KEYWORDS: PERIPROSTHETIC JOINT INJECTION, TOTAL HIP ARTHROPLASTY, TOTAL KNEE ARTHROPLASTY, PERIOPERATIVE NURSING, ALGORITHMIC APPROACH TO DIAGNOSIS, PATIENT IMPACT.

PERIPROSTHETIC INFECTION: THE ROLE OF THE PERIOPERATIVE NURSE

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ABSTRACT

The incidence of periprosthetic joint infection and the impact on patients and the health system is substantial due to significant patient morbidity and mortality. A systematic review of the current literature by Christchurch surgeons resulted in the development of an algorithm to outline the current best practice for diagnosis and management of periprosthetic joint infection (Ailabouni, Jennings, & Hooper, 2015). The algorithm and the role of the perioperative nurse in the management of patients with periprosthetic joint infection is discussed.

Total joint arthroplasty demand is increasing worldwide, with projections from the USA suggesting that by the year 2030 the demand for total hip arthroplasty (THA) and total knee arthroplasty (TKA) will have increased in that country by 174 per cent and 673 per cent respectively (Kutz, Ong, Lau, Mowat, & Halpern, 2007).

Within New Zealand a similar pattern is predicted, with increases by 2030 of 110 per cent and 260 per cent for THA and TKA (Hooper, Lee, Rothwell, & Frampton, 2014). The percentage of revision procedures has changed very little over the last decade with about six per cent of primary implants revised after five years and 12 per cent after ten years (Labek, Thaler, Janda, Argreiter, & Stockl, 2011).

Although the percentage of revision procedures remains static, the absolute numbers are increasing due to the increased numbers of primary arthroplasty (Ailabouni, Jennings, & Hooper, 2015).

Surgical site infections are a big problem and are the second most commonly reported healthcare associated infection (World Health Organisation (WHO), 2011). Infection is the most common cause of failure in TKA and the third most common cause of failure in THA (Bozic et al., 2009; Bozic et al., 2010). Revision arthroplasty for infection is associated with a five times greater mortality at five years than revision arthroplasty for aseptic loosening (Zmistowski, Karam, & Durinka, 2013).

Failure to adequately diagnose infection in its early stages or treat appropriately will lead to further interventions...

The estimated cost for an infected revision procedure is about four times that of a primary arthroplasty (Dreghorn & Hamblin, 1989; Klouche, Sarali, & Mamoudy, 2010). Failure to adequately diagnose infection in its early stages or treat appropriately will lead to further interventions which increase the overall cost and also result in an inferior functional outcome for the patient.

BACKGROUND

In accordance with the Musculoskeletal Infection Society (2011) criteria regarding diagnosing periprosthetic joint infection (PJI) is considered present when:

- A pathogen is isolated from two separate tissue or fluid samples obtained from within a joint; or
- A sinus tract is present that communicates with the prosthesis; or four of the following six criteria exist:
- Elevated serum erythrocyte sedimentation rate (ESR) and serum C-reactive protein (CRP) concentration;
- Elevated synovial leukocyte count;
- Elevated synovial neutrophil percentage (PMN%);
- Presence of purulence in the affected joint;
- Isolation of a microorganism in one culture of periprosthetic tissue or fluid;
- Greater than five neutrophils per high-power field in five high-power fields observed from histological analysis of periprosthetic tissue at 9,400 magnification. (Parvizi, et al., 2011).

Risk factors with a known association to PJI include: prior infection of the knee; obesity (hip); superficial surgical site infection; operative time of more than 2.5 hours and immunosuppression (American Academy of Orthopaedic Surgeons, 2010).

