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Review article

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Perioperative prognosis of infectious complications after total hip and knee arthroplasties. Part I

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Abstract

Introduction The number of total joint arthroplasties performed globally has increased over time, and the projected growth for total knee arthroplasty (TKA) and total hip arthroplasty (THA) in 2030-2050 is associated with an increase in the number of surgical complications, such as periprosthetic joint infection (PJI). Perioperative modifiable risk factors can be altered to help improve rates of the devastating scenario. **The purpose** of the review was to systematize information on modifiable risk factors for PJI after THA and TKA and the ways to improve them. **Material and methods** Scientific literature search was performed via web-based services of PubMed, eLibrary, Scopus, Dimensions. The search depth was 30 years. **Results** Modifiable risk factors were shown to be associated with the patient's condition, medical history, current status, intraoperative and postoperative surgical options. Well-established modifiable risk factors include tobacco use, alcohol consumption, excess body weight, obesity, malnutrition, duration of surgery, postoperative wound hematoma. **Discussion** Timely diagnosed modifiable risk factors for PJI can be improved at the preparation stage, perioperatively and postoperatively. The interaction of inpatient and outpatient hospital services in the perioperative period is essential for reducing the risk of PJI after THA and TKA.

Keywords: arthroplasty, surgical site infection, periprosthetic infection, prognosis, modifiable risk factors

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INTRODUCTION

Advances in health care services continue to have a significant measurable improvement in lives of doctors and patients who suffer a severe pathology of large joints of lower limbs with the use of extremely effective and successful surgery of total joint replacement (TJR) [1–4]. The number of total hip replacement (THR) and total knee replacement (TKR) are predicted to significantly increase by 2030–2050 [5–8]. Although a very high implant survival rate of 95 % is reported at ten years, 3 % of patients may have early complications during the first 30 days after surgery that would require a revision intervention [9]. Surgical site infection is one of the most common and devastating complications of TJR that can develop in the first days after surgery [10–16]. As the demand for TJR increases over time, the number of concurrent complications such as surgical infection will also increase [8, 17, 18]. It is assumed that risk is a term used to express the likelihood or probability that a hazardous event (with a given outcome or consequence) will occur. In medical practice risk is usually understood as the likelihood of complications. There is a distal risk factor that represents an underlying vulnerability for a particular condition and a proximal risk factor that represents an immediate vulnerability for a particular condition or event. Accurate identification of individuals at high risk of surgical site infections (SSIs) or periprosthetic joint infections (PJIs) influences clinical decisions and development of preventive strategies. Knowledge of risk factors is used primarily to predict the disease. Forecasting is the identification of future trends in the development of a phenomena, based on the analysis of retrospective data [19]. Risk stratification can help identify those patients at risk of adverse outcomes that can be prevented preoperatively, intraoperatively and postoperatively.

The purpose of the review was to systematize information on modifiable risk factors for PJI after THA and TKA and the ways to improve them.

MATERIAL AND METHODS

The original literature search was conducted on key resources using open electronic databases of scientific literature PubMed, eLibrary, Scopus, Dimensions. The search depth was 30 years. The search was carried out using keywords in Russian and English: hip arthroplasty, knee arthroplasty, PJI (‘periprosthetic joint infection’), SSI (‘surgical site infection’), ‘predict’, ‘risk factor’.

RESULTS

A variety of risk factors have been hypothesized to contribute to the development of infectous complications. Risk factors can be broadly categorized into patient related, procedure related and post procedural care related and classified as modifiable and non-modifiable, general and local with preoperative, intraoperative and postoperative parameters to be considered [20]. The consensus of experts of the 2019 Second International

Consensus Meeting on Musculoskeletal Infection, identified (98 % votes in the affirmative, with a strong level of evidence) modifiable factors related to the patient (body mass index – BMI, smoking, alcohol consumption, opiates, concomitant pathology) and non-modifiable factors (older age (over 75), male sex, black ethnicity) with an increased risk of developing SSI/PJI) [21]. The review focuses on the modified risk factors. There are studies based on the analysis of isolated factors, their combination and the mutual effect on the prediction of purulent complications.

