Abstract

Periprosthetic joint infection (PJI) remains a serious complication following a total knee replacement. Infections rates following arthroplasty range from 0.5% to 3%. The acutely infected knee replacement often presents to the on call Orthopaedic Surgeon who can often lack the expertise or resources for the definitive management. However, obtaining an early and accurate diagnosis and potentially performing an early treatment such as irrigation and debridement may be required by the on call surgeon. Management of these patients should include a team of specialists including Medical or Intensive Care, and Infectious Disease. Management of PJI is expensive, complicated and has a high morbidity. These patients should have their definitive care by specialist multidisciplinary teams on a regional basis.

Introduction

Periprosthetic joint infection (PJI) remains a serious complication following a total knee replacement. Cumulative rates of both acute and chronic infections following arthroplasty range from 0.5% to 3%[1-6]. A two-stage revision arthroplasty is considered the gold standard for treatment in chronic PJI. Success rates for two stage revision range from 72 to 93%[7-9]. A one stage revision arthroplasty has also become a standardized treatment for chronic PJI in some specialized European centres, and has some potential benefits over a two stage revision[8,10,11].

Treatment for the acutely infected knee replacement is broader and can vary from irrigation and debridement with exchange of modular parts, to revision arthroplasty. Acute infection can present to the Orthopaedic surgeon on-call who may not have sub-specialty training in knee arthroplasty. In this article we focus on the basic framework of knowledge, including the diagnosis and treatment options, for acute periprosthetic joint infections of the knee for the on-call surgeon. It should be noted that some of our suggested protocols are meant for the on-call surgeon who does not specialize in knee arthroplasty and who may not work in a tertiary referral centre, where a more definitive treatment would be performed.

Classification

In general, most guidelines distinguish prosthetic joint infections as early or late infections[12-14]. We use the definition of early (or acute) PJI, as described by Gerhke et al., as those with either a recent knee replacement or late haematogenous infections of which the onset of symptoms have been less than 3 weeks[10]. This 3 week period has been fairly well accepted and is premised on the basis of biofilm formation.

Within this group of early infections a subset of this group may present with acute sepsis and should be treated much more urgently. Based on this, acute PJI can be divided into 3 distinct groups:

1. Acute post-operative infections
2. Acute haematogenous infections (or delayed acute infections)
3. Acute infection with sepsis

The distinction between early and late (or chronic) infections (symptoms greater than 3 weeks) is important as it helps dictate the type of treatment and likely outcomes[10,13,15-18]. Some early infection may be treated with aggressive irrigation and debridement, exchange of modular components and retention of well-fixed components. However, other factors must be taken into account in addition to the timing of the infection. This includes host factors such as the patients medical and immune status, local soft tissue factors and virulence of the microorganism (See Key Factors Box)[1,3,5,8,10,11].

Key Factors Influencing Outcome of Treatment

1. **Timing of Infection (Early versus Late)**
2. **Patient Medical and Immune Status**
3. **Local Soft Tissues**
4. **Virulence of the Microorganism**

Pathophysiology

The importance of timing of symptoms is based on the idea of bacterial formation of a biofilm. Once a biofilm has been formed, irrigation and debridement is unlikely to be successful[19,20]. It is presumed that organisms produce this biofilm within a 3 week period, and hence the distinction between early and late infection at the 3 week mark. However, there is evidence to suggest that a biofilm may be formed much earlier than this, potentially within days or even hours[21,22]. It is therefore likely that earlier treatment and using antimicrobials with activity against biofilms, may lead to better outcomes[4,15,16]. Equally, some microorganisms are more aggressive biofilm formers than others.

Diagnosis of Periprosthetic Joint Infection

All patients suspected for an acutely infected prosthesis should undergo the same standard diagnostic algorithm (Figure 1). This includes history, physical examination, blood tests (including ESR and CRP) and radiographs of the prosthesis[23]. A knee aspiration and potentially blood cultures should also be performed if an acute infection is suspected. We recommend the diagnosis for PJI as defined by the International Consensus on PJI rather than using the surgical site infection (SSI) criteria defined by the Centers for Disease Control (CDC). The latter encompasses superficial infections and, therefore, by definition is not an infection of the prosthesis itself. The International Consensus on PJI have recently made some adaptations in the criteria initially made by the Musculoskeletal Infection Society (MSIS)[24]. Based on their recommendations, criteria for the diagnosis for PJI exists when[14]:

1. Two positive periprosthetic cultures with phenotypically identical organisms, or
2. A sinus tract communicating with the joint, or
3. Having three of the following minor criteria:
    a. Elevated ESR and CRP

b. Elevated synovial fluid white blood cell (WBC) count or ++change on leukocyte esterase test strip
c. Elevated synovial fluid polymorphonuclear neutrophil percentage (PMN%)
d. Positive histological analysis of periprosthetic tissue
e. A single positive culture

However, patients who meet the criteria for systemic inflammatory response syndrome (SIRS) with acute onset of symptoms (such as pain, warmth, erythema and swelling) in a previously asymptomatic knee, should be treated as an acute emergency. The SIRS criteria are shown in Table 1.

History and Physical Examination

As for any diagnosis, a thorough history and physical examination should be performed on every patient suspected of an early PJI. History suspicious for an acute infection includes acute onset of pain, warmth, erythema and effusion surrounding a patient's prosthetic knee as well as potential systemic features of fever, chills or night sweats. In the setting of an early post-operative period, this may also include persistent drainage from the surgical wound or even the formation of a sinus tract. Symptoms of pain are highly sensitive for PJI, but non-specific[25,26]. In contrast, local features of warmth, erythema and swelling are less sensitive for infection but more specific with specificity ranging 0.77 to 1[25,27]. History should include the date of the primary procedure, past surgeries to the joint, wound healing problems, recent or on-going wound drainage, previous infections of the joint, comorbid conditions and drug allergies and intolerances[13]. A medication history should be obtained including the on-going or past use of antibiotics and immunosuppressive drugs. The use of anticoagulants should also be identified prior to surgery and should be reversed if at all possible. However, in the systemically unwell patient where reversal may delay surgery, a less invasive procedure to decrease bacterial load, such as arthroscopic washout, may be considered as a temporizing measure. Any inciting source of infection including dental work, recent

skin breaches or recent infections such as urinary tract or chest infections, should be elicited as they may need to be addressed in conjunction with the infected joint[28]. Implant records and operative notes should be obtained if at all possible to provide information for revision for exchangeable parts. Determining the duration of symptoms is of key importance as this will help dictate whether the infection is an early or late infection, and thus, its appropriate treatment. Early presentation should be considered within three weeks of the procedure, or within three weeks of the development of symptoms[10].

A thorough examination should include a full set of vital signs as some patients can present with signs of severe sepsis and subsequent hemodynamic instability. Focused examination of the knee should be performed looking for signs of infection such as warmth, swelling or erythema. Assess for skin changes such as erythema, wound breakdown or presence of a sinus. Pain with range of motion or weight bearing in a previously non-painful knee is also suspicious for an acute infection. A physical examination of the heart, lungs, abdomen, and other joints should also be performed to look for other potential sources of infection. Although a more thorough physical examination is often performed by a medical or emergency physician, the orthopaedic surgeon should be aware of other primary sources of infection as if it is not identified and addressed, then there is a high likelihood of treatment failure.

Investigations

Blood tests including CRP and erythrocyte sedimentation rate (ESR) should be performed on all patients suspected of PJI[10,13,14]. The combination of ESR and CRP is highly sensitive for infection[29,30]. Following surgery, CRP levels are typically elevated and return to normal levels within 3 weeks[4,31]. Recent evidence suggest the cut-off levels for the diagnosis for PJI are an ESR > 55 mm/h and CRP > 24mg/L when within 4 weeks of a patient undergoing a total knee replacement and an ESR > 47 mm/h and CRP > 24mg/L when beyond a 4 week period from surgery[32].

Blood cultures to assess for concomitant bacteraemia, should be obtained in patients who are febrile or meet the SIRS criteria, have a known associated infection, or have a known bacteria with a propensity for haematogenous spread (S. *aureus*)[13]. It is mandatory to obtain blood cultures in patients with symptoms suspicious of infective endocarditis.