DIAGNOSIS

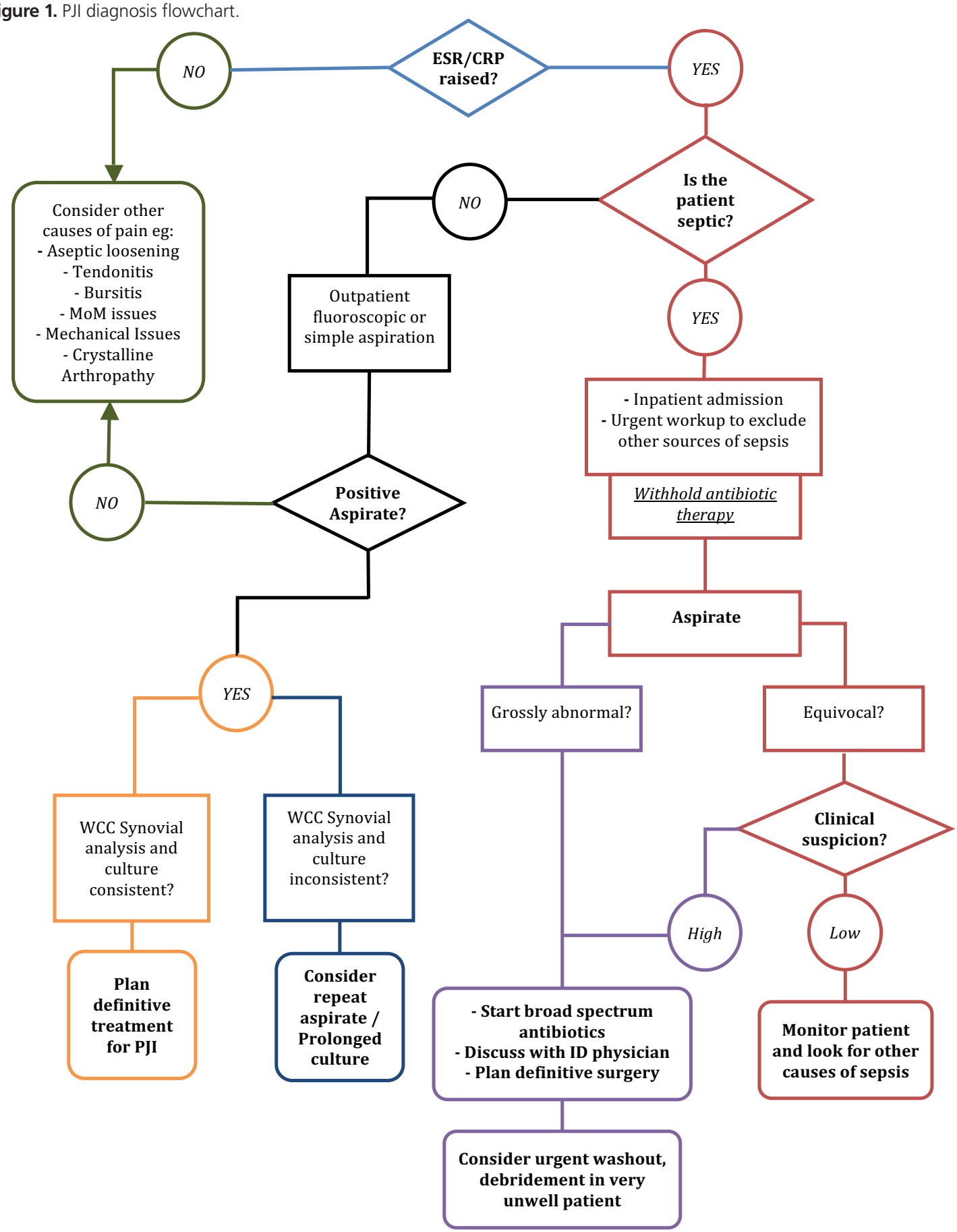
Periprosthetic joint infection should be suspected in any patient presenting acutely with a painful joint replacement, especially if they are also febrile or constitutionally unwell. Figure 1 is an algorithmic approach to diagnosing patients with suspected hip PJI. This algorithm is more complex than for patients with acutely symptomatic knees as aspiration for TKA can be done at the bedside.

