

*Full Length Research Paper*

# Antibiotic Prophylaxis in Joint Arthroplasty: Do we get it right?

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**Purpose:** The goal of this study was to investigate whether our institution adhered to current guidelines for the use of prophylactic antibiotics in hip and knee arthroplasty.

**Type of Study:** Retrospective case series.

**Methods:** Data on the administration of prophylactic antibiotics for 798 consecutive total hip arthroplasty, total knee arthroplasty, and hip hemiarthroplasty procedures were recorded. All primary and revision procedures were included. This data has been analysed to assess if antibiotic prophylaxis administration has followed the current American Academy of Orthopaedic Surgeons guidelines.

**Results:** Prophylactic antibiotics were correctly administered in 266 cases (91.4%) of THR, 259 cases (92.5%) of TKR, 148 cases (86%) of hip hemiarthroplasties, 34 cases (82.9%) of revision THR and 13 cases (92.9%) of revision TKR.

**Conclusions:** The benefit of appropriate prophylactic antibiotic administration in joint arthroplasty is well established and documented in the literature<sup>1</sup>. This study demonstrates that 9.8% of patients undergoing hip and knee arthroplasty procedures are not receiving antibiotic prophylaxis as per AAOS guidelines. This highlights that there is scope for improving current practice and demonstrates the need for clinical audit to ensure that best practice is being undertaken.

**Level of evidence:** Level IV, case series

**Key words:** prophylactic, infection, arthroplasty, antibiotic, total hip, total knee

## BACKGROUND

Infection following total joint arthroplasty is a devastating complication. It adds a significant degree to patient morbidity, mortality, and cost to the health care system<sup>2</sup>. Many measures have been shown to reduce the rates of infection in joint arthroplasty, with multiple trials supporting the use of prophylactic antibiotics in particular<sup>1</sup>. To maximise the effect of prophylactic antibiotics, the appropriate agent must be administered at the correct time and in the correct dose. Pavel et al<sup>3</sup> in a randomised control study of 1591 clean orthopaedic procedures reduced the postoperative infection rate from 5% to 2.8% with the use of a prophylactic cephalosporin (cephaloridine). There are numerous subsequent studies which support Pavel's findings<sup>4,5,6</sup>. As such, the current

guidelines for the use of prophylactic antibiotics in total joint arthroplasty are well established. The burden of disease for an infected prosthetic hip or knee is enormous. A recent study published in the JBJS<sup>7</sup> compared the overall cost of infected hip prostheses with revision arthroplasty for aseptic loosening and with primary joint arthroplasty. They demonstrated that revision hip arthroplasty as a result of infection showed a significant difference in operative time, blood loss, number of complications, number of hospitalisations, days in hospital, outpatient visits and overall cost to the health system. In dollar terms they calculated that revision for infection (USD \$96,166 ± \$60,664) was 2.8 times greater than revision for aseptic loosening (USD \$34,866 ± \$15,547) and 4.8 times the cost of primary hip arthroplasty (USD \$21,654 ± \$4291). Although these figures cannot be directly applied to the Australian health system, they clearly demonstrate the additional monetary

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cost of infection. Patient's experience of infection following hip or knee arthroplasty must also be considered. The uncertainty of the clinical course, the pain associated with multiple procedures, and the reduction in mobility are some factors which can contribute to the patient's dissatisfaction with an infected prosthesis.

Wound infections in clean orthopaedic procedures are commonly caused by skin commensals and airborne microorganisms<sup>1</sup>. Epidemiological studies demonstrate that gram positive organisms are the most likely to cause infection, with *Staphylococcus aureus* and *Staphylococcus epidermidis* being the most common<sup>8</sup>. *Enterococcus*, *Streptococcus*, *Escherichia coli*, *Pseudomonas* and *Klebsiella* species are less common<sup>8</sup>. The selection of antibiotic must provide adequate coverage for these organisms, whilst taking into account local bacterial resistance patterns. The AAOS recommends the use of cefazolin or cefuroxime where the local bacterial resistance patterns are favourable<sup>9</sup>. These are broad spectrum agents with good levels of activity against many of the common pathogenic organisms. It should be remembered that constant vigilance of a particular facilities resistance patterns needs to be undertaken on a regular basis, and appropriate changes in antibiotic choice needs to be considered.