A diagnostic aspiration should be performed in all patients with a suspected acute PJI where synovial fluid should be submitted for cell count and differential, gram stain, leukocyte esterase and aerobic and anaerobic culture. This should be performed in a clean environment such as a dedicated treatment room or theatre. Aspirated fluid should be inoculated in blood culture flasks as some authors have found that this yields better results towards growing and identifying microorganism[33]. The sample should be marked as urgent and the micro on call team should be notified to culture the sample immediately. Other tests such as those testing for synovial levels of alpha defensin, which is an antimicrobial peptide released by neutrophils in response to pathogens, have shown a high sensitivity and specificity but are much more costly and its role in the diagnosis in the scenario of acute infection is less well defined[34].

Antibiotics should be withheld prior to knee aspiration and preferably patients should have an antibiotic free period of 14 days prior to the aspiration[12,35]. However, in the acutely infected knee, it may be necessary to start a patient on antibiotics acutely without samples from the joint especially if the patient shows signs of sepsis with hemodynamic instability. An aspiration may need to be performed in the emergency department if there is an urgent need to start antibiotic therapy and the diagnosis is obvious. However, routine aspiration in the emergency room environment should be avoided, as every effort should be made to avoid contamination of results or iatrogenic infection. If aspiration is performed in the emergency department, it must be done using a strict sterile technique. Obtaining

an aspiration will not only help in determining a PJI, but if positive, an effective treatment plan can be tailored towards the specific pathogen that is grown with potential for a better outcome.

Current threshold levels for diagnosing PJI as recommended by the International Consensus on PJI are a synovial white blood cell (WBC) count > 3,000 cells/ml and neutrophil percentage greater than 80%[14]. However, it should be noted that these are thresholds more suitable for chronic infections rather than acute infections. This threshold increases to synovial WBC count > 10,000 cells/ml and neutrophil percentage greater than 90% for acute infections, where acute infections are within 6 weeks of surgery. For acute haematogenous infections the threshold is also higher.

Management

Treatment options for acute PJI include arthroscopic or open irrigation and debridement (I & D) with retention of the prosthesis or removal of the prosthesis via either a one or two stage exchange arthroplasty. Other options that exist include long-term antibiotic suppression, arthrodesis and amputation, but these alternatives are better suited in some instances for failed treatment for acute infections or chronic infections and will not be covered here.

Irrigation and Debridement

An open irrigation and debridement with exchange of modular components is a generally accepted treatment for acute (early) infections, where early infection is defined as within 3 weeks of the onset of symptoms[10]. Despite this being a treatment option for this 3 week window, we advocate for surgical management to be performed as early as possible to the onset of symptoms as this has been shown to result in a higher success rate for infection clearance[15,16]. Post-operative antibiotics should be prescribed following I & D although their duration is not fully delineated[10,36]. Micro guidance for antibiotic type and duration is essential.

Typically, IV antibiotics are given until CRP levels return to levels below 50mg/L, at which point they are switched to oral. Some authors advocate for prolonged antibiotic treatment in addition to the debridement and implant retention in what is called a DAIR (debridement, antibiotics, implant retention) procedure for the treatment of PJI[37,38].

Absolute contraindications to an open I & D for acute infection include presence of a sinus tract, inability to close the wound or a loose prosthesis (Table 2)[36,39]. Other relative contraindications include highly virulent organisms (e.g. MRSA, polymicrobial or fungal), significant patient comorbidities or immunosuppression [1,40,41]. A number of factors influence the decision to perform an I &D, including:

- Host factors – the immune status of the patient, comorbidities
- Knee factors – the number of previous surgeries, scars, skin bridges or presence of a sinus
- Organism factors – the resistance or type of organism isolated.

If there are concerns regarding the host, the organism, the soft tissues or the stability of the implant, a more reliable treatment result can be achieved using a revision procedure rather than perform a debridement procedure. Outcomes following irrigation and debridement appears to be quite variable with success rates ranging from 31% to 100%[42-45]. Whereas revision procedures, in general, appear to be more reliable with success rates ranging from 72% to 100%[7-9,11].

Arthroscopic Washout

There is a limited role for arthroscopic irrigation and debridement in the definitive treatment for early prosthetic joint infections. Several studies have shown worse outcomes with arthroscopic irrigation and debridement compared with an open procedure[37,46,47]. In an arthroscopic debridement, the surgeon is unable to adequately access all compartments and areas of the joint and therefore this will likely lead to an inadequate debridement[36]. Only under specific circumstances

should arthroscopic debridement be considered. This potentially includes situations where definitive treatment will likely be delayed in patients who are acutely septic who are not fit for a major procedure. The bacterial load may be decreased through arthroscopic debridement while the patient awaits a more definitive treatment. This option may be suitable for patients awaiting transfer to a referral centre, who are medically unwell or are on anticoagulation[47]. An urgent arthroscopic washout with aspiration and biopsy in theatre on the day of admission may reduce the septic load, allow for improved micro diagnosis and prevent SIRS. However, arthroscopic irrigation and debridement should not delay a more definitive treatment and should not be used as the sole form of surgical treatment in the acutely infected knee replacement.