Modifiable risk factors studied in isolation

The fact that smoking is a risk factor for different conditions is well known. Smoking is known to be associated with increased postoperative morbidity and mortality [22].The pathophysiology of the phenomenon is that smoking reduces blood flow to the healing tissue and impairs delivery of humoral and cellular mechanisms of immunity to the surgical site [23–26]. Nicotine in cigarettes releases catecholamines that lead to vasoconstriction and hypoperfusion, changes in hemostasis and endothelial dysfunction that can result in inflammation, progression of atherothrombosis with limited tissue perfusion [27]. Tissue hypoxia in the postoperative wound deregulates protective mechanisms of neutrophils and tissue regeneration [23, 28]. Tissue hypoxia can occur not only from vasoconstriction but also from inhaled carbon monoxide in cigarette smoke [29]. Carbon monoxide binds strongly to hemoglobin and forms carboxyhemoglobin, which has a high affinity for oxygen and significantly decreases oxygen delivery to healing tissues [30]. Cigarette smoking and exposure to tobacco smoke is associated with a higher risk of developing infectious complications in TJR patients [31].

JA Singh et al. reported the rates of complications in current tobacco users of cigarettes, cigars, pipes or smokeless tobacco, former users and never users. current tobacco users who were more likely to be male ($p < 0.001$), and less likely to be obese ($p \leq 0.008$), be older than 60 years, have Charlson score >0 or have undergone TKA rather than THA ($p < 0.001$ each). The hazard ratios for deep infection (2.37; 95 % CI 1.19, 4.72; $p = 0.01$) and implant revision (1.78; 95 % CI 1.01, 3.13; $p = 0.04$) were higher in current tobacco users than in non-users. No significant differences were noted for periprosthetic fractures or superficial infections [32]. Different authors [33–36] reported that current tobacco consumption compared to non-smokers was associated with a high risk of deep infection and revision surgery after primary THR/TKR (OR = 1.41; 95 % CI 1.16–1.72) [37]. Current smoker status was also identified as a significant risk factor for wound infection, as current smokers had approximately twice the rate of deep wound infection compared with former smokers or nonsmokers [38–39]. Observational studies demonstrated important effects of smoking cessation on decreasing total complications (relative risk [RR] 0.76, 95 % CI, 0.69–0.84) [40]. In the preoperative period, tobacco users and smokers should be evaluated and smoking cessation should be strongly recommended [41] in order to optimize the patient's condition before TJR and reduce the risk of developing SSI/PJI. Tobacco use before total hip and total knee arthroplasty significantly increases the risk of wound complications and PJI. This increased risk is present for both current and former tobacco users. However, former tobacco users had a significantly lower risk of wound complications and PJI compared to current tobacco users, It is suggested that cessation of tobacco use before TJA can help to mitigate the risk of wound complications and PJI at a short and long term [32, 42]. Although an optimal period of preoperative smoking cessation has yet to be established, most reports suggest a period of 4 to 8 weeks is effective [35–37, 43–44]. Tønnesen et al. reported that, in smokers, immune function is restored after 4–6 weeks of abstinence and wound healing capability is restored after 3–4 weeks [45]. Longer periods of preoperative smoking cessation, however, have also been associated with lower rates of postoperative infection and preoperative cessation periods of up to 6 months have also been suggested [25, 46]. Abrupt reduction in cigarette consumption is rarely permanently successful in terms of smoking cessation. However, individual counseling, self-help groups, nicotine-replacement therapy and physician advising are proven techniques that promote prolonged cessation [43, 46]. Patients with mental and behavioral disorders caused by alcohol consumption may have a significantly increased risk of postoperative morbidity.

