



The multidisciplinary approach to managing prosthetic joint infection: could this lead to improved outcomes?

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Abstract: Periprosthetic joint infection (PJI) is a devastating complication of the total joint arthroplasty (TJA). It presents a great challenge for the treating clinician. Diagnosis as well as management can prove difficult with significant morbidity for the patients and cost for patients, health care providers and society as a whole. Outcomes of equally challenging pathology such as tumors and polytrauma have been shown to be improved when patients are managed by a team as specialists as opposed to single individuals. The purpose of this study is to review the role of the multi-disciplinary team (MDT) approach in the diagnosis and management of PJI. We examine the influence of this approach on clinical outcomes in patients with PJI. We also discuss the organisational and logistical issues associated with establishment of a MDT as well as several other issues not mentioned in the contemporary orthopaedic literature. All published literature examining the role of multidisciplinary care in the management of PJI and the influence of this approach to the management and outcomes of patients with this diagnosis were included. Studies published in languages other than English were excluded. There is a paucity of data on the influence of multidisciplinary care on outcomes of the management of PJI. Evidence suggests that the MDT has important role in ensuring all factors in the management of this complex group are considered and best possible care is delivered. Multicentre randomised clinical trials are required to assess the influence of MDT'S on outcome as well as important questions around the structuring of these teams.

Keywords: Multidisciplinary team; multi-disciplinary team (MDT); periprosthetic joint infection (PJI); hip; knee; revision

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Introduction

Periprosthetic joint infection (PJI) affects about 1–3% of patients undergoing total joint arthroplasty (TJA) (1). In some units the infection rate is reported to be as high as 5% (2). It is one of the most devastating complications and poses significant challenges for the patient, health care providers and the treating institution. The financial cost of treating a single case of PJI can be as high as £100,000 (2).

Costs for patients are even higher, with long hospital stay, multiple operations, associated pain and suffering, reduced life quality as well as risks associated with surgical morbidity and mortality. Diagnosis and management of PJI remains controversial and complex. There is no universal definition of the PJI. The definition of PJI proposed by the International Consensus Meeting on PJI is the most universally accepted one (3,4). Other definitions also exist. Tansey *et al.* (5) acknowledged 7 definitions

produced by various consensus meetings. This illustrates that PJI remains a debatable and controversial topic and diagnosis is not straight forward. There is no one single test that can adequately diagnose PJI. Up to 10% of cases undergoing revision for aseptic loosening are later found to have prosthetic joint infection (5). PJI can present in variety of ways and at varying phases from the time primary arthroplasty implantation. Tsukayama *et al.* proposed a classification system that divided PJI into four categories (6).

It can be challenging for an individual surgeon to make an accurate diagnosis when faced with a patient with a painful arthroplasty. One way of addressing this has been to manage this complex group of patients with a multidisciplinary team. Failure to make a timely and accurate diagnosis can significantly compromise therapeutic options and have a negative impact on the result of surgical treatment (7). Furthermore, if PJI is not recognized, it may lead to systemic symptoms such as bacteraemia and septicemia.

PJI can be challenging to treat, and patients may need a number of major surgical procedures, coupled with antimicrobial treatment for several weeks to eradicate the infection (8). Treatment of PJI of the knee may be associated with a long period of disability with possible immobilization of the knee. This may lead to a poor functional outcome. Recurrence of the infection is high and reported between 8% and 70% (9) and complications associated with surgery are common. Furthermore, PJI is associated with significant mortality. Berend *et al.* (10) reported that 11% patients treated for PJI with a 2 stage regime died between the first and second stages of surgical treatment. Zmistowski *et al.* (11) found that the 5-year survivorship of patients with PJI is worse than for some common cancers including breast cancer or testicular cancer. For this reason PJI must be managed expeditiously, providing patients with all available expertise to achieve the optimum outcome. Added to this is the psychological burden associated with the issues described and its impact on post operative function (12). This combination of the knowledge that there has been a complication or suboptimal outcome, multiple surgical procedures, prolonged hospital stay, prolonged disability and associated medical comorbidities as well as social isolation and pain illustrates multiple issues which can be associated with patients presenting with PJI and the multiple facets which require management in a synchronised manner. These factors have been acknowledged in other aspects of orthopaedic surgery and it is acknowledged that optimal outcomes result from a multidisciplinary approach to management (13,14).

Treatment options for PJI

Debridement, antibiotics and implant retention (DAIR)

When infection is diagnosed early, open debridement and exchange of modular prosthetic components followed by prolonged antibiotic therapy may lead to satisfactory results. Retention of the implant leads to superior functional results in cases where the infection is eradicated (10).

Single stage revision

Exchange off all components of the arthroplasty (both fixed and modular) is coupled with radical debridement of the joint and antibiotic treatment. Removal of all implants and reconstruction with new definitive prostheses. Single stage revision is usually performed in selected patients. The ideal patient is a well host, with a healthy soft tissue envelope, absence of a draining sinus and a known sensitive microbe are commonly accepted prerequisites (11,15).