To be an effective prophylaxis, the selected antibiotic must be present at the correct site and in the correct concentration. It is important to remember some basic principles of antibiotic pharmacodynamics. Bactericidal compounds kill bacteria act by inhibiting cell wall synthesis and causing cell lysis, whereas bacteriostatic agents prevent replication of the bacteria. High concentrations of bacteriostatic agents can be bactericidal and low doses of bactericidal agents can be bacteriostatic. Therefore, the tissue concentration of the antibiotic throughout the entirety of the procedure is essential to its effectiveness. The pharmacodynamic properties of the cephalosporins result in bactericidal concentrations in bone, synovium, muscle and haematoma soon after administration, with cephazolin in particular achieving the highest concentration in a fracture haematoma of 5 cephalosporins studied<sup>10</sup>. Cephalosporins have relatively long half-lives which enable a therapeutic tissue concentration to be maintained throughout most orthopaedic operations<sup>10</sup>. The AAOS recommends prophylactic antibiotics should be given within one hour of the skin incision.

Classen<sup>11</sup> et al in their study investigating the timing of prophylactic antibiotics of 2847 operations found that infection rates were lowest when the antibiotics were given within two hours of the skin incision. For the purposes of this study we have classified the timing of prophylactic antibiotics to be correct if they were given within two hours prior to the skin incision. The literature supports the postoperative duration of prophylactic

antibiotics for 24 hours. Extended use has not been shown to reduce infection rates and may theoretically contribute to antibiotic resistance<sup>12</sup>. Mauerhan et al<sup>13</sup> compared the effectiveness of administration of cefuroxime for 24 hours post operatively with 3 days administration of cephazolin in 1354 primary hip and knee arthroplasties in a randomised controlled multicentre study. They found that there was no statistical difference in infection rates between these two antibiotic regimens. The AAOS recommendations are consistent with these findings and recommends only 24 hours of prophylactic antibiotics for operative procedures, irrespective of the presence of drains or catheters. The surgeon must also take into account individual patient factors in the selection of prophylactic antibiotics. Fortunately, adverse reactions to cephalosporins are rare. If such a reaction is identified the AAOS recommends the use of clindamycin or vancomycin as an appropriate alternative agent. If the patient is, or ever has been colonised with MRSA, the AAOS recommends vancomycin as the antibiotic of choice. Using vancomycin as prophylaxis doesn't reduce the overall infection rate, but there is evidence to show that it changes the flora of infections when compared with cephazolin<sup>14</sup>. In a study of patients undergoing cardiothoracic surgery in an institution with high rates of MRSA, two groups were randomised to receive either vancomycin or cephazolin. There was no difference in the rate of post-operative infection, however the type of infection varied between the two groups. The cephazolin group had infections which were more likely to be infected with MRSA and the vancomycin group was more likely to have an infection with methicillin susceptible *Staphylococcus aureus*<sup>14</sup>. A copy of the AAOS guidelines on the use of prophylactic antibiotics in orthopaedic surgery can be found in appendix<sup>1</sup>.

## METHODS

A retrospective review of all patients who underwent hip and knee arthroplasty at our institution during a 3 year period (01/01/2005 - 31/12/2007) was performed. All patients who underwent either a primary total knee or total hip replacement, a revision total knee or total hip replacement, or a hip hemiarthroplasty were included. No patients were excluded from the study. Information recorded included patient demographics, patient allergies, antibiotic agent administered, and timing of administration in relation to the procedure. The data was analysed in categories according to the procedure performed.

## RESULTS

Figures 1-4 display the results for the various procedures.

**Figure 1 : Was prophylactic antibiotics given?**

	Prophylaxis Given / Total Number	Percentage operations
THR	276 / 291	94.9%
TKR	268 / 280	95.7%
Hemiarthroplasty	156 / 172	90.7%
Rev THR	38 / 41	92.7%
Rev TKR	13 / 14	92.9%

**Figure 2: Was timing correct?**

	> 2hrs pre-op	0 – 2 hrs pre-op	Post Incision
THR		268/276 (97.1%)	8/276 (2.9%)
TKR	2/268 (0.7%)	260/268 (97.0%)	6/268 (2.3%)
Hemiarthroplasty		150/156 (96.1%)	6/156 (3.9%)
Rev THR		34/38 (89.5%)	4/38 (10.5%)
Rev TKR		13/13 (100%)	

**Figure 3: Was the correct antibiotic given?**

	Cephalosporin (Cefazolin)	Vancomycin	Gentamicin	Second Line Antibiotic	Inappropriate Antibiotic
THR	267/276 (96.7%)	4/276 (1.4%)	8/276 (2.9%)	3/276 (1.1%)	2/276 (0.7%)
TKR	262/268 (97.8%)	3/268 (1.1%)	3/268 (1.1%)	2/268 (0.75%)	1/268 (0.4%)
Hemiarthroplasty	154/156 (98.7%)	1/156 (0.6%)	5/156 (3.2%)	1/156 (0.6%)	
Rev THR	36/38 (94.7%)	1/38 (2.6%)	4/38 (10.5%)	1/38 (2.6%)	
Rev TKR	12/13 (92.3%)	1/13 (7.7%)	1/13 (7.7%)		

The total percentage of THR, TKR, Hemiarthroplasty, Revision THR and Revision TKR procedures which received prophylactic antibiotics were 94.9, 95.7, 90.7, 92.7 and 92.9% respectively.

