAOS) considers TKA procedures to be both safe and effective.

Problem Statement

An individual's pain and disability, rather than age, determines the recommendation for total knee replacement surgery. The orthopedic surgeon evaluates each patient on an individual basis because there are no age or weight restrictions for TKA surgery (American Academy of Orthopedic Surgeons, 2011). Several studies found that a high number of individuals undergoing TKA have additional co-morbidities such as diabetes, hypertension, and obesity.

Individuals who undergo knee replacement surgery are at risk for postsurgical complications such as cardiac events, pulmonary embolism, deep infection, peripheral nerve damage, urinary tract infections, deep vein thrombosis, superficial infection, and wound dehiscence. Research suggests that individuals with certain co-morbidities undergoing knee replacement surgery are at a greater risk of the complications occurring. The presence of these complications makes post-operative nursing care of patients more complex.

When compared to individuals without complications, those with postsurgical infection and vascular complications had longer hospital stays and a 90-day cost increase of 80% (Maradit Kremers et al., 2013). In addition, medical complications often result in the need for additional revision surgery. The financial cost of revision surgery is 40% higher and the patient is once more exposed to the risk of postsurgical complications.

Purpose

     The purpose of this integrated review of the literature was to explore the postsurgical infection complications commonly occurring in individuals undergoing total knee replacement surgery, and the relationship of co-morbidities, lifestyle choices, and genetics on the risk for complication. The findings of this thesis offer recommendations for nursing practice, research, education, and policy.

Method

A comprehensive search of the literature focusing on the patient surgical site infection and total knee replacement surgery using the Cumulative Index to Nursing Allied Health Literature (CINAHL), and Medical Literature On-line (MEDLINE). Key search terms included infection, risk factors, knee arthroplasty, and knee replacement. Initial searches revealed 80 results. Upon closer scrutiny, duplicates were removed, as well as those not relevant to infection in TKA. Articles that investigated any type of surgery other than total knee replacement, such as partial knee replacements or hip replacements, were also excluded. This resulted in a review of 6 articles that fit the inclusion criteria. Inclusion criteria were articles written in the English language and published in scholarly, peer-reviewed journals, from 2009 to present. In addition to published articles, pertinent material from current nursing textbooks was evaluated and chosen to further substantiate the literature results.

Background

Postsurgical Complications of Knee Replacement

A postsurgical complication is considered to be any negative deviation from the expected normal postoperative course. Complications can range from minor to serious to life-threatening. A study by Belmont et al. (2014) found the rate of all complications within the first 30 days following total knee arthroplasty was 5.55%. Individuals undergoing knee replacement surgery most commonly experienced postsurgical complications including infection, deep venous thrombosis, pulmonary embolism, and nerve damage. Additional complications specific to knee replacement include prosthetic component wear, malpositioning, and prosthetic loosening, all of which may lead to the need for additional revision surgeries to the knee.

Infection and Wound Healing

One of the major concerns for individuals undergoing TKA surgery is the risk of wound healing complications and infection (Lewis, Dirksen, Heitkemper, Bucher, & Camera, 2011). In relation to total joint arthroplasty, the Center for Disease Control and Prevention (CDC) defines surgical site infection as a superficial wound infection occurring within 30 days postoperatively, or periprosthetic (deep) infection within 1 year of surgery (Everhart, Altneu, & Calhoun, 2013).

Symptoms of postsurgical infection may include continual pain, stiffness, limited range of motion, and fever. Patients suspected to have periprosthetic joint infections should follow the American Academy of Orthopedic Surgeons guidelines of evaluating for infection. Diagnosis starts with measuring the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels (Garvin & Konigsberg, 2012). If either are found to be positive, the joint is aspirated and

cell count, differential, and culture is performed on the fluid. Once infection is confirmed, treatment is determined based on the severity of the infection and may include parenteral antibiotics, surgical debridement, and resection of the implant (Garvin & Konigsberg, 2012).

The majority of deep periprosthetic joint infections are caused by *Staphylococcus aureus* (Gavin & Konigsberg, 2012). Deep wound infection can lead to removal of the prosthesis, joint fusion, and in some cases even amputation. Regardless of the reason, with deep infection, additional surgeries are almost always necessary.