One or Two Stage Revision Arthroplasty

If any of the contraindications to I & D exist, there is a high likelihood of failure and a one or two stage revision arthroplasty should be performed and the patient should immediately be referred on to a revision knee surgeon. In a two-stage revision arthroplasty, the first stage entails removing all implants and implant related material (such as cement) with a further thorough debridement of all possibly infected tissue and synovium. An antibiotic spacer is implanted, with the goal of delivering high doses of antibiotics to the local soft tissue. Antibiotics are usually given for a six-week period but this is somewhat dependent on the virulence of the organism being treated as well as response to treatment. Antibiotics are stopped and typically two weeks later the patient is reassessed clinically and inflammatory markers (CRP and ESR) are repeated. Once the infection appears to have cleared clinically and inflammatory markers have normalized, the second stage is performed. This typically occurs between 2 and 3 months after the first stage, and involves a second thorough debridement followed by re-implantation of a knee replacement. There is a role for a single stage revision procedure but this is somewhat dependent on the philosophy and expertise of the individual centre as well as consideration for patient factors, soft tissue envelope and virulence of the organism[13]. Both one and two stage revision arthroplasty should be performed by

orthopaedic surgeons with sub-specialty training in knee arthroplasty. It is not recommended to be performed by the orthopaedic surgeon on call unless they have sub-specialized training in this area and are at a centre with adequate resources to do so.

Antibiotic Treatment

Antibiotic treatment should be tailored to the organism grown on cultures. In the acutely infected knee replacement, broad-spectrum antibiotics should be started if the patient is showing signs of sepsis. In our centre, empiric antibiotics for acute sepsis include Vancomycin and Tazocin. A Microbiology disease specialist should be consulted to help determine the type and duration of antibiotic, as well as to monitor the patient during treatment. Following surgery, a standardized protocol with respect to duration and mode of administration of antibiotics has yet to be agreed upon. In the presence of a negative culture, but a history and physical suggestive of infection and positive criteria for PJI, the patient should still be treated as an acute infection.

Below is the Exeter Knee Reconstruction Unit individual algorithms for the treatment of acute periprosthetic infections of the knee.

1. **Acute Post-operative Infections in the Stable Patient**

Patients with acute post-operative infections may present with persistent wound drainage or the development of a sinus tract. This may be associated with symptoms of an acutely painful knee or on-going pain since the initial procedure. These patients may require acute admission and investigation for PJI. Early specialist referral is suggested before surgical intervention or exploration.

A protocol should be followed when performing an I & D for an acute infection. In general this includes preoperative optimization of the patient, good visualization and thorough debridement, removal and exchange of all modular parts, obtaining

multiple culture samples and copious irrigation (6–9 L) of the joint (Figure 2)[36]. The following is our recommended protocol for irrigation and debridement:

- Optimization and treatment of the patient should be done in conjunction with a team of specialists. This often includes an Orthopaedic surgeon, Medical physician and Infectious Disease specialist. In the stable patient, all efforts should be made to optimize the patient prior to surgery. This includes addressing any coagulopathy, uncontrolled glycaemia, and easily reversible medical conditions[36]. If the surgeon at the time of initial diagnosis has no experience in the debridement of joint replacements, they should refer the case to a specialist as the success of this operation depends greatly on the quality of the debridement. Access into an infected TKR where the tissue planes have been distorted can be challenging, even to an experienced surgeon.
- All efforts should be made to identify the implants in the patient. This includes obtaining hospital notes to look for operative records and preferably implant stickers. If your hospital does not stock the specific implant or knowledge is lacking on how to remove or implant the tibial insert, one should not proceed to exchange the tibial insert.
- Bleeding is often encountered during the debridement. The use of diathermy and tourniquet may aid in visualization and haemostasis during debridement. Although we would not advocate the routine use of a tourniquet in order to maximize skin perfusion throughout the procedure.
- The tissue planes are often difficult to identify. It is recommended to keep large tissue flaps.
- An aspiration of the knee should be performed and sent for culture once the skin incision has been made in order to avoid contamination from skin flora. If enough fluid is aspirated, the fluid should be sent as three samples: one sterile pot for microscopy, cell count and culture, and two blood culture bottles for aerobic and anaerobic culture. A Leukocyte esterase strip should be considered for the diagnosis of infection if the diagnosis is still uncertain.