Excessive alcohol consumption (greater than 40 units per week) increases the risk of the adverse events including episodes of bleeding and infection [45, 47]. The authors evaluated patients who had undergone serious non-cardiac surgery and reported that alcohol abuse significantly increased the risk of infection [48]. The consumption of two or three drinks per day impairs the function of the immune response [49] with metabolic stress reactions that is being combined with the physiological stress from surgery aggravate the depression of immunity [45]. However, there are also opposite opinions indicating the absence of a statistically significant association between alcohol abuse and the risk of developing PJI [50, 51].

Although alcohol cessation has not been demonstrated to reduce the risk of PJI prior to elective TJA, several studies have reported reduced morbidity after a period of abstinence [49, 52]. In alcoholics, immune competence is recovered after 2–6 weeks of alcohol cessation [53] and wound-healing capability is restored after 3–4 weeks of cessation [54]. Furthermore, Tønnesen et al. reported that alcohol cessation 4 weeks prior to surgery significantly reduced postoperative morbidity in alcohol abusers [45]. A history of alcohol consumption should be preoperatively evaluated and a cessation period of at least 4 weeks prior to surgery should be recommended for alcoholic arthroplasty patients in order to reverse physiological abnormalities associated with excessive alcohol consumption that increase the risk of PJI [52, 55].

Opioids have well-known immunosuppressive properties and and preoperative opioid consumption is relatively common among patients undergoing TJA in Western countries, in particular. Opioids are reported to be used before primary arthroplasty from 21.3 [56] to 36.7 % with the majority of patients (80 %) were older than 50 years and more than half of them were females (56.8 %) [57]. Preoperative use of opioids in general was found to be a significant risk factor for the development of PJI in one-dimensional (OR 1.63; p = 0.005) and multidimensional analysis (adjusted OR 1.53; 95 % CI, 1.14–2.05, p = 0.005). The authors emphasize the need for a balanced approach to prescribing opioids to patients with degenerative joint diseases who may subsequently require TJR [56, 58].

Overweight and obesity are reported to have an adverse effect on the development of infectious complications in TJR patients. The duration of surgical intervention, an increase in the need for allogeneic blood transfusion, and the presence of other concomitant diseases in obese patients increase the risk of PJyI [59–63]. may be characteristic for this group of These patients may experience divergence of the wound edges due to increased skin tension, hematomas and prolonged drainage of the wound as predisposing factors for the development of SSI/PJI [64].

There is evidence of a correlation between the posterior surgical access for THR and the infection rate [65]. Although pathological obesity is considered a modifiable risk factor for PJI, it took a long time to determine a relatively suitable threshold for BMI, above which the risk of infection may outweigh the benefits of arthroplasty. A BMI of > 25 kg/m^2 was shown to be associated with an increased risk of developing infectious complications of THR/TKR [31]. N. Shohat et al. reported the relationship between the PJI identified within 90 days of the index surgery and for each BMI category (underweight ≤ 18.49 kg/m^2; normal 18.5–24.9 kg/m^2; overweight 25–29.9 kg/m^2; obese class I 30–34.9 kg/m^2; obese class II 35–39.9 kg/m^2; obese class III ≥ 40 kg/m^2). The authors found that the risk of PJI increased gradually throughout the full range of BMI, but no threshold existed. Among the BMI classes, patients with class III obesity (≥ 40 kg/m^2) were the only ones showing a higher risk for PJI within 90 days and carried a threefold higher risk for PJI [66], and with a BMI > 50 kg/m^2, an 8–21-fold increase in the frequency of complications reported [67–69].

S.K. Kunutsor et al. confirmed the hypothesis by comparing groups of patients with a BMI ≥ 30 vs < 30 kg/m^2; ≥ 35 vs < 35 kg/m^2 and ≥ 40 vs < 40 kg/m^2. The combined odds ratios (OR) were 1.60 (1.29–1.99); 1.53 (1.22–1.92) and 3.68 (2.25–6.01), respectively [50]. Preoperative planning in the patients require careful comparison of the risks of surgery with its benefits and weight correction in preparation for surgery [41]. Preoperative weight correction can reduce the risk of infection for all patients with a BMI above normal limits [66]. Some studies demonstrated the impact of obesity on the risk of PJI decreasing over time. Bozic et al. reported the risk of PJI decreasing by 19 % in obese patients at one-year follow-up (p = 0.025) [70].