The recommended workup for diagnosing a PJI includes blood tests for CRP and ESR, X-rays and occasionally scintography and joint cultures (Ailabouni, Jennings, & Hooper, 2015). The joint aspiration cultures must be done under strict aseptic technique to avoid the introduction of pathogens into a joint or the contamination of specimens.

Knees are amenable to percutaneous aspiration but hips are usually aspirated under fluoroscopic guidance (Yee, Chiu, Yan, & Ng, 2015). Local anaesthetic infiltration should be confined to the soft tissues to reduce the risks of negative culture due to the bactericidal activity of the anaesthetic (Johnson, Saint John, & Dine, 2008). Systemic antibiotic prophylaxis should be withheld until all microbiological samples are obtained to minimise the risk of false negatives. Samples should be promptly transported to the laboratory for analysis and include an absolute cell count and differential, gram stain and crystal analysis (Schinsky, Della Valle, Sporer, & Paprosky, 2008).

Intraoperative tissue samples are indicated during any revision surgery where PJI is suspected or confirmed. Samples should be taken meticulously using fresh surgical instruments. An odd number of specimens (three or five) will simplify the decision making if not all samples yield positive results. Tissue cultures demonstrated higher sensitivity, specificity, positive predictive value and negative predictive value for diagnosing PJI than swab cultures. Swab cultures had more false-negative and false-positive results than tissue cultures (Aggarwal, Higuera, Deirmengain, Parvizi, & Austin, 2013). Frozen section remains a useful additional tool in the diagnosis of PJI, especially if the preoperative workup has been negative or the likelihood deemed low. Removed implants can also be microbiologically

Figure 1. PJI diagnosis flowchart.



cultured for biofilm producing organisms (Achermann, Vogt, Leunig, Wust, & Trampuz, 2010).

TREATMENT

Once the suspicion of infection has been confirmed through the above diagnostic tests, a decision needs to be made regarding the next line of treatment. Figure 1 and 2 algorithms offer simplified frameworks for hip and knee PJI to guide through the available surgical options. The charts are only a guide to these highly complex patients as surgeon experience and local department expertise will also play a role. Every surgical treatment has a failure rate and discussion with the patient should be the ultimate determinant of definitive treatment (Ailabouni, Jennings, & Hooper, 2015).

The goals of surgical treatment differ between acutely unwell patients and those presenting with low grade symptoms. The septic patient may need surgical and medical stabilisation before definitive treatment is undertaken. The eradication of infection is the ultimate aim of intervention with the least overall morbidity for the patient. Therefore, consideration of the patient's suitability for surgery is the first and most important consideration.

Determining whether revision arthroplasty should be performed depends on patient fragility and suitability for a long anaesthetic (Rao, Crossett, Sinha, & Le Frock, 2003). Once suitability for revision arthroplasty has been determined, deciding if this should be a one or two stage procedure depends on multiple factors. These include the recommended workup for diagnosing a PJI, identification of a specific organism and its virulence and whether the patient has any soft tissue issues such as a sinus or significant risk factors for compromised wound healing.

One-stage procedure:

A single-stage revision involves removing the infected prosthetic joint along with any potentially infected materials, debriding and irrigating the surgical site and re-implantation of a new THA under the same anaesthetic (Strange et al., 2016). The proponents of one-stage revision feel that a single operation is associated with lower morbidity, shorter overall hospital stay, lower cost and less interference with patients' quality of life (Sia, Berbari, & Karchmer, 2005).

Two-stage procedure:

A two-stage procedure with a variable course of high dose antibiotics between the two-stages of traditionally four to six weeks, remains the gold standard of treatment for both hip and knee PJI (Della Valle & Cooper, 2013; Romano, Gala, Logoluso, Romano, & Drago, 2012). The first operation involves removing the infected prosthetic joint along with any potentially infected material and debridement and irrigation of the surgical site. The second operation, under a separate anaesthetic, involves implanting a new prosthesis (Strange et al., 2016).