Two stage revision

Removal of all implants during one surgical procedure is performed. The joint is excised with or without placement of a temporary spacer. Antibiotics are delivered locally (with cement or other delivery modes) and systemically. Following a prolonged period of antibiotic treatment (6 weeks or more), when infection is deemed to be eradicated, re-implantation (the second stage) is performed. During the second stage procedure further debridement takes place. The spacer is removed and the joint is reconstructed. The success rate is greater than of single stage revision procedure (10,16). The significant downside of this approach relates to the time between the 2 stages of the revision. During this time the patients' mobility is poor, joint function is very limited, and the patient is often required to stay in health care facility. The risk of complications (renal failure, Clostridium Difficile diarrhea) and mortality are significant. The patient also undergoes two separate major surgical procedures.

Excision arthroplasty

This involves removal of all the implants and excision of the joint followed by a course of antibiotics. The function of the joint is severely compromised, and the patient suffers significant disability. This salvage mode of treatment is reserved for the most complex infections in compromised hosts, with severe bone loss, presence of poly-microbial

infection and an unhealthy soft tissue envelope exist (17).

Amputation

When the infection is not manageable or becomes a threat to the patient's life this might be the only option.

Prolonged suppressive antibiotic therapy (PSAT)

In the presence of draining sinus and well-functioning joint, or when the host suffers from serious comorbidities that could preclude surgical intervention, antibiotic suppression may lead to satisfactory results. The infection cannot be eradicated, but it does not manifest itself systematically and symptoms related to the affected joint may be manageable for the patient. The senior author has previously reported found that infection control could be achieved in selected cases of PJI using this approach (18). The patients' comorbidities and fitness for major surgery as well as psychological condition of the individual are also of incredible importance (18).

The physical, but also psychological needs of patients should be addressed. PJI may be emotionally difficult to cope with and lead to sequelae such as depression and anxiety (19). Many patients struggle with the impact that the treatment of PJI has on their personal and family lives'. Patients' depression may require treatment and support during the treatment as well as during the recovery phases (20).

The role of the multi-disciplinary team (MDT)

Ideally personnel should be present in the same location in order to provide a seamless, clinically and cost-efficient service to patients with PJI. They should be involved in all stages of the management pathways including, diagnosis, treatment (both surgical and non-surgical) and long term follow up. The multidisciplinary approach has made a significant difference in care of oncology patients. Time to diagnosis and clinical outcomes have all been shown to improve when the MDT functions well (21,22). There is no published evidence to the authors' knowledge on the management of PJI with this approach however the principles of diagnosis and factors influencing management and outcomes of patients with PJI are similar. It seems intuitive therefore that a similar approach to treatment might produce similar outcomes.

What comprises a MDT?

Most published studies examining the benefits of MDT's

have focused on clinical results (22). There is a relative paucity of data on the components of the MDT. An important principle of care delivery in this setting is consideration of the wholistic needs of the patient and including appropriate specialists to address these issues. In the context of PJI the following team members are required:

Orthopaedic surgeon

The surgeon coordinates and orchestrates the care of the patient. They need to establish the diagnosis, identify the individuals required to care for the patient and coordinate meetings. They are required to have the necessary skillset and to carry out the surgical treatment required. A minimum requirement would be fellowship training in revision arthroplasty surgery.

Microbiologist

A microbiologist is vital to the multidisciplinary team. With their expertise and specialist knowledge of microbial metabolism specific diagnostic requirements, mechanism of antibiotic function and interactions and the requirements for monitoring of these issues, their importance is non controversial. The role of musculoskeletal microbiology is rapidly evolving with developments in diagnosis such as 16s polymerase chain reaction (16s PCR) testing. This speciality has made significant contributions to the practical management of patients with PJI such as the OVIVA (Oral versus Intravenous Antibiotics for Bone and Joint Infection) trial (23). A dedicated microbiology clinic also provides another medium for follow-up and support of this complex group of patients.

Musculoskeletal radiologist

Radiologists are central in the decision making process. This stage often requires judgement based on a variety of imaging modalities. An experienced radiologist is invaluable in advising on the optimal imaging modality and interpreting subtle signs on imaging. In the experience of the authors this is one of the most useful and educational parts of the MDT meeting.

Nutritionist

Nutritionists contribute significantly to pre and post

operative optimisation of the patient. Malnutrition and vitamin D deficiency have been shown to positively correlate with PJI (24). Low serum albumin level and low lymphocyte count are at increased risk of infection, wound dehiscence and medical complications (25-27). Cross *et al.* (28) postulated that normalisation of the serum albumin level and tight glucose control may lead to better outcomes in orthopaedic surgery. Management of these factors has an important role in reducing the risk of reinfection following revision surgery.