The infection rate after primary total knee arthroplasty is 0.4% to 2% (Gavin & Konigsberg, 2012). Two percent is a seemingly low rate of infection, however, if the number of performed TKA procedures continue to increase in frequency as predicted to the estimated 3.48 million by 2030, this could result in at least 69,000 cases of periprosthetic knee infection each year. These numbers only estimate infections occurring within one year after primary knee replacement. Infections may also occur more than a year after surgery, or after a revision TKA surgery. After accounting for all of these infections, the number could be much higher, and thus further increase the possibilty of infections.

<center>**Results**</center>

Namba, Inacio, and Paxton

     In a retrospective review of research data, Namba, Inacio, and Paxton (2013) explored the relationship of deep surgical site infection between patient, hospital, surgeon, and procedural variables in 56,216 TKA surgeries. They noted a higher prevalence of diabetes, Body Mass Index ≥35, and certain specific diagnoses in the group of patients that developed deep infections. Patients diagnosed with osteonecrosis and posttraumatic arthritis were found to be at 3.65 times and 3.23 times higher risks respectively compared to patients with osteoarthritis or other diagnoses. Gender was found to be a significant patient-specific risk factor, as males were 1.89 times more likely to develop infection than women. Obese patients with a BMI ≥35 were found to develop deep infection at a 1.47 times higher rate compared to those with a BMI <35. When compared to those without diabetes, patients with a diagnosis of diabetes were found to be at a 1.28 times higher risk of postsurgical deep infection. There was reduced rate of deep infection in Hispanic patients compared to Caucasian patients.

     The Namba et al. study further identified several risk factors for infection related to the procedure and hospital. Knee arthroplasties performed in hospitals that performed 100-199 cases/year had a higher proportion of postsurgical deep infection. There was a higher proportion of deep infection in patients who had received general anesthesia and a lower proportion of infection in patients who had received spinal anesthesia. A significant risk factor for postsurgical deep infection was the use of a quadriceps release during the procedure, putting the patient at 4.76 times higher risk. Antibiotic-laden bone cement use during procedure was associated with a 1.53 times greater risk of deep infection post TKA. Finally, several factors were identified with a

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lower risk for post-surgical infection occurrence. Paradoxically a hospital having a lower-volume (<100 cases/year) hospital procedure site, the procedure consisting of bilateral TKA, and the use of antibiotic irrigation during the procedure.

Chen, et al.

In 2013, Chen et al. completed a meta-analysis on 12 studies focusing on risk factors for postsurgical infection following TKA. Fifteen patient and procedure variables were evaluated against 57,223 TKA surgeries to determine individual impact on risk of postoperative infection.

The study found BMI > 30 to be the highest risk factor. When compared to an individual of normal weight, the obese patient incur infection at 2.53 times higher rate, and the morbidly obese at a four times higher rate. Diabetes mellitus (DM) was also found to be a significant risk factor, as TKA patients with DM had a 3.72 times greater chance of developing infection. Patients diagnosed with hypertension were found to be at over 2.5 times higher risk of postsurgical infection as those with blood pressure within the normal range. Chen et al. cited a previous study that showed for patients having both diabetes mellitus and hypertension, the risk of infection was over ten times higher than a patient without either disease. Two other risk factors for infection, steroid use and rheumatoid arthritis, were also identified.

Jamsen, et al.

A retro-analysis of knee arthroplasties performed in Finland over a 7½ year period was undertaken by Jamsen et al. in 2009. Each individual having knee surgery was followed for a minimum of six months post operatively. Although the study included primary, partial, and revision knee arthroplasties, 93% of the cases were on primary knee procedures so this study was determined appropriate to include in this literature review.

The Jamsen et al. study found that male patients were at higher risk for infection and reoperation due to infection than females. The patient diagnoses of posttraumatic osteoarthritis, unspecified osteoarthritis, seropositive rheumatoid arthritis, and knee fracture were also found to be linked to higher risk of infection and reoperation than those patients diagnosed with primary osteoarthritis. In addition, an increased rate of infection was found with the use of constrained and hinged prosthetic implants. Lastly, the study found that infection risk was increased when antibiotic-impregnated bone cement was not used. The lowest risk of infection was the use of intravenous antibiotics and antibiotic-impregnated bone cement used in combination.

