



Risk factors for periprosthetic joint infections

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ABSTRACT

Periprosthetic joint infection is one of the complications developing after surgical implantation of the prosthetic joint. Combined with ageing of society, number of arthroplasties will grow. Knowledge of risk factors of PJIs (periprosthetic joint infections) is essential for surgeons performing such interventions. There are many groups of risk factors. Patient's race does not clearly predispose to developing PJIs. Age is not a key factor of occurrence of PJIs. Sex of patient plays important role (more PJIs in male patients) when there are no additional risk factors such as comorbidities – in that case females are suffering from PJIs more often. Alcohol intake is not clearly correlated with increased risk of PJIs while tobacco smoking and higher BMI increased that risk significantly. Cardiovascular, pulmonary tract, renal, gastrointestinal, rheumatological and oncological diseases are important PJIs risk factors as well as as diabetes, immunosuppression, preoperative infection and depression. Such complications are also bond with higher ASA score, some of the lab test results. Last group of risk factors is related with treatment – complications during surgery, other conditions like hypothermia, longer hospital stay, blood transfusion and reoperations. It is vital to acknowledge these risk factors and manage to remove these related to surgeon while encouraging patient to deal with these related to him.

Keywords: periprosthetic joint infections, arthroplasty, hip arthroplasty, orthopaedic, microbiology