During the first stage of the revision there are a variety of techniques that can be used to assist with infection eradication. These include the insertion of a cement spacer impregnated with antibiotic to produce high local levels of antibiotic and maintain limb stability and length between the two surgeries (Evans, 2004). Vancomycin is commonly added for gram positive infections and tobramycin for gram negative infections. Articulating spacers have been used to limit the functional deficit following multiple surgeries and an extended period of compromised joint function. They also make revision surgery technically easier and have shown superior results to static spacers (Romano, Gala, Logoluso, Romano, & Drago, 2012). The use of "poorly cemented" cheaper prostheses is increasingly used locally as a stable temporary joint replacement that allows near full function, whilst providing all the benefits of local antibiotic therapy of cement spacers (Durbhakula, Czajka, Fuchs, & Uhl, 2004). They also reduce the risks of spacer fracture due their stronger inherent stability. In the knee, the removed components can be sterilised and loosely cemented back in to act as articulating spacers with excellent infection eradication and obvious cost benefits (Lee & Choi, 2012).

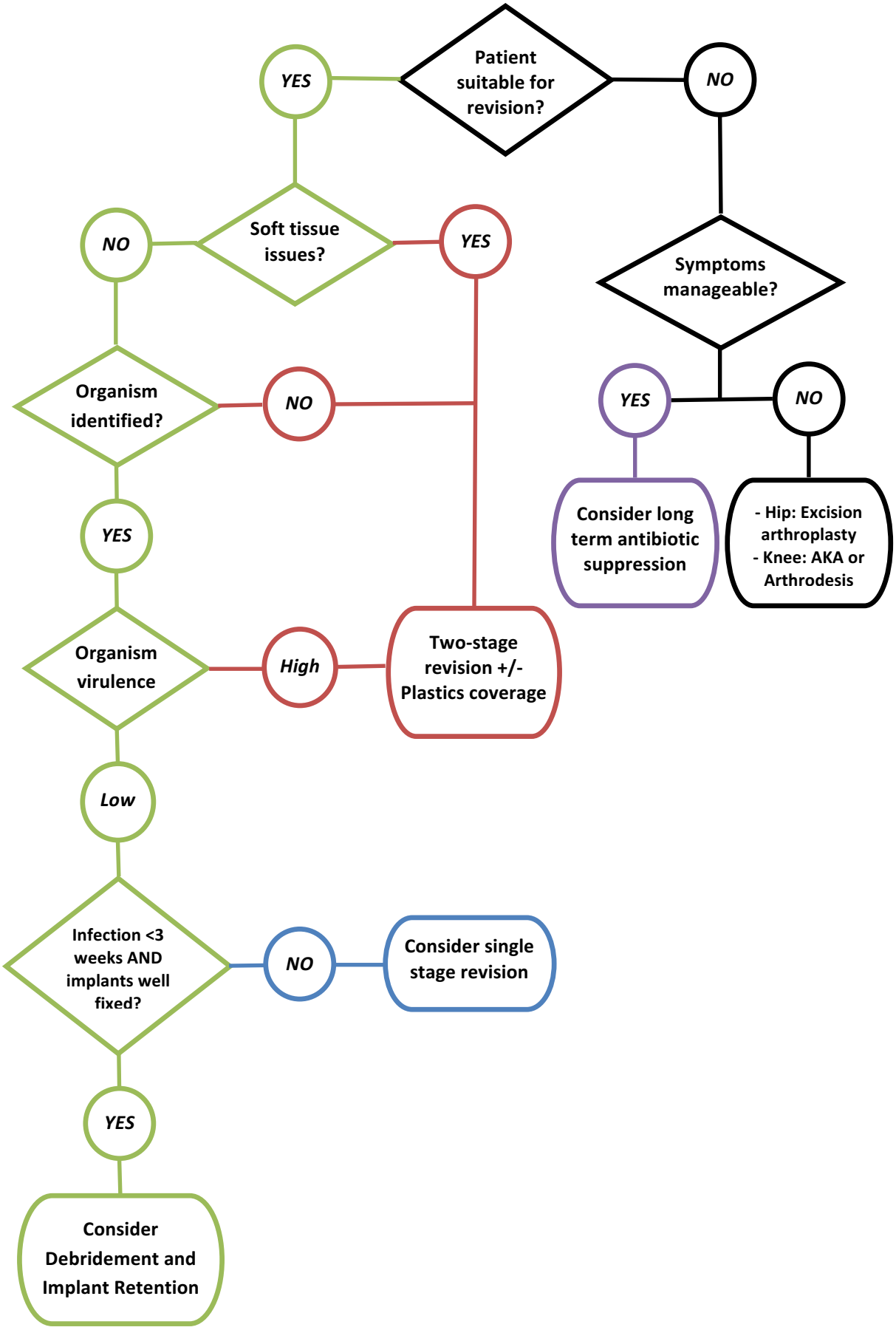
DEBRIDEMENT AND IMPLANT RETENTION

For patients with acute postoperative (within four weeks) or acute haematogenous infections (within two weeks onset); debridement, antibiotic suppression and implant retention (DAIR) is indicated, providing the implants are stable. The procedure should be open rather than arthroscopic and involve a liner exchange. Postoperative antibiotics should be given for at least six weeks until normal inflammatory markers occur. The attraction of DAIR is the presumed lower patient morbidity especially if the patient is physiologically unstable (Qasim, Swann, & Ashford, 2017; Scheper, et al., 2016). However, some evidence suggests that DAIR may compromise the results of future two-stage revision surgery (Sherrell, et al., 2011). Therefore careful patient selection is advised as this technique can have significant long term morbidity for patients (Ailabouni, Jennings, & Hooper, 2015). If debridement is to be undertaken, it needs to be done meticulously with removal of all infected looking material. Local antibiotic impregnated cement beads could be