Bozic, et al.

In 2011, Bozic et al. conducted a retro-analysis of 83,011 patients who underwent total knee arthroplasty between 1998 and 2007. The purpose was to determine the relative risk of periprosthetic joint infection (PJI) within 90 days of TKA as a function of preexisting comorbidities. This analysis was limited to patients within the Medicare population.

Twenty-nine comorbidities were explored and results showed 13 of the 29 to be independent risk factors for periprosthetic joint infection. Of the 13, congestive heart failure was the comorbidity shown to have the highest independent risk for PJI, followed by chronic pulmonary disease. The additional 11 comorbidities independently influencing risk of PJI in order of decreasing significance were preoperative anemia, diabetes, depression, renal disease, pulmonary circulation disorders, obesity, rheumatologic disease, psychoses, metastatic tumor, peripheral vascular disease, and valvular disease.

Dowsey & Choong

A retrospective analysis of 1,214 total knee arthroplasty procedures was conducted by Dowsey and Choong in 2008. The purpose of their study was to determine what influence obesity had on deep infection within 12 months following primary knee replacement surgery. Additional patient and surgical variables including comorbidities, gender, age, use of surgical drains, blood transfusion, and antibiotic-impregnated cement, were also analyzed to determine the relationship, if any, to postsurgical deep infection.

The overall rate of periprosthetic infection within 12 months of TKA was found to be 1.5%, or 18 of the 1,214 cases. The greatest risk was found in morbidly obese patients, or those with BMI $\geq$ 40, who were almost nine times more likely to develop periprosthetic infection. Patients considered obese, with a BMI 30-39, were at a 2.2 times greater risk for developing deep infection within the first year of TKA. When compared to patients without diabetes mellitus (DM), the periprosthetic infection rate for patients with DM was 6.87 times higher. The study found that males were almost six times more likely to develop deep infection than women. In addition, it was determined that the use of a postsurgical drain reduced the risk of deep infection.

Greenky, et al.

The association between preoperative anemia and periprosthetic joint infection was explored by Greenky et al. in 2012. A retrospective analysis of 15,222 cases was conducted on patients undergoing TKA or total hip arthroplasty (THA) from January 2000 to June 2007. Follow up ranged from 3 to 9 years. For the purposes of the analysis, the World Health Organization (WHO) definition of anemia, Hb <12g/dL in women and <13g/dL in men, was used.

The study found the prevalence of preoperative anemia to be 19.6%. Periprosthetic joint infection occurred in 4.3% of anemic patients and 2% of non-anemic patients. Analysis revealed that patients with preoperative anemia were 1.95 times more likely to develop deep infection after surgery. In addition, anemic patients were found to have a longer length of hospital stay, averaging 4.35 days compared to non-anemic patients who averaged 3.99 days.

Discussion

The studies reviewed for this thesis have provided insight about specific patient and surgical variables that relate to deep surgical site infection rate following total knee replacement. The two variables showing the most significance in risk of periprosthetic joint infection were obesity and diabetes mellitus. Based on these findings, it is suggested that all patients undergoing surgery for total knee arthroplasty address these two risk factors prior to surgery.

Obesity

Obesity was identified as a risk factor for periprosthetic infection following TKA, and in many cases it was the comorbidity that placed patients at highest risk. Of the six studies included in this literature review, four explored the relationship of obesity and postsurgical infection after total knee arthroplasty. All four identified obesity as a comorbidity that increased deep infection rate. Two of the studies found that patients classified as morbidly obese, with a BMI >40, were at substantially higher risk of deep infection. The same two studies also found patients with BMI >30 to be at greater risk for postsurgical deep infection than those patients of a normal weight. An additional study identified BMI ≥35 to show an increased incidence of infection after TKA. The last study did not define the criteria used for obesity, but did also find an increased risk of infection in patients with obesity.