There are works devoted to the study of local indicators of obesity at the site of surgery. In cases of EX, X-rays were analyzed in 2 standard projections based on body weight before surgery to determine the thickness of the prepatellar subcutaneous fat (PFA), the bone width of the tibial plateau and the total width of the soft tissues of the CS. The local distribution of PFC varies greatly for any given BMI. None of the indicators of the local distribution of PFA in the CS area showed a significant correlation with the risk of PPI.

Local measures of adiposity at the surgical site have been identified as a risk factor for PJI after TKA. Preoperative weight-bearing AP and lateral x-rays were analyzed to determine prepatellar adipose thickness (PAT), bony width of the tibial plateau, and total soft tissue knee width. The knee adipose index (KAI) was calculated from the ratio of bone to total knee width. Local adipose deposition varied greatly for any given BMI. Neither measure of local knee adipose showed a significant correlation with PJI risk. By contrast, there was a strong correlation between PJI risk and BMI >35 (odds ratio 2.9, 95 % CI 1.4–6.1). Surgical duration increased with both BMI and measures of local adipose tissue [71]. Peritrochanteric fat thickness was radiographically measured from the sourcil to skin surface, from tip of greater trochanter to skin surface, and lateral greater trochanter to skin surface. he authors found no difference in local adipose tissue and PJI after primary THA [72].

Malnutrition can also affect the incidence of infectious complications [41, 64, 73] Malnutrition can be defined as the level of BMI below 18.5 kg/m^2, serum albumin < 3.5 g/dL, serum transferrin < 200 mg/dL, serum prealbumin < 15g/dL and total lymphocyte count (TLC) < 1500 cells/mm^3 [64, 74]. R. Somayaji et al. reported that patients with a BMI below 18.5 kg/m^2 had a higher risk of developing SSI compared to control patients with normal BMI (OR 6.0; 95 % CI 1.2–30.9) [75]. A.G. Tsantes et al. investigated the link between malnutrition with SSIs and PJIs following TKA and THA through a comprehensive meta-analysis of observational studies with >250,000 subjects. SSIs and PJIs were seen to be more likely to develop in malnourished patients (OR: 2.49; CI: 2.13–2.90; and 3.62; 2.33–5.64, respectively). The association of SSI with malnutrition was evident both after TKA (2.42; 1.94–3.02) and after THA (2.66; 1.64–4.30). Similarly, PJI was associated with malnutrition after TKA (2.55; 1.10–5.91) and after THA (3.10; 1.84–5.25) [73]. The risk of PPI was was reported to be 5 times higher in patients with preoperative TLC < 1500 cells/mm^3 and 7 times higher in patients with albumin levels < 3.5 g/dL [76].

Undernourished patient with a serum albumin level below 3.5 g/dL is an independent risk factor for the development of SSI/PJI after total arthroplasty. Despite the lack of evidence the need to optimize the patient's nutrition before TJR is recognized and agreed (92 % in favor, with an average level of evidence) to reduce the risk of SSI/PJI and that body weight deficiency (BMI < 18.5 kg/m^2) is an unfavorable criterion for the surgery [21]. Malnutrition interferes with the optimal synthesis of collagen and proteoglycans with longer period of wound healing, prolonged drainage of the wound and an increased risk of infection [64, 77]. Total blood protein for the determination of malnutrition is not effective for detecting a deficiency of other parameters indicating malnutrition, including a deficiency of calories or vitamins [64, 78]. There is evidence of a higher prevalence of vitamin D deficiency in patients with PJI compared to non-infected patients [79]. Therefore, malnutrition increases the risk of PJI in patients who have undergone TJR. The nutritional status of patients with suspected exhaustion is to be comprehensively examined before elective surgery [64, 76]. Patients with a BMI below 18.5 or more than 40 kg/m^2 should be referred to nutritional specialist and weight correction prior to surgery [80]. Weight correction using a high-calorie diet with the intake of supplements with a high content of protein, vitamins and minerals would be practical for undernourished patients preparing for surgery [74, 81]. Although the effect of other markers of metabolism other than serum albumin continues to be investigated, they cannot yet be considered predictors of infectious complications due to insufficient study [21].