Physiotherapist

The ultimate aim of revision surgery is restoration of a pain free, mobile with restoration of function and activity. Pre and post operative physiotherapy is vital to achieving these aims. Physical therapy has been shown to improve soft-tissue tension, joint range of motion, and muscle strength and can reduce pain and stiffness (29-31).

Clinical nursing specialist (CNS)

The role of a dedicated nurse specialist care cannot be understated. Walker (32) acknowledged the vital role which nurses play in the management of patients undergoing joint replacement surgery. The nurse specialist has several key clinical and organisational roles including being the point of contact for referrals, organising investigations, coordinating care between multiple specialities when these are involved and being a point of contact for patients.

Examples of multidisciplinary teams

At the authors' institution, there is an established referral network for complex cases including those presenting with PJI. Clinicians from the region can refer any patient who needs complex arthroplasty assessment and treatment, including those with PJI to a centralised hub. There is a standardized referral proforma and MDT coordinator who promptly responds to all referrals. There is a weekly MDT attended by complex arthroplasty surgeons, a CNS and radiologists with an interest in musculoskeletal medicine. Cases are discussed and either advice is provided or a decision on transfer of the patient to the Hub Hospital is organized. In complex cases when surgery is required, surgical planning is performed and details such as surgical approach, instruments and required implants are all discussed. Each week between 10 to 20 cases are

discussed. Advice of plastic surgeons, vascular surgeons and microbiologists is available on request. There is also a monthly MDT meeting attended by the same team of complex arthroplasty surgeons as well as microbiologists with an interest in bone and joint infection and outpatient antibiotic treatment (OPAT) team. All cases undergoing treatment for infection are discussed, plans for surgical and non-surgical treatment are established and progress of treated patients is discussed. This ensures that most appropriate treatment plan is made for each individual.

The East Midlands Specialist Orthopaedic Network (EMSON) (Nottingham, UK) was established and its success has been reported (32). All referrals are received by email by the MDT coordinator. The meetings are conducted using secure videolink, with complex arthroplasty surgeons from Nottingham University Hospital and microbiologists attending while consultants from neighbouring hospitals dial in to discuss challenging cases. During first 6 months 166 cases were discussed, 43% of which the initial plan was amended as the result of the discussion. In several cases, there was a significant alteration to the treatment plan. Referring surgeons are also encouraged to come to tertiary centre with the potential for joint consultant operating. This improves the experience of all clinicians involved.

Why should we adopt a multidisciplinary approach

The potential benefits of care delivered via a MDT approach can be experienced on a variety of levels:

- (I) *The Unit level:* The centre which provides this level of care will likely benefit from an increased volume of patients and referrals. This will increase the experience gained by clinicians in dealing with his condition.
- (II) *The clinician level:* Individual clinicians will have improved exposure to a larger number of cases. This has the potential to improve technical proficiency. Clinicians will also be motivated to receive further training and broaden their knowledge in field of PJI. This will also improve their knowledge and level of expertise by participating in MDT discussions.
- (III) *The patient level:* Patients are more likely to receive coordinated, individual care by specialists with greatest level of expertise in the field of PJI.

Challenges to the establishment of a multidisciplinary team

The treatment of PJI is labour and resource intensive. Patients often stay on the ward for extended periods and face a higher risk of surgical and medical complications than non-infected cases. It is likely that the number of referrals and number of treated patients will increase over time which increases this burden (32).

Bloch *et al.* have shown that the cost of surgical treatment is significantly higher than septic revisions (33). There is a potential risk of rapid depletion of financial resources. Renumeration strategies need to be established prior to starting this type of service (34,35).

The logistics and practical aspects of establishing a MDT requires careful attention to detail. An understanding of what is required on a practical level is important. Meetings of large numbers of specialists takes these services from other departments. To the authors' knowledge there has been no definition of the optimal constituents a MDT or of the minimal number of specialists required or whether the teams involved in diagnostic and therapeutic parts of the patient journey should be different.

Job planning for all the members of the team should be coordinated to allow all members to meet or dial in to discuss cases. Surgeons, radiologists, microbiologists and other health care professionals involved in PJI management need to find time during their busy weekly schedule for MDT to work. Furthermore, when transfer of the patient is necessary to the specialist centre, logistical arrangements need to be in place to avoid delays.

Another unexplored aspect of delivering care in this way is the issue of responsibility and autonomy. The MDT moves away from the hierarchical system in which decisions are made by one senior individual towards one where there is shared decision making. This raises the subject of accountability. When a decision is taken by a group, who is responsible and who, if anyone, is accountable when things go wrong? For the same reason there can be a perceived risk to the autonomy of the referring surgeon. These issues have not been addressed.

In conclusion the management of PJI is complex and multifactorial. Multidisciplinary management has resulted in improved clinical results in similar settings setting such as tumor surgery however establishment of multidisciplinary care presents significant challenges to the treating institution.

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