- Separate clean scalpels and forceps should be used to obtain 5 tissue samples from around the knee and sent urgently for microbiology.
- All component interfaces should be exposed to assess for loosening[48]. If loosening is encountered, one should proceed to removal of the implants via either a one or two stage revision.
- Perform a thorough and aggressive debridement of all infected synovium and tissue. Care and time must be spent clearing the gutters (including behind the patella), the notch and suprapatellar pouch. The tibial liner, if modular, should be removed to gain access to the posterior capsule as well as to effectively clear organisms and biofilm under the liner[36].
- 6 to 9 litres of normal saline should be used to thoroughly irrigate and wash the wound until the fluid is clear. An aqueous chlorhexidine solution (2%) can be used to soak the knee for 5 minutes.
- At this point, the wound can be covered and new drapes are placed over the limb in addition to obtaining a new instrument table and surgical instruments. Surgeon and nursing staff should regown and glove prior to inserting a new polyethylene liner. Adequate haemostasis should be achieved prior to closure.
- Post-operatively, the patient should be discussed with an Infectious Disease specialist for on-going antibiotic treatment which should be tailored to the specific organism identified on cultures.

2. **Acute Haematogenous Infections in the Stable Patient**

This group of patients may present with an acute onset of pain, warmth, erythema and effusion surrounding their prosthetic knee**.** This may be associated with decreased range of motion and possible inability to weight bear. Again this patient may require acute admission and investigation for PJI with early specialist referral. Surgical treatment is similar to acute post-operative infections as described above (Figure 2). Aspiration and biopsy could be performed in theatre by the on call team if the acute prescription of broad spectrum antibiotics is being considered.

3. **Patients with acute sepsis**

Patients with an acutely infected knee replacement and signs of sepsis must be treated differently and much more urgently (Figure 3). There is a higher risk of mortality in patients presenting with an acute infection and sepsis. These patients may present with a painful erythematous knee, pyrexia and possible signs of SIRS and haemodynamic instability. Patients with acute sepsis may become extremely unwell very quickly so it is advised to contact the Intensive Care team early. These patients must be treated urgently, with the primary focus being to reduce the septic load through surgical intervention. The following is our recommended protocol for irrigation and debridement for the surgeon on call:

- Admit the patient to hospital and perform urgent observations. A thorough history and examination should be performed to look for other sources of sepsis such as the chest, abdomen or urine.
- An early referral to ITU should be made in all patients who present with signs of sepsis and hemodynamic instability.
- Urgent blood work should be performed including a full blood count, urea and electrolytes, CRP, and ESR. If the patient is febrile, meets the SIRS criteria or has a known source of infection, blood cultures should be obtained.
- Intravenous access should be gained early.
- If at all possible, avoid starting antibiotics prior to samples being taken from the knee. However, in the acutely infected knee, it may be necessary to start a patient on antibiotics without formal operative samples from the joint especially if the patient shows signs of sepsis with hemodynamic instability. It may be appropriate to perform an aspiration in the Emergency Department if there is an urgent need to start antibiotic therapy and the diagnosis is obvious, but if performed it must be done using strict sterile technique.
- If the joint is clearly the source of the severe sepsis, the initial treatment is to irrigate and debride the joint. This should be performed in theatre under full aseptic precautions. Either an open or arthroscopic irrigation and

debridement should be performed. The aim of the surgery is to washout the knee and debride any obvious purulent and necrotic tissue. This is in the hope of reducing the septic load, not to definitively treat the patient. If the patient is systemically septic, this should be performed emergently. It is recommended to irrigate the joint with a minimum of 6 to 9 litres of warm Normal Saline; the fluid in the knee must be clear after washout.