Glucocorticosteroid (GCS) drugs have been used to treat joint pathology since 1950, when Y.W. Thorn of Boston first used 10 mL hydrocortisone injection for a patient's knee [82]. S.E. McMahon et al. identified, by systematic review of the literature, that steroid injection prior to TJR conferred no increased risk of deep or superficial prosthetic infection [83]. There are recommendations that patients and their surgeons consider delaying elective THA until 3 months after an injection to avoid this elevated risk of infection [84]. A group of researchers evaluated the risk of superficial, deep, and overall rate of infections in patients who had received intra-articular corticosteroid infiltration within 12 months before undergoing TKR and compared them with a matched cohort who had undergone TKA, but who did not have any prior corticosteroid knee injections. At a mean follow-up of approximately 3.5 years after TKA, there were no significant differences in the rate of superficial incisional infections, deep PJI in the two groups. In addition, no significant differences were found in the rate of deep infections when intra-articular corticosteroids were administered 10 weeks to 2 months, and beyond 12 months before surgery. We concluded that intra-articular corticosteroid injections are safe and do not increase the rate of postoperative infections [85].

Assessment of the effect of the duration of surgery on the development of PJI after THR/TKR is changing dynamically. At the end of the last century more-than-three-hour surgery was seen as an unfavorable factor, with the frequency of early infectious complications noted in 90 % of cases. Now the duration of primary arthroplasty procedure has decreased, and a more-than-90-minute procedure can indicate a high risk of PJI ($p < 0.001$) [20, 60, 61, 86, 87]. Q. Wang et al. explores whether prolonged operative time was an independent risk factor for of SSI within 90 days and PJI within 1 year following TJA. Overall, the incidence of 90-day SSI and 1-year PJI was 1.2 % and 0.8 %, respectively. Patients with an operative time of > 90 minutes had a significantly higher incidence of SSI and PJI (2.1 % and 1.4 %, respectively) compared to cases lasting between 60 and 90 minutes (1.1 % and 0.7 %), and those lasting ≤60 minutes (0.9 % and 0.7 %, $p < 0.01$) [88]. The risk for PJI increased by 18 % and SSI by 11 % for each 15-minute increase in operative time [63]. In patients undergoing primary TJA, each 20-minute increase in operative time was associated with nearly a 25 % increased risk of subsequent PJI [88]. Non-standard clinical scenarios increase the operating time. Intraoperative timing optimization may provide additional benefits for infection prophylaxis [21].

Modifiable risk factors studied in combination

A combination of risk factors and the possibility of the influence of institutional criteria (BMI ≤ 40 kg/m^2, hemoglobin A1c ≤ 7.5 %, hemoglobin ≥ 12 g/dL, albumin ≥ 3.5 g/dL, smoking cessation within 30 days before surgery, decolonization of Staphylococcus aureus) of preoperative surgical selection on the incidence of PJI for patients undergoing primary THR was explored. There was a statistically significant decrease in the frequency of PJI seen in patients who met all the criteria of preoperative screening: the cohort of patients without risk factors developed a PJI of 0.0 %, while the cohort of patients with risk factors had PJI of 2.9 % ($p = 0.0038$) [89]. The authors reviewed smokers with a history of knee infection and found the patients had a higher risk of PJI (OR 8.06; 95 % CI 1.33–48.67; $p = 0.023$). Patients with a history of treated septic arthritis are at high risk of PJI after TJR [90].