1. INTRODUCTION

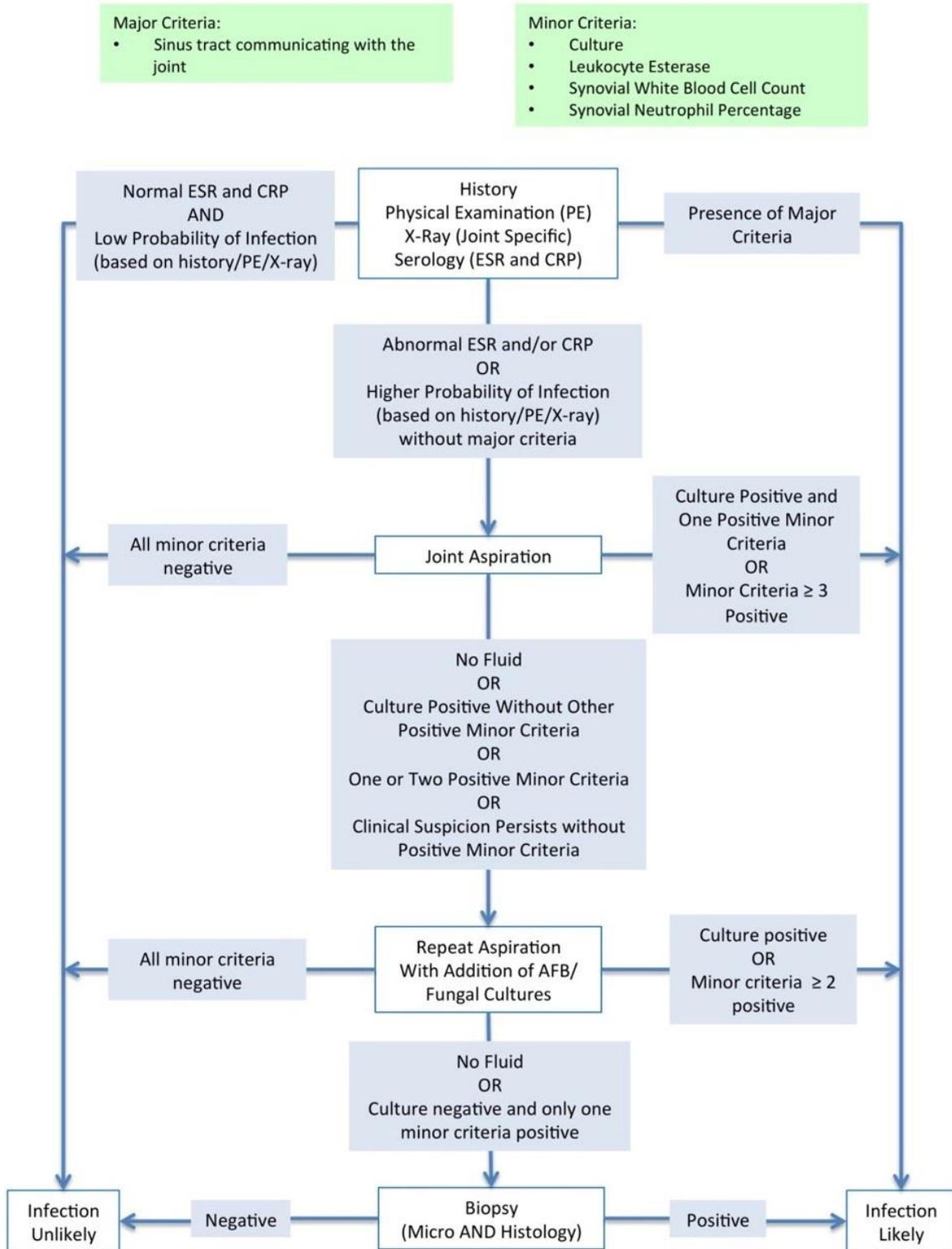


Figure 1. Diagnosis algorithm of periprosthetic joint infection [21].

Periprosthetic joint infection is a condition developing as a complication in patients who undergo an arthroplasty with implantation of the prosthetic joint. There are multiple known risk factors for periprosthetic joint infection, that can be divided into several groups, both patient-related and surgery-related [1]. This serious complication can be an emerging problem in the future, as it is stated, that by 2050 even more than 6 million people around the world yearly will suffer from femoral neck fracture, that often has to be treated with hip arthroplasty [2], and the hip joint is not the only one of the joints possible to replace, as knee joint and shoulder joint replacements are also worth mentioning.

Knowing the risk factors for PJIs (periprosthetic joint infections) is vital in preparing the patients for the surgery, as the state can be potentially fatal. Moreover, many of the joint replacement surgeries are performed in older patients with multiple comorbidities such as cardiovascular or rheumatological diseases. The aim of the study is to make a review of the literature concerning risk factors for periprosthetic joint infections and the ways to prevent them.

2. RESULTS

Risk factors for the PJIs will be divided in this work into following groups: medical, lifestyle and demographic patient-related risk factors, surgery-related risk factors and hospital-related risk factors. What is worth mentioning, in many patients an overlap of different risk factors exists. Most of the cited articles will refer to hip replacement, as the most common type of joint replacement arthroplasty.

2. 1. Patient-related risk factors

2. 1. 1. Demographic-related risk factors

2. 1. 1. 1. Race

A study from 2013 concerning over 53,000 patients after primary THA (total hip arthroplasty) reveals, that patients of white (Caucasian) race are at higher risk of developing periprosthetic joint infection within 90 days from the surgery in comparison to the patients of other races, although in this study the race is not an independent factor determining the increased risk of infection [3].

However, there are limited data in the literature to back this theory; a large systematic review on this topic from 2014 indicates, that incidence of PJIs within 90 days from the surgery is in general bigger in non-white patients, although this fact can be explained by co-existence of other risk factors in the non-white patients involved in the analyzed studies like, for example, higher BMI [1].

2. 1. 1. 2. Age

The same study from 2013 mentioned in the previous paragraph suggests, that the age of 70-74 places the patients at the highest risk of developing PJI, but the conclusion is, similarly like in case of race, true only for patients with other risk factors [3]. Many other studies show that patients older or younger than abovementioned ones are at higher risk of infection [1].

In a meta-analysis from 2016 data on more than 500,000 patients were analyzed, and no significant association between age of the patient and incidence of PJIs was found [4].

2. 1. 1. 3. Sex

Authors of most studies agree, that male gender is a predisposing factor in developing periprosthetic joint infections. The relative risk of suffering from this condition is even 36% higher in males, than females, according to a large meta-analysis [4,5]. However, there are suggestions that in some certain groups of patients with many comorbidities and risk factors like depression, urinary tract infection, peptic ulcer disease etc. this risk can be higher in females [3].

2. 1. 2. Lifestyle-related risk factors

2. 1. 2. 1. Alcohol intake

High alcohol intake was a known risk factor for developing periprosthetic joint infection after joint replacement surgery [3,6], until 2016 meta-analysis in which 23 prospective cohort and 43 retrospective cohort and case-control studies were investigated. No significant correlation between high alcohol intake and PJIs was found [4], which shows that this issue needs further investigation.

2. 1. 2. 2. Tobacco smoking

Tobacco smoking is strongly associated with periprosthetic joint infections. Smokers are exposed to 83% higher risk, on average, of developing PJIs than non-smokers. There are no convincing studies showing that there is no correlation between smoking and PJIs [4,7].