Diabetes Mellitus

Patients with diabetes mellitus (DM) were also identified to be at higher risk for deep surgical infection after total knee replacement. While the calculated increased risk varied, four of the studies included in this literature review explored the relationship of DM and all four found

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this comorbidity to increase risk. One study also found that deep infection occurred when diabetes was associated with obesity. None of the studies distinguished between Type I diabetes, usually in younger people, and Type II diabetes, which is usually associated with obesity. In addition, none of the studies specified the patient's blood sugar levels, or HbA1C.

Other Patient and Provider-Specific Variables

Gender was identified as a risk factor for postsurgical infection. Three sources included in this literature review found much higher rates of deep infection in males versus females after TKA. One additional study explored gender as a risk factor for infection but concluded that there was no evidence that males were more likely to develop infection than females.

The influence of patient pre-surgical diagnosis patient diagnosis on deep infection was explored in several studies. Two studies found a greater risk for infection in patients with posttraumatic arthritis or posttraumatic osteoarthritis. Rheumatoid arthritis was also found to be associated with an increased risk for infection. Patients with preoperative anemia developed deep infection at a higher rate than non-anemic patients, as evidenced by the Greenky and Bozic (2012) studies. In a study of Medicare patients, Bozic et al. (2012), found multiple other patient comorbidities that negatively influenced infection rates. However because no other studies evaluated these factors a conclusion was not made on these variables in this literature review.

Procedure, Facility, & Surgeon Specific Variables

A relationship between the use of the type of antibiotic prophylaxis and the occurrence of periprosthetic infection could not be determined. One study found that the use of antibiotic cement increased the risk for infection, another found that the absence of the use of antibiotic-impregnated cement increased the risk. Additional procedure specific variables, such as the type

of prosthetic used, procedure operation time, and the use of a quadriceps release, were found to increase risk for infection. Because all of these variables were separately analyzed by one study, Namba et al. (2013), this literature review was not able to determine a relationship between the presence of these variables and the risk of periprosthetic joint infection.

Limitations

Several limitations were noted with this integrative literature review. The number of available and current research studies including the key words 'knee replacement' and/or 'knee arthroplasty' are numerous; however, only a limited number of those studies focus on the risk factors for postsurgical infection. Also, most of the articles that were available are reviews of literature, rather than reports of an investigation by the primary researcher. This reality hinders development of nursing focused evidence based guidelines regarding infections post knee replacement surgery.

Implications for Nursing

Research

Research has been conducted on patient-specific comorbidities and the impact on deep surgical site infection following total knee arthroplasty; However, data are lacking in several areas. Further research is needed regarding the comorbidity of both obesity and diabetes mellitus and of deep infections in patients with these comorbidities undergoing TKA, in particular prevention measures.

While evidence shows that patients who are obese are at a greater risk for deep surgical infection following TKA, no studies were identified that explored interventions which could reduce the risk of infection in obese patients. Procedure specific variables of the obese patient undergoing TKA should be analyzed such as prosthetic type, antibiotic prophylactic type and use, and anesthesia method. In addition to exploring intraoperative variables, it would also be beneficial to study the effects of postsurgical weight reduction on infection rates in the obese and morbidly obese TKA patients.

A diagnosis of diabetes mellitus also increased risk of periprosthetic infection, however the type of diabetes was not specified. Further research is needed regarding the impact of Type I versus Type II diabetes on postoperative infection rate in TKA patients with diabetes. The studies found did not indicate HbA1C level or the patient's daily capillary blood glucose record. It would be beneficial to determine if patients with HbA1C levels above specific numbers are more likely to develop infection than those patients that have control of their blood glucose.

Very few of the studies provided any relationship to positive factors associated with a reduced risk of deep surgical site infection. There was some mention of surgical drain use, lower

levels of facility volume, and bilateral procedures having a reduced incidence of infection post TKA. Additional research on variables related to positive outcomes would be valuable for nursing practice implications.

Education

Pre-operative nurses working with potential total knee replacement patients should be educated on the risk factors for postsurgical infection and methods of reducing or preventing these risk factors. Obesity and diabetes mellitus were found to be the two most significant risk factors for postsurgical infection. Nurses working in orthopedics, specifically with knee replacement patients, should be educated that these two co-morbidities put the patient at a greater risk for infection after surgery. Education should also be provided on pre-surgical interventions to reduce the risk of infection, such as weight reduction and blood glucoses control and management. In addition, all nurses working with the patient after surgery should know the signs and symptoms of deep postsurgical infection, which may include pain, stiffness, and fever. Patients should be monitored closely for these signs of infection during the first postoperative year as this is the time in which deep infections most commonly occur.