Despite the fact that many publications have confirmed that obesity is an independent risk factor for the development of PJI, there is interest in the synergistic effect of obesity with other factors on the occurrence of PJI. A group of researchers studied the relationship between obesity and PPI in the Chinese population and revealed the combined effect of obesity with other risk factors on the development of purulent complications after primary total arthroplasty of TBS/CS. The study of interaction and stratified analysis were carried out depending on age, gender, type of surgery, smoking status, alcohol consumption, history of diabetes, inflammatory arthritis, liver and kidney diseases in comparison of patients with PPI and without deep infection using a comparison of propensity scores for several important parameters.

Although a large number of studies have identified obesity as an independent risk factor for the development of PJI, the synergistic impacts of obesity with other factors on PJI remain unknown. Additionally, few studies have specifically explored the risk factors of PJI within a Chinese population and identified synergistic impacts of obesity with other risk factors on the development of PJI after primary THR/THK. Interaction and stratified analyses were conducted according to age, sex, type of surgery, smoking status, alcohol use, diabetes, inflammatory arthritis, liver disease and renal disease. In the interaction analysis, patients who were obese and smoked had a higher OR of developing PJI than non-smokers who were obese (OR 3.54 vs 1.55, P-value for interaction = 0.031). Similarly, the OR was much higher for patients with both obesity and inflammatory arthritis than for patients who were obese with no history of inflammatory arthritis (OR 3.9 vs 1.55, P-value for interaction = 0.029). No other significant interactions were found in the association between obesity and PJI [91].

The Russian authors conducted a comparative analysis to identify significant perioperative factors for the development of PJI after primary THR, as well as their combinations, and noted that the group with an increased risk of infectious complications included patients with a combination of four or more factors: BMI > 40 kg/m^2, preoperative hemoglobin < 115 g/L, operating time > 90 min., intraoperative blood loss > 410 mL, CRP > 69 mg/L on the 4th–5th day after surgery ($p < 0.001$) [20].

Modifiable risk factors of the surgical intervention site

Local risk factors for the development of SSI/PJI are reported. Hematomas at the site of the postoperative wound reported in 0.8 – 4.1 % of cases can cause infectious complications. Hematoma results in early SSI in every fifth patient [92]. There is controversy regarding permanent drainage of the postoperative wound (DPW) [93]. SSI is reported to develop in 1.3 to 50 % of cases after DPW. Alisina Shahi et al. have developed an authors' evidence based protocol for the management of postoperative wounds to allows successful DPW in 65 % of patients without subsequent surgical intervention for infectious complications. One third of the patients required surgical intervention in the form of superficial irrigation and debridement of the wound in 60.4 %, deep irrigation and debridement with modular replacement of implant components in 39.6 %. Additional risk factors contributing to increased rate of DPW and, consequently, the risk of SSI were female gender (OR: 1.9; 95 % CI: 1.1–2.2), glycated blood hemoglobin (HbA1c), diabetes (OR: 21.2; 95 % CI: 12.8–25.1), pathological obesity (OR: 17.3; 95 % CI: 14.7–21.5), RA (OR: 14.2; 95 % CI: 11.7–16.5), chronic alcohol consumption (OR: 4.3 ; 95 % CI: 2.3–6.1), hypothyroidism (OR: 2.8; 95 % CI: 1.3–4.2).

Aspirin was reported to be useful for anticoagulation with 50 % decrease of infection cases resulting from DPW as compared with warfarin [94].

Current epidemiological studies examining clinical risk factors do not usually take the site of the prosthetic joint into account. TN Peel et al. suggested that risk factors for deep prosthetic joint infection differ with the anatomical site. The risk factors for knee arthroplasty infection were SSI and the presence of wound discharge. The presence of a drain tube at the operative site was associated with a reduced risk of infection. In hip arthroplasties, increased drain tube loss, increased BMI and superficial incisional SSI were associated with prosthetic joint infection. In the combined cohort, superficial incisional SSI, wound discharge, increased drain tube loss and systemic steroid administration were all associated with prostheticjoint infection [16].