2. 1. 2. 3. Increased BMI and obesity

Higher BMI (body mass index) is undoubtedly an important risk factor for developing periprosthetic joint infection (both continuous and dichotomous variables) [5,8,9]. Obesity (defined as $BMI \geq 30 \text{ kg/m}^2$) can increase the risk of PJI's incidence up to 70%, while having BMI as high as 40 kg/m^2 and more can boost this risk 4 times, on average [7,10,11].

2. 1. 3. Medical patient-related risk factors

2. 1. 3. 1. Cardiovascular diseases

Cardiac arrhythmia, congestive heart failure and ischemic heart diseases are cardiovascular conditions, which, when present in a patient, put the patient in a high risk of developing periprosthetic joint infection after the surgery [3]. Even a history of myocardial infarction seems to be an aggravating factor for patients undergoing joint replacement [5]. Peripheral vascular diseases are also one of major risk factors for PJIs [3].

2. 1. 3. 2. Pulmonary diseases

Among diseases of the respiratory tract, chronic obstructive pulmonary disease seems to be an important risk factor not only for developing periprosthetic joint infection, but also for fatal complications after total hip arthroplasty [3].

2. 1. 3. 3. Rheumatologic diseases

Rheumatologic diseases such as rheumatoid arthritis are one of the major risk factors for developing periprosthetic joint infection. In 2012 data of more than 40,000 patients after primary total hip arthroplasty were analyzed. The conclusion of the study was, that the risk of PJI's incidence in patients with rheumatologic comorbidity was 71% higher than in general population [3,4,9-11].

2. 1. 3. 4. Renal insufficiency and urinary tract diseases

There are not many studies concerning the risk assessment of the periprosthetic joint infection's incidence in patients with kidney failure. However, a study from 2011 on the role of perioperative hyperglycemia in the development of PJI suggests, that renal insufficiency can also increase the abovementioned risk [5]. Also perioperative urinary tract infections (even asymptomatic bacteriuria) are significantly related to PJIs [3,6,10].

2. 1. 3. 5. Gastrointestinal diseases

A study from 2014 including more than 16,000 patients who have developed periprosthetic joint infection and have been suffering from cirrhosis showed, that this liver condition was a serious risk factor for PJI's incidence, as well as for longer hospital stay, higher rate of mortality after the surgery, increased costs and more often need for reoperation [12]. In turn, peptic ulcer disease also turns out to be a statistically significant risk factor for PJI's incidence [3].

2. 1. 3. 6. Diabetes

Diabetes mellitus is a widely known endogeneous risk factor for different kind of infections, including periprosthetic joint infections [4,9,10]. A study on a group of 101 infected patients and 1847 noninfected patients (within 2 years from the surgery), showed that diabetic patients were one-fifth of the infected group, while being only one-tenth in the noninfected group [5]. Moreover, a cohort study from 2015 of more than 20,000 patients who underwent total hip or knee arthroplasty procedures showed, that the risk of PJI's incidence in diabetic patients were 55% higher than in general population [13]. Also perioperative hyperglycemia is associated with an increased incidence of PJIs. According to different studies, a hazard ratio for incidence of PJIs in patients with perioperative hyperglycemia varies in compartment of 1.44-1.59 [13,14]. What is more alarming, patients who do not suffer from diabetes, but have an increased blood glucose level in the morning on the next day after the surgery, are three times more likely to develop an infection [5]. Even the sole fact of using diabetes medications is an independent risk factor for developing PJI [13]. On the other hand, hemoglobin A1c values do not correlate with the risk of periprosthetic joint infections [13,14].

2. 1. 3. 7. Oncological diseases

Oncological diseases, especially malignancy are statistically significant risk factor for periprosthetic joint infections, according to two large systematic reviews from 2015, where one includes a meta-analysis of 14 studies on patients after total joint arthroplasty performed between 1980 and 2004 [9,10].

2. 1. 3. 8. Depression

A study analyzing more than 53,000 patients whose data were collected in Medicare base and a meta-analysis of studies including more than 512,000 patients after total joint arthroplasty confirm that depression is an identified factor increasing the risk of incidence of periprosthetic joint infections, especially in women [3,4].