A total of 2.9% of THR, 3.0% TKR, 3.9% Hemiarthroplasties, and 10.5% revision THR procedures received the prophylactic antibiotics outside the 0-2 hour recommended window.

**Figure 4: Total percentage of correct administration**

	<b>Total Operations</b>	<b>Total Correct Administration</b>
<b>THR</b>	<b>291</b>	<b>266 (91.4%)</b>
<b>TKR</b>	<b>280</b>	<b>259 (92.5%)</b>
<b>Hemiarthroplasty</b>	<b>172</b>	<b>150 (87.2%)</b>
<b>Rev THR</b>	<b>41</b>	<b>34 (82.9%)</b>
<b>Rev TKR</b>	<b>14</b>	<b>13 (92.9%)</b>

A total of 0.7% THR and 0.4% TKR patients received an inappropriate antibiotic.

## DISCUSSION

Antibiotic prophylaxis in total joint arthroplasty is an essential component of avoiding infection. It must also be remembered that this is only one of a number of important strategies employed in preventing infections in the pre-, intra- and post-operative stages.

Although there are guidelines for the administration of prophylactic antibiotics for joint arthroplasty, there remains a paucity of literature documenting the actual number of correct cases. One recent comparison study undertaken by W-Dahl et al 2011<sup>15</sup> showed that only 69% of 12707 primary TKR procedures performed in 2009 were reported to have received antibiotic prophylaxis within a 45-15 minute time interval, and 79% in 2010. They reported that in 2008 only 45% received their first dose in the 45 -15 minute window they arbitrarily set. Based on this information they improved their success rate with prophylactic antibiotics by highlighting the issues and introducing the WHO checklist.

This study highlights the discrepancy between the ideal for administering antibiotic prophylaxis and the reality of everyday practice. The reasons for this are likely to be multifactorial. Multiple possibilities can be postulated and include broad topics such as the delegation of responsibility, failure of adequate peri-operative checks,

and staffing factors such as constantly rotating staff (surgical/anaesthetic/nursing). Nevertheless, it is paramount that all of these factors be addressed to ensure optimal patient care. Ultimately the responsibility rests upon the surgeon to ensure that the current antibiotic prophylaxis guidelines are followed.

Our recommendations for achieving appropriate antibiotic prophylaxis in joint arthroplasty include a pre-operative checklist and vigilant education of staff as to the importance of prophylactic antibiotics. The goal of correct antibiotic prophylaxis for every case of joint arthroplasty is achievable.

## CONCLUSION

This retrospective analysis demonstrates that 78 out of 798 (9.8%) patients who underwent hip or knee arthroplasty surgery did not receive antibiotic prophylaxis as per AAOS guidelines. This potentially means that 1 in 10 patients are at an increased risk of suffering a post-operative infection. Only through this extensive audit of our clinical practice could this issue be identified. We believe these findings would not be isolated to our institution and we would strongly encourage other institutions to perform a similar audit. It is our recommendation that administration of prophylactic antibiotics is included in the 'final check' to ensure stricter vigilance with following the AAOS guidelines.

## ABBREVIATIONS

THR: total hip replacement, TKR: total knee replacement,  
AAOS: American academy of Orthopaedic Surgeons,  
MRSA: Methicillin Resistant Staphylococcus Aureus

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## APPENDIX 1

The Journal of The American Academy of Orthopaedic Surgeons published recommendations for the use of intravenous antibiotic prophylaxis in primary total joint arthroplasty in 2008. They are summarised as follows.

- Cephazolin or cefuroxime are currently preferred; in patients with known Beta-lactam allergy then Clindamycin or Vancomycin may be used. In patients with known colonisation with MRSA or where the facility has a high rate of MRSA infection then Vancomycin should be used.
- Prophylactic antibiotics should be given within one hour prior to skin incision. Vancomycin should be given two hours prior. The antibiotic should be completely infused before a tourniquet is inflated
- For patients greater than 80kg the dose of cephazolin should be doubled. Additional doses are advised when the procedure exceeds one to two times the antibiotic's half life or when there is significant blood loss.
- Duration of antibiotics should not exceed 24 hours postoperatively.