Practice

Patients with BMI >35 are at increased risk for infection, and should be informed of the risk and counseled on ways to reduce it (Garvin & Konigsberg, 2012). Weight loss may be recommended prior to undergoing TKA surgery. Bariatric surgery may be recommended before knee replacement in those morbidly obese patients with adequate nutritional status (Garvin & Konigsberg, 2012). Patients with diabetes mellitus should also be informed of the increased risk

for periprosthetic joint infection and what they can do about this to prevent complications and reduce risk.

As mentioned earlier, the majority of deep surgical joint infections are caused by *staphylococcus aureus.* While the infections can be hospital acquired, patients may also be carriers of *s. aureus* and infect themselves. For example, patients can be screened postoperatively for the bacteria and a decolonization can be carried out before undergoing TKA surgery. One hour prior to the surgical incision being made, prophylactic antibiotics should be administered. The preferred antibiotics are cefazolin and cefuroxime as published by The American Academy of Orthopedic (AAOS) guidelines (Garvin & Konigsberg, 2012). Vancomycin may be recommended for patients with beta-lactam allergies or those having TKA at a facility with a methicillin-resistant *staphylococcus aureus* (MRSA) prevalence rate >25% in orthopedic patients.

Policy

Medicare as well as third party payers may consider implementing policies related to postsurgical infection following knee replacement surgery. Since infection is preventable, providers and facilities should receive reduced or no reimbursement for cases in which postsurgical infection occurs. Payers may also consider implementing policies around pre-surgical weight reduction and diabetic management before the patient is approved for surgery. In addition, postsurgical nutrition and diabetic counseling may be helpful to ensure the patient stays at a healthy weight and controls diabetic blood sugar levels.