2. 1. 3. 9. Immunosuppression and immunodepression

Immunosuppression of different causes is a significant risk factor for incidence of periprosthetic joint infections according to different studies [9,10]. Also using of immunosuppressants like corticosteroids can lead to an increased risk of developing PJI [4,9]. Especially intraarticular injections can cause a growth of the risk – in two studies published in 2016 researchers proved that performing an intraarticular steroid hip injection within 3 months before total hip arthroplasty puts patients under significantly higher risk of PJI. If the arthroplasty is performed after 3 months, abovementioned risk returns to population norm [15,16].

2. 1. 3. 10. Preoperative infection and colonization

Preoperative or chronic infection can increase the risk of incidence of periprosthetic joint infection [10]. Especially infection in the area of the surgery may be dangerous. Preoperative ESBL (Extended Spectrum β -Lactamase bacteria) infection is a significant factor for PJI [6], as well as *Staphylococcus aureus* colonization [7].

What is more disturbing, the risk of developing a PJI in a joint after arthroplasty at one side is also increased, when the patient underwent another arthroplasty at another side before, complicated by periprosthetic joint infection, especially, if the initial infection was a staphylococcal species [17].

2. 1. 3. 11. ASA score

Higher ASA score (American Society of Anesthesiologists physical status classification system) can be a predictive factor for the increased risk of developing periprosthetic joint infection, according to a prospective cohort study of 1104 patients that underwent a primary, elective total hip arthroplasty [8].

2. 1. 3. 12. Laboratory test results

Following laboratory conditions are identified risk factors for periprosthetic joint infections:

- preoperative anemia [3,11,18];
- electrolyte disorder [3];
- coagulopathy [9,11];
- hypoalbuminaemia [9];
- elevated preoperative serum-CRP (C-reactive protein) [6].



A



B

Figure 2. Early Prosthetic Hip Joint Infection (A) at presentation with infection showing wound erythema, swelling and purulent discharge and (B) intra-operative appearance showing purulence surrounding the prosthetic joint [22].