added to improve local antibiotic therapy (Bistolfi, et al., 2011). Failure of a single attempted debridement and liner exchange should be followed by a two-stage revision (Parvizi & Gherke, Proceedings of the international consensus meeting on periprosthetic joint infection, 2013). The presence of immunocompromise, MRSA infection, poor local soft tissues and failure of one DAIR procedure should prompt revision arthroplasty (Qasim, Swann, & Ashford, 2017; Scheper, et al., 2016).

SURGICAL OPTIONS FOLLOWING FAILED REVISION SURGERY

FOR the small and unfortunate group of patients who experience recalcitrant infection and who are not suitable for revision arthroplasty, there are a variety of options. In patients where medical management is the only option, implant retention and long term antibiotic suppression is indicated (Osmon, et al.,

Figure 2. PJI management algorithm.



The scrub and circulating nurse roles can assist in reducing operative time by ensuring the patient's surgery is appropriately planned with the necessary equipment available.

2013). Antibiotic duration should be at least six weeks and continued until inflammatory markers have returned to normal. However, in immunocompromised patients, or MRSA infection, alternative surgical management should be considered (Marculescu, et al., 2006; Osmon, et al., 2013).

In the hip, removal of the hip implants, known as excision arthroplasty or Girdlestone procedure, remains an option for the frail patient who is not suitable for reconstruction, or those whose infection has not resolved with repeated two stage revisions (Sharma, Leeuw, & Rowley, 2005). Although associated with shortening of the affected limb, up to 90 per cent of patients will be able to ambulate with a walking aid (Cordero-Ampuero, 2012).

In the knee, a patient with adequate bone stock and reasonable soft tissue cover, knee arthrodesis can be attempted. This is especially so in the multiply-operated knee with significant preoperative restriction in range of movement (Kalore, Gioe, & Singh, 2011). Before embarking on arthrodesis, the surgeon must take into account the patient's biology, likelihood of healing and their ability to undertake an above knee amputation if the procedure fails (Ailabouni, Jennings, & Hooper, 2015). If successful, arthrodesis avoids stumps for ambulation and their associated complications (Kalore, Gioe, & Singh, 2011).