- At time of surgery, one fluid and five tissue samples should be taken using biopsy forceps from within the joint. Samples should be sent urgently for microscopy and culture. Samples should be taken even if the patient has already been started on antibiotics.
- Once samples have been taken, intravenous antibiotics should be commenced. Typically broad-spectrum IV antibiotics should be started empirically. In our unit, this consists of Vancomycin and Tazocin.
- The patient should be referred to an Infectious Disease specialist for advice regarding on-going care and antibiotic treatment.
- The patient should be referred to an arthroplasty surgeon as soon as possible for continued on going care. This would include a specialist within your unit or a surgical team within your region or network. Patients will then often require a further procedure by a specialist knee surgeon including a more thorough irrigation and debridement and exchange of modular components or removal of the prosthesis (via a one or two stage revision) depending on the microbiology and patient factors.

Discussion

Diagnosis and treatment for the acutely infected knee replacement can at times be a challenging undertaking for the on call surgeon. It is felt, however, that a fairly standardized approach should be used in the diagnosis of infection[10,13,14]. Acute management can be much more variable and is dependent on the stability of the patient, duration of symptoms, medical and immune status of the patient, local soft tissue factors and virulence of the organism grown. Treatment options range from

412 open irrigation and debridement and exchange of modular components, to revision
413 of the prosthesis via either a one or two stage revision arthroplasty.
414
415 In the setting of an acute infection in the patient presenting with sepsis, the focus
416 should be on stabilization of the patient and decreasing the bioburden of the
417 infection. Initial treatment often consists of irrigation and debridement of the knee.
418 Definitive management of the infection often requires a referral to a surgeon with
419 subspecialty training in arthroplasty and often consists of a more thorough I & D
420 with exchange of modular components or removal of the prosthesis.
421
422 Outcomes for irrigation and debridement are quite variable. Success rates of
423 irrigation and debridement have been noted to be as high as 75 to 100%[17,37,49,50]. In
424 contrast, other authors have found much lower success rates with Odum et al.
425 having a success rate of 31%[42]. Koyonos et al., also found similar results with a
426 success rate of 35%[48]. A distinguishing factor for the success of surgical
427 debridement in the acutely infected periprosthetic knee appears to be the timing of
428 the surgery with better outcomes resulting in patients with shorter duration of
429 symptoms[17,49]. Brandt et al. and Marculescu et al. showed a higher rate of failure
430 when debridement was performed after 2 days and 8 days of symptoms
431 respectively[16,39]. Other prognostic factors include age and comorbidities of the
432 patient, virulence of the organism grown and local soft tissue envelope[39,51,52]. MRSA,
433 gram negative organisms and *S. aureus* when not treated with multimodal agents,
434 have previously shown higher failure rates for irrigation and debridement[3,37,39,49,50].
435 In contrast, some authors have found promising results with multimodal antibiotic
436 treatment for *S. aureus* with the addition of rifampicin treatment following irrigation
437 and debridement with success rates ranging from 75 to 83%[50,51,53]. Several studies
438 have shown worse outcomes with arthroscopic irrigation and debridement
439 compared to open procedures[37,46,47]. It is therefore, not recommended to perform
440 an arthroscopic irrigation and debridement as sole form of treatment for the acute
441 infection of periprosthetic joint infections.
442

Removal of the prosthesis may be indicated in the acutely infected knee. A two-stage revision has long been considered the "gold standard" for treating periprosthetic infections of the knee with some specialized centres performing a one stage revision. Recent studies for one and two stage revision arthroplasty have shown similar results with success rates ranging from 72 to 100%[7-9,11,43-45]. However, retention of the prosthesis with irrigation and debridement and exchange of modular components followed by appropriate medical management remains a viable option for the acutely infected knee if performed in a thorough manner, under the correct circumstances and with significant expertise.

One of the key recommendations of the GIRFT report concerned the management of these periprosthetic joint infections. These patients have a high morbidity and mortality with their management being expensive. Their care should be handled by units with significant expertise ideally as part of a regional network. It is not appropriate to perform a one or two stage revision procedure if you are not the unit or surgeon with subspecialty training nor the resources to do so. However, patients with an acute PJI generally present locally to the on call orthopaedic service. The on call surgeon may play a role in the diagnosis and potential early management via irrigation and debridement if transfer or definitive treatment is to be delayed. The on call or admitting orthopaedic team, even if they were the team performing the initial primary total knee replacement, should be encouraged to refer the patient onward to a specialist revision team or as a minimum discuss the case within their network.

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