APPENDEX A

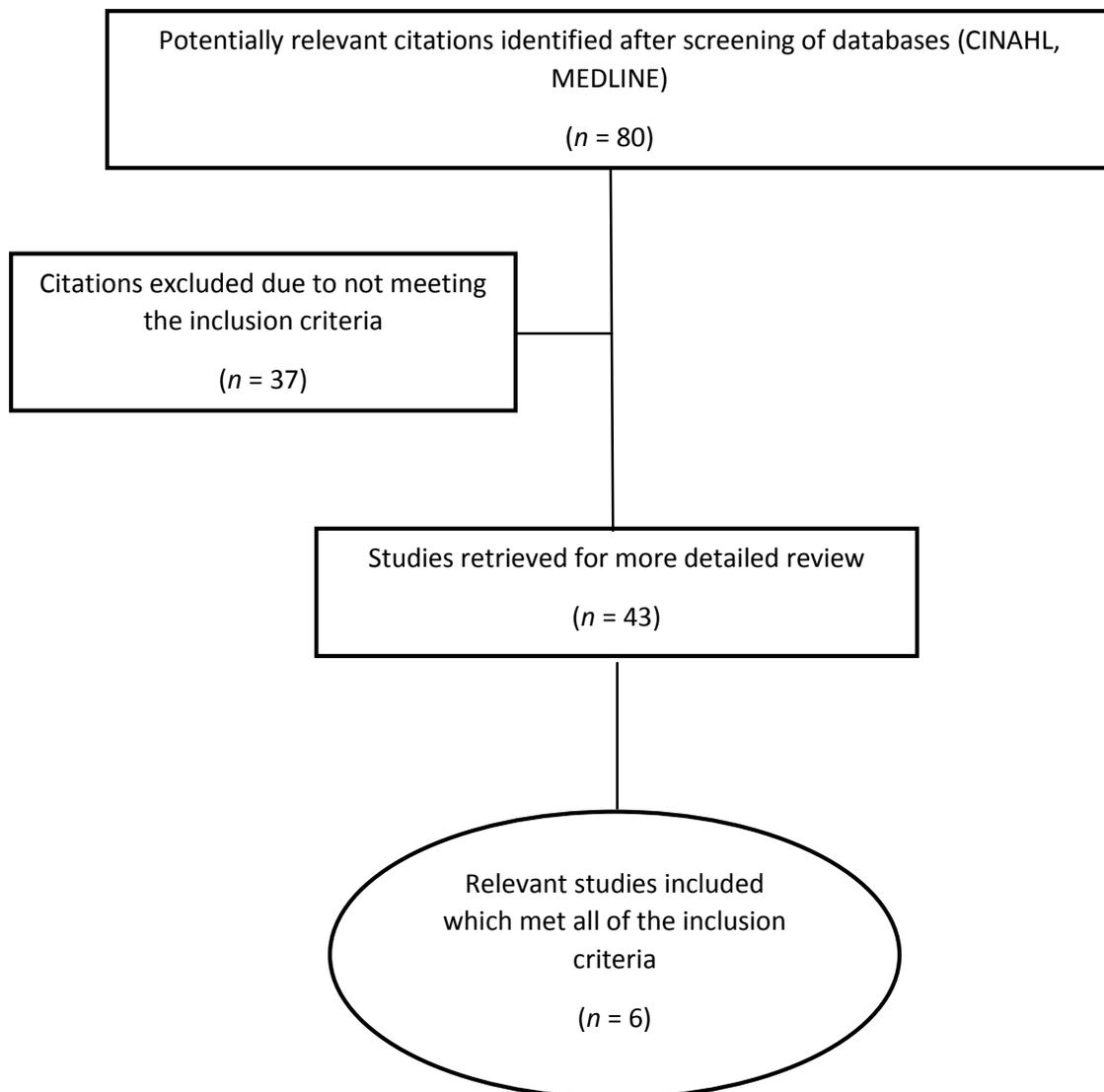## Figures

Figure 1: Consort Diagram

Flow Diagram of Study Selection Process

Key Search Terms = Knee Replacement or Knee Arthroplasty, Infection, Risk Factor, Nurs*

Limiters = English language, Publication Date of 2009 or More Recent

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┌─────────────────────────────────────────────────────────┐
│  Potentially relevant citations identified after screening │
│                of databases (CINAHL, MEDLINE)              │
│                        (n = 80)                            │
└─────────────────────────────────────────────────────────┘

┌──────────────────────────────┐
│ Citations excluded due to not │
│   meeting the inclusion       │
│          criteria             │
│         (n = 37)              │
└──────────────────────────────┘

        ┌─────────────────────────────────────────┐
        │  Studies retrieved for more detailed      │
        │               review                      │
        │              (n = 43)                     │
        └─────────────────────────────────────────┘

           ╭───────────────────────────────╮
          ╱   Relevant studies included      ╲
         │   which met all of the inclusion   │
         │             criteria               │
          ╲            (n = 6)               ╱
           ╰───────────────────────────────╯
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APPENDIX B

Tables

Table 1: Table of Evidence

Article	Bozic, K., Lau, E., Kurtz, S., Ong, K., & Berry, D. (2012). Patient-related risk factors for postoperative mortality and periprosthetic joint infection in Medicare patients undergoing TKA. *Clinical Orthopaedics & Related Research*, *470*(1), 130-137.
Study Design	Retro-analysis
Purpose	Calculated the relative risk of postoperative mortality and PJI associated with 29 comorbid conditions in Medicare patients undergoing TKA
Participants	83,011 patients who underwent primary TKA between 1998 and 2007
Results and/or Key Findings	"The independent risk factors for PJI (in decreasing order of significance) were congestive heart failure, chronic pulmonary disease, preoperative anemia, diabetes, depression, renal disease, pulmonary circulation disorders, obesity, rheumatologic disease, psychoses, metastatic tumor, peripheral vascular disease, and valvular disease." (p. 130)
Nursing Implications	Relationship of patient specific co-morbidities and postsurgical infection
Article	Chen, J., Cui, Y., Li, X., Miao, X., Wen, Z., Xue, Y., & Tian, J. (2013). Risk factors for deep infection after total knee arthroplasty: a meta-analysis. *Archives Of Orthopaedic And Trauma Surgery*, *133*(5), 675-687. doi:10.1007/s00402-013-1723-8
Study Design	Meta-analysis
Purpose	Estimate the risk factors for postoperative infection after TKA
Participants	57,223 general cases of TKA
Results and/or Key Findings	Found relationship with BMI, diabetes mellitus, hypertension, steroid therapy, and rheumatoid arthritis and deep infection
Nursing Implications	Relationship of patient specific co-morbidities and postsurgical infection
Article	Dowsey, M., & Choong, P. (2009). Obese diabetic patients are at substantial risk for deep infection after primary TKA. *Clinical Orthopaedics And Related Research*, *467*(6), 1577-1581. doi:10.1007/s11999-008-0551-6
Study Design	Retrospective analysis
Purpose	Compare the deep prosthetic infection rate between obese and non-obese patients, determine whether patient or surgical variables such as comorbidities, age, gender, blood transfusion, use of surgical drains, and antibiotic-impregnated cement were predictors of subsequent prosthetic infection after primary TKA
Participants	1214 primary TKA cases in Australia