Above knee amputation (AKA) is considered the last remaining option for patients with infection not responsive to the above surgical treatments who cannot tolerate an arthrodesis or further staged revision arthroplasty (Rodriguez-Merchan, 2015). AKA is considered an inferior option to knee arthrodesis as it significantly impacts on patient function and independence with only half of patients being able to walk after AKA (Rodriguez-Merchan, 2015).

DISCUSSION – THE ROLE OF THE PERIOPERATIVE NURSE

Prevention of PJI is key and the Perioperative Nurse can play an important part in minimising patient risk. This starts from the patient's first contact with the perioperative service through to after their discharge.

PREOPERATIVELY

Previous joint infection, morbid obesity, poor glycaemic control and higher anaesthetic risk are all associated with increased rates of infection (Garvin & Konigsberg, 2011). It is important to address these issues preoperatively to optimise the patient's pre-operative health. The preassessment nurse is well positioned to spend time with the patient discussing their risk factors and co-morbidities and ways that they can optimise their health in the preoperative period (Greene, 2015). Discussions with patients regarding potential sources of infections and how to avoid these in the perioperative and postoperative period is also shown to be an effective way of reducing surgical site infection (Bramhall, 2002). A practical example of this is discussing with patients the importance of protecting their legs while working in the garden to avoid injury as this could lead to infection and cancellation of their surgery. A thorough examination of the patient is invaluable in detecting and treating infections pre-operatively and avoiding delays to surgery (Gilmartin & Wright, 2007). Included in this is screening for methicillin-resistant Staphylococcus aureus (MRSA) colonisation (Muto, et al., 2003). Although preoperative treatment is controversial if MRSA carriage is known, Vancomycin can be included as a pre-operative antibiotic and patients treated with contact precautions to minimise nosocomial transmission (Muto, et al., 2003).

INTRAOPERATIVELY

Antibiotic prophylaxis is likely the most important prophylactic measure (Ailabouni, Jennings, & Hooper, 2015). Two grams of Cephazolin given 30-60 minutes prior to initial incision, or three grams if the patient is over 120kg is the current recommendation. If there is a Penicillin allergy or MRSA colonization then Vancomycin should be infused 90 minutes prior to incision (American

Academy of Orthopaedic Surgeons, 2014). Therefore, the intraoperative nursing role is important to ensure timely and appropriate antibiotic administration to the patient and adherence to the surgical safety checklist (Pugel, Simianu, Flum, & Dellinger, 2015). An operative time of more than 2.5 hours is associated with increased infection. For this reason a further dose of Cephazolin is recommended at two hours or if blood loss of more than 70 per cent of the patients circulating volume occurs (American Academy of Orthopaedic Surgeons, 2014). The scrub and circulating nurse roles can assist in reducing operative time by ensuring the patient's surgery is appropriately planned with the necessary equipment available. Furthermore, ensuring an appropriate skill mix in the operating theatre has also been shown to reduce operating time (Rothrock, 2014).

The role of intraoperative joint contamination from operating theatre air flow has been examined as a potential cause of infection. Seminal work by Charnley (1972) demonstrated a significant reduction in periprosthetic joint infection with measures that improved air cleanliness in the operating room. It has also been known for a long time that an increase in the number of staff in the operating theatre, their activity levels and the number of theatre door openings have all been associated with increased air contamination intraoperatively (Panahi, Stroh, Casper, Parvizi, & Austin, 2012; Quraishi, Blais, Sottile, & Adler, 1983; Ritter, Eitzen, French, & Hart, 1975).

Laminar flow ventilation systems and modern exhaust suit systems have also been devised to reduce the rate of infection. However, there is no conclusive evidence that these reduce infection and a growing body of evidence demonstrates they introduce other risks of contamination. In a New Zealand Joint Registry study, Hooper, Rothwell, Framptom, and Wyatt, (2011) showed an increased risk of hip, but not knee, joint infection in theatres using laminar flow. A novel study looking at the glove forearm interface in ventilated protective gowns demonstrated contamination at the surgeon's wrists could be eliminated by the addition of barrier tape if exhaust suits are used (Young, Chisholm, & Zhu, 2014).