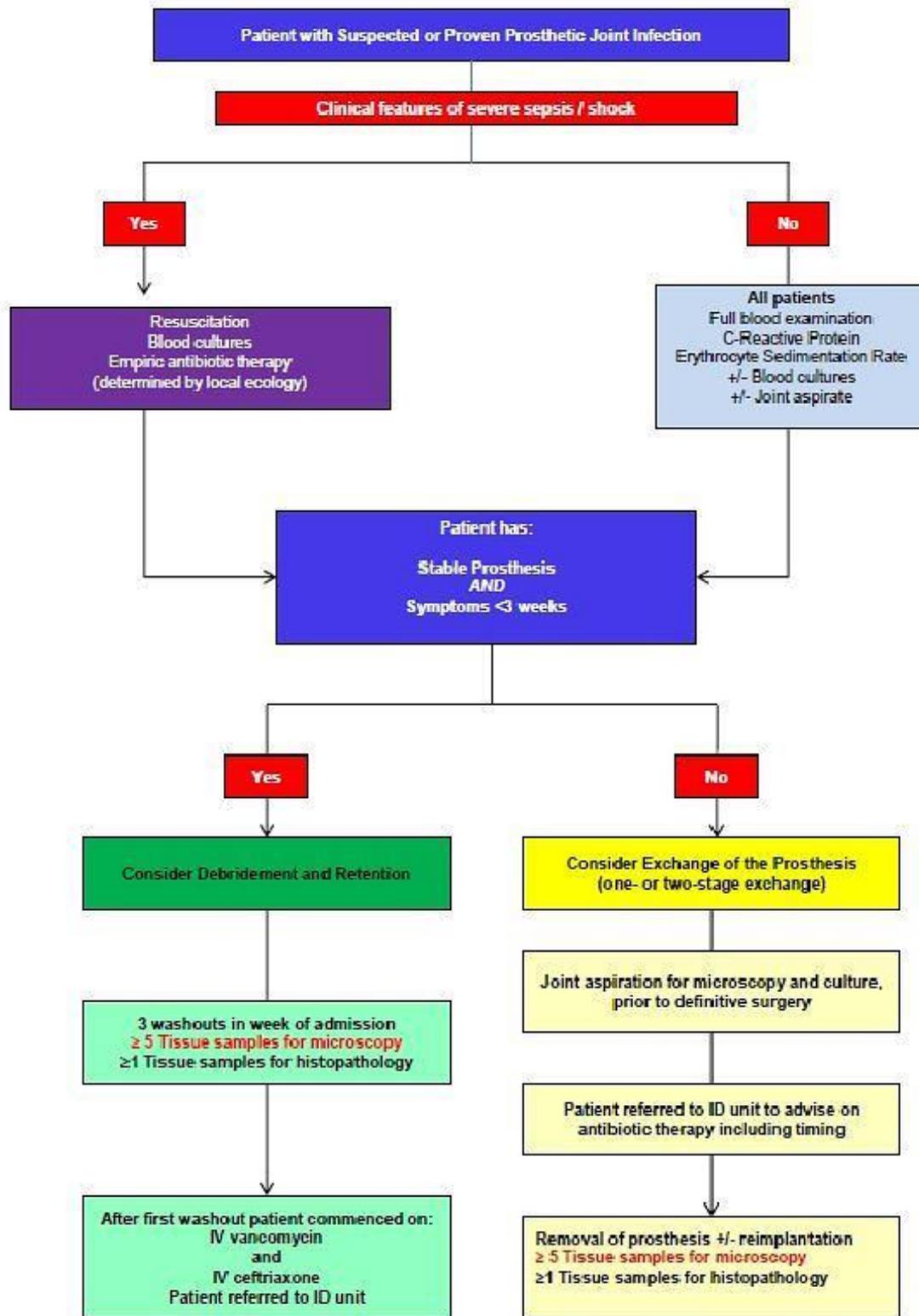


Figure 3. SVHM Protocol Algorithm for Management of Prosthetic Joint Infection [22].

2. 2. Treatment-related risk factors

2. 2. 1. Surgery-related risk factors

It is proven, that extended operative time is a key factor in increasing the risk of periprosthetic joint infections' incidence, especially, when the duration of the surgery is longer than 115 minutes (with odds ratio 3.38) [5-7,9,10].

Also intraoperative complications, a presence of a wound drain, wound dehiscence and superficial surgical site infection are the risk factors for developing periprosthetic joint infection [6,9].

The history of previous joint surgeries and the type of the operation (knee arthroplasty especially) are also associated with more often incidence of PJIs [4,5,9].

Also hypothermia during surgery is responsible for growth of incidence of PJIs [10].

On the other hand, there are no evidences, that a specific approach during the surgery (in case of total hip arthroplasty) is somehow associated with an increased risk of PJI. Both direct anterior approach and lateral transgluteal approach have similar outcomes in terms of infectious complications [8].

There are also no proofs that the arthroplasty performed immediately after an infected case in the same operating room just before can be risky for patients in terms of possible sources of infection [19].

In turn, bearing surface type in an implant, if it is CoC (ceramic-on-ceramic) bearing, can even lower the risk of the PJI in comparison to CoP (ceramic-on-polyethylene), MoP (metal-on-polyethylene) and MoM (metal-on-metal) [20].

2. 2. 2. HOSPITAL STAY-RELATED RISK FACTORS

Extended hospital stay is a serious risk factor for developing periprosthetic joint infection [5,6], which is often explained by an exposure to hospital-acquired (nosocomial) infections [9]. Even the sole fact of postoperative antibiotic therapy is significantly related to PJIs incidence [6]. Blood transfusion during hospital stay is also considered as a risk factor for periprosthetic joint infection, according to different studies [9,10].

Nonsame-day surgery

3. CONCLUSIONS

There are multiple risk factors for periprosthetic joint infections. Only a few of them, especially demographic-related risk factors are unmodifiable. Many others are modifiable at least up to a certain point. Thus it is vital to encourage patients who are planned to undergo a joint replacement procedure to quit smoking and limit the alcohol intake, as well as to lose some weight and lead healthier lifestyle. If possible, every comorbidities should be well controlled before the surgery, most of all - chronic infections. Treatment-related risk factors are also partially modifiable, for instance, if possible, it is important not to extend operative time if not necessary. Also extended hospital stay without a clear need should be avoided.

Knowing of all abovementioned risk factors (and the list probably do not include all possible conditions) is a key factor to minimize the incidence of periprosthetic joint infections in patients undergoing joint replacement procedures, as well as the incidence of all

complications of PJIs, including fatal outcome. Presentation of the PJI, diagnostic algorithm and management algorithm can be seen on Figures 1-3.

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Biography

Mr. Marcin Kulczyński, M.D., is a young doctor working in a military hospital, for years cooperating with microbiology department at local medical university. His main fields of interest are drug resistance, neurological infections and aviation epidemiology.

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