Results and/or Key Findings	Correlation with obesity, diabetes, gender, and use of surgical drain and risk of deep infection
Nursing Implications	Relationship of patient specific co-morbidities as well as procedure variables and postsurgical infection
Article	Greenky, M., Gandhi, K., Pulido, L., Restrepo, C., & Parvizi, J. (2012). Preoperative anemia in total joint arthroplasty: is it associated with periprosthetic joint infection?. *Clinical Orthopaedics And Related Research*, *470*(10), 2695-2701. doi:10.1007/s11999-012-2435-z
Study Design	Retrospective review
Purpose	We therefore (1) determined the incidence of preoperative anemia in patients undergoing TJA; (2) assessed the possible association between preoperative anemia and subsequent PJI; and (3) explored the relationship between preoperative anemia with postoperative mortality.
Participants	15,722 patients who underwent TJA from January 2000 to June 2007
Results and/or Key Findings	PJI occurred more frequently in anemic patients at an incidence of 4.3% in anemic patients compared with 2% in nonanemic patients
Nursing Implications	Relationship between pre-operative anemia and postsurgical infection
Article	Jämsen, E., Huhtala, H., Puolakka, T., & Moilanen, T. (2009). Risk factors for infection after knee arthroplasty. A register-based analysis of 43,149 cases. *The Journal Of Bone And Joint Surgery. American Volume*, *91*(1), 38-47. doi:10.2106/JBJS.G.01686
Study Design	Register-Based Retro Analysis
Purpose	To determine the risk factors for infection following primary and revision knee replacement in a large register-based series.
Participants	43,149 primary and revision knee arthroplasties, registered in the Finnish Arthroplasty Register
Results and/or Key Findings	Increased risk of deep postoperative infection in male patients and in patients with rheumatoid arthritis or a fracture around the knee as the underlying diagnosis for knee replacement
Nursing Implications	Relationship of patient specific co-morbidities and postsurgical infection
Article	Namba, R. S., Inacio, M. S., & Paxton, E. W. (2013). Risk factors associated with deep surgical site infections after primary total knee arthroplasty. *Journal Of Bone & Joint Surgery, American Volume*, *95-A*(9), 775-782.
Study Design	Retrospective review
Purpose	Evaluate risk factors associated with deep surgical site infection
Participants	56.216 primary knee arthroplasties in the US from 2001 to 2009

Results and/or Key Findings	Increased risk of deep surgical infection with obesity, diabetes mellitus, diagnosis of osteonecrosis, diagnosis of posttraumatic arthritis, quadriceps-release exposure and use of antibiotic laden cement
Nursing Implications	Relationship of patient specific co-morbidities and postsurgical infection

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    http://orthoinfo.aaos.org/topic.cfm?topic=a00389

Bozic, K., Lau, E., Kurtz, S., Ong, K., & Berry, D. (2012). Patient-related risk factors for

    postoperative mortality and periprosthetic joint infection in Medicare patients undergoing

    TKA. *Clinical Orthopaedics & Related Research*, *470*(1), 130-137.

Chen, J., Cui, Y., Li, X., Miao, X., Wen, Z., Xue, Y., & Tian, J. (2013). Risk factors for deep

    infection after total knee arthroplasty: A meta-analysis. *Archives of Orthopaedic and*

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