Based on the current evidence, Ailabouni, Jennings, and Hooper (2015) recommend a closed theatre procedure for joint arthroplasty with the least number of staff in the operating theatre. Preoperative templating should allow a small range of implants to be kept in the theatre room to prevent unnecessary door opening. If protective barrier suits are used, taping the glove gown area is recommended (Young, Chisholm, & Zhu, 2014).

UPCOMING EVENTS / PROCHAINS ÉVÉNEMENTS

Perioperative Nurses Week is November 5 - 9, 2018.

La semaine des infirmières et des infirmiers en soins périopératoires est du 5 au 9 novembre 2018.

ORNAC & PROVINCIAL COUNCILS
L'AIISOC ET LES CONSEILS PROVINCIAU

26th ORNAC National Conference	Halifax, NS	Apr 26 - 30, 2019
ORNAA Conference	Red Deer, AB	Sep 19 - 22, 2018
ORNAO 15th Biennial Conference	Ottawa, ON	Sep 27 - 30, 2018
N&LORNA Provincial Conference	Max Simms Camp, NL	Oct 19 - 21, 2018
28th Atlantic Conference	Moncton, NB	Oct 25 - 27, 2018
CIISOQ/CORNQ Conference	Laval, QC	Oct 10 - 13, 2018

OTHER CONFERENCES • AUTRES CONFÉRENCES

AORN www.aorn.org	Nashville, TN	April 6 -10, 2019
EORNA www.eorna.eu	The Hague, Netherlands	May 16 - 19, 2019

Additional conferences can be found at www.ornac.ca.
Jetez un coup d'œil aux conférences additionnelles à www.aiisoc.ca.

POSTOPERATIVELY

Expert postoperative nursing care has long been known to minimise patient complications including infection (Collins, 2008). Ensuring patient's pre-existing conditions such as diabetes and chronic obstructive respiratory disease are well managed reduces infection by improving wound perfusion and avoids higher circulating volumes of glucose at the surgical site (Anderson, et al., 2014). Avoiding the potential exposure of the surgical site to microbes by minimising disruptions to and changes of the surgical dressing has been shown to reduce infection risk (Ratto, et al., 2016). Furthermore, the utilisation of negative pressure and antimicrobial dressings have also been shown to reduce postoperative infection rates in higher risk patient groups (Cai, Karam, Parvizi, Smith, & Sharkey, 2014; Chow, 2016; De Vries, et al., 2016; Webster, Scuffham, Stankiewicz, & Chaboyer, 2014).

PERIOPERATIVELY

One of the challenges with perioperative patient care is the range of different health professionals involved and the number of handovers of critical patient information that are required (Garrett, 2016). There are many ways that communication can be improved in the perioperative environment. Examples include surgical team briefings and debriefings and structured handover tools (Fabila, et al., 2016; Friesen, White, & Byers, 2008). Having advanced practice nurses such as Registered Nurse First Surgical Assistants and Nurse Practitioners has also been shown to result in more holistic patient care focused on troubleshooting and addressing all health needs and the provision of excellent patient education (Porton-Whitworth & Doughty, 2016; Sebach, Rockelli, Reddish, Jarosinski, & Dolan, 2015; Varughese, Byckowski, Wittkugel, Kotagal, & Kurth, 2006).

CONCLUSION

The diagnosis and management of PJI remains a challenge. With the increasing utility of joint arthroplasty locally and internationally, the absolute numbers of infected joints are bound to increase. A systematic approach to preventing infection is key. Once presented with a potentially infected prosthesis, the surgeon should approach the issue methodically and once proven, the treatment should be holistic, reflect best practice and be cognizant of the patients' other co-morbidities It is important that the Perioperative Nurse has an understanding of the current best practice for management of PJI so they are well equipped to prepare and educate the patient and provide optimum care.

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