Modifiable risk factors – invasive interventions in the perioperative period

There are few studies reporting invasive interventions in the perioperative period of arthroplasty, such as esophagogastroduodenoscopy (EGDS) with biopsy, elective soft tissue hand surgery, dental procedures with antibiotic prophylaxis. N.Coelho-Prabhu reported EGDS with biopsy performed for TJR patients in the preceding 2 years being associated with an increased risk of prosthetic joint infection (OR = 3; 95 % CI 1.1–7). In a multivariable analysis adjusting for sex, age, joint age, immunosuppression, BMI, presence of wound drain, prior arthroplasty, malignancy, ASA score, and prothrombin time, the OR for infection after EGDS with biopsy was 4 (95 % CI: 1.5–10). The association will need to be confirmed in other epidemiological studies and adequately powered prospective clinical trials prior to recommending antibiotic prophylaxis in these patients [95]. Berbari EF et al. explored the association between dental procedures with or without antibiotic prophylaxis and prosthetic hip or knee infection and found that antibiotic prophylaxis in high-risk or low-risk dental procedures did not decrease the risk of subsequent total hip or knee infection [96].

Although current guidelines do not recommend the routine use of surgical antibiotic prophylaxis to reduce the risk of SSI following soft tissue hand surgery, antibiotics are nevertheless often used in patients with an existing joint prosthesis to prevent PJI. K. Li et al. explored whether clean, soft tissue hand surgery after THA or TKA can be associated with PJI risk and whether surgical antibiotic prophylaxis before hand surgery can decrease PJI risk in patients with recent THA or TKA. Clean, soft-tissue hand surgery was not found to be associated with PJI risk in patients who had undergone primary THA or TKA within 2 years before their hand procedure with data supporting routine use of surgical antibiotic prophylaxis in this setting [97].

DISCUSSION

Coexisting risk factors should also be taken into consideration and treatment plans are devised since the factors can individually predispose patients to increased infection risk with amplifying effects. It is imperative that orthopaedic surgeons understand and identify these risk factors prior to TJA so that they can develop interventions to optimize patients and minimize their risk of developing a postoperative infection. Preventive care is a cornerstone of public healthcare in the XXI century aimed at reducing. Prevention is the most important strategy to deal with such disabiling complication of TJR as SSI/PJI this disabling complication, and prevention should begin with identifying patient-related risk factors. They should be evaluated and optimized prior to surgery [6, 98].

Unfortunately, the preparation stage for the elective surgical intervention does not always allow you to use the time for active work with the patient to reduce the risks of postoperative complications. Primary care specialists involved in the examination and correction of the patient's status at the preoperative stage are forced to use a significant amount of time preparing medical documentation, rather than questioning and talking with the patient. There is often no links between outpatient and inpatient treatment.

Providing high-tech medical care, the "continuous flow process" of hospitalization gives little chances to attending doctor to be involved in the part of the work to minimize risks of complications during the patient's preparation for surgery. Iatrogenic effects in the form of invasive surgical interventions are also important and modifiable at the preoperative stage. Doctors who treat patients with joint pathology and produce intra-articular and paraarticular injections, GC, in particular, should be accurate administering local injection therapy for arthroplasty candidates. Related specialists should be informed about the elective TJR surgery and also take a more balanced approach to prescribed invasive diagnostic and therapeutic interventions. Appropriate information about the risk factors of the intraoperative and postoperative stages is binding for the attending physician to adhere to generally accepted practices of preoperative planning, the choice of an implant, including a friction pair, surgical technique and time of surgery, drain use or no-use for the postoperative wound, timely evacuation of hematoma and early effective treatment of superficial infection, high-quality antibiotic prophylaxis and personalized antibacterial therapy.

CONCLUSION

Many of the above modifiable risk factors are presented with strong and moderate-quality evidence confirmed by experts in the field. All of them can be corrected in the perioperative period. Nevertheless, the evidence is too limited for many of these risk factors including multiple combined comorbidities in these patients.

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