Best evidence topic - Valves

What type of valve replacement should be used in patients with endocarditis?

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Summary

A best evidence topic in cardiac surgery was constructed according to a structured protocol. The question addressed was ‘in patients undergoing a surgery for endocarditis is a biological valve or mechanical valve superior for achieving long-term low rates of reinfection?’ Altogether more than 41 papers were found using the reported search, of which nine represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes and results of these papers are tabulated. Out of the studies that include statistical comparisons, in mechanical valve replacement the average endocarditis recurrence rate ranged from approximately 3 to 9% and in biological valves from approximately 7 to 29%. Out of the studies that specifically compared the outcomes of the two valves, 50% concluded there to be no significant difference when separated from other risk factors and 50% recommended a mechanical valve for lower recurrence and higher survival rates. The Euro Heart Survey found that 63% of valve replacements were mechanical, due to young age (90%) and physician preference (75%) and only 21% bioprosthetic. Current guidelines from American College of Cardiology/American Heart Association (ACC/AHA) recommend a mechanical valve in patients <65 years old and a bioprosthetic valve if >65, without risk factors for thromboembolism, but this is based on class II evidence (conflicting evidence or opinion). These guidelines are not specific to patients with infective endocarditis, so it is vital to review the literature related to this. Three of the studies in the search specify that for patients under 60–65 years old, a mechanical valve has greater benefit, but this was not found to be true for the over 65 years. It can be concluded that for patients under 65 years old, a mechanical valve may offer greater freedom from reoperation and increased long-term survival when compared to a bioprosthetic valve (assuming no other co-morbidities), although this divide is narrowing with the use of newer generation bioprosthetic valves and has to be off-set against potential bleeding risks. For patients over 65 years, other important variants need to be considered including patient choice, correct protocols of antibiotics and radical debridement.

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Keywords: Review; Endocarditis; Bioprosthetic valve; Mechanical valve; Reinfection

1. Introduction

A best evidence topic was constructed according to a structured protocol. This is fully described in the ICVTS [1].

2. Three-part question

In [patients undergoing a surgery for endocarditis] is [a biological valve] or [mechanical valve] superior [for achieving long-term low rates of reinfection]?

3. Clinical scenario

You are an a multi-disciplinary team (MDT) meeting discussing the case of a young patient with infective endocarditis and a senior consultant states that a biological valve must be inserted to reduce the risk of reinfection, even though the patient will require a mechanical valve replace-
### Table 1. Best evidence papers

<table>
<thead>
<tr>
<th>Study type</th>
<th>Author, date and country of publication</th>
<th>Patient group</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Comments</th>
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</thead>
</table>
| Retrospective cohort study (level 2b) | Sweeney et al., (1985), J Thorac Cardiovasc Surg, USA, [2] | 185 patients who had undergone valve replacement for life-threatening active valvar native or prosthetic endocarditis during 1979–1984 were identified | Actuarial rate for freedom from reoperation at four years | – Mechanical: 94.6%  
– Bioprosthetic: 75%  
(P<0.01) | This paper concludes that mechanical valve replacement leads to a reduced reoperation rate and rate of recurrent endocarditis compared to bioprosthesis valve replacement |
| Retrospective cohort study (level 2b) | Wos et al., (1996), J Cardiovasc Surg, Poland, [3] | 71 patients were reviewed who were treated between 1988 and 1993 for active endocarditis with either a mechanical or bioprosthetic valve | Four-year mortality | – Mechanical: 20%  
– Bioprosthetic: 28.6%  
(P>0.05 – not significant) | A limitation to this study is that it did not separate the native valve endocarditis patients from the prosthetic valve endocarditis patients, which may have impacted the results. Also, the bioprosthetic valves used during the study were an early pericardial valve which is no longer on the market |
| Retrospective cohort study (level 2b) | Edwards et al., (1998), Eur J Cardiothorac Surg, UK, [4] | 322 patients with valve replacement for prosthetic valve endocarditis between 1986 and 1996 | Significant determinants of 30-day mortality | No evidence that the type of prosthesis used for reoperation determines survival or freedom from reoperation. Age was the only significant determinant (P=0.04) | The conclusions to be made from this study are that using either a mechanical or bioprosthetic valve replacement makes no difference to short-term survival or reoperation in cases of prosthetic valve endocarditis. The main limitation of this study is that it researched only the first 30 days following surgery |
| Randomised prospective cohort trial (level 1b) | Hammermeister et al., (2000), J Am Coll Cardiol, USA, [5] | 575 patients undergoing aortic or mitral valve replacement were randomised to receive either a bioprosthetic or mechanical valve, between 1977 and 1982 | Reoperation rate | – Bioprosthesi: 29±5%  
– Mechanical: 10±3%  
(P=0.004) | This study was not focused on infective endocarditis, but simply the differences of valve replacements in general |
| Randomised prospective cohort trial (level 1b) | | | 15-year mortality | – Bioprosthesi: 66±5%  
– Mechanical: 79±3%  
(P=0.02) | It found that the advantages of using a mechanical valve for aortic valve replacement (lower mortality, primary valve failure and reoperation) were off-set by a greater bleeding risk. It also found that primary valve failure accounted for the high mortality in bioprosthetic valves in patients <65 years, but not those aged >65 years |
| Randomised prospective cohort trial (level 1b) | | | Primary valve failure | <65 years:  
– Bioprosthetic: 26±6%  
– Mechanical: 0%  
(P=0.0001) | |
| Randomised prospective cohort trial (level 1b) | | | | >65 years:  
– Bioprosthetic: 9±6%  
– Mechanical: 0%  
(P=0.16) | |

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Table 1. (Continued)

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<thead>
<tr>
<th>Author, date and country of publication Study type</th>
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<tr>
<td>Moon et al., (2001), Ann Thorac Surg, USA, [6] Retrospective cohort study (level 2b)</td>
<td>306 patients were identified who underwent valve replacement for left-sided endocarditis between March 1964 and December 1995</td>
<td>Linearised rate of recurrent or residual endocarditis</td>
<td>– Mechanical valves: 0.5±0.5%&lt;br&gt;– Bioprosthetic valves: 1.1±0.4%&lt;br&gt;(P&gt;0.25 – insignificant)</td>
<td>This review demonstrated that the use of bioprosthetic valves in older patients (&gt;60) led to a greater freedom from reoperation, but mechanical valves lead to greater freedom from reoperation in those patients &lt;60 (who have an otherwise normal life expectancy)</td>
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<td>Overall long-term survival at 10 years</td>
<td>– Mechanical: 50±8%&lt;br&gt;– Bioprosthetic: 51±4%&lt;br&gt;(P&gt;0.27)</td>
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<td>Overall long-term survival at 20 years</td>
<td>– Mechanical: 38±9%&lt;br&gt;– Bioprosthetic: 34±5%&lt;br&gt;(P&gt;0.64)</td>
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<td>Overall freedom from reoperation</td>
<td>– Mechanical: 74±9% at 10 years, 74±9% at 15 years&lt;br&gt;– Bioprosthetic: 56±5% at 10 years, 22±6% at 15 years&lt;br&gt;(P&gt;0.64)</td>
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<td>Renzulli et al., (2001), Ann Thorac Surg, Italy, [7] Retrospective cohort study (level 2b)</td>
<td>271 patients received valve replacement surgery for infective endocarditis between 1979 and 2000</td>
<td>Incidence of recurrence of endocarditis</td>
<td>The type of valve substitute implanted did not affect the incidence of recurrence</td>
<td>No statistical values are given to support this conclusion</td>
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<td>Tornos et al., (2005), Heart, Spain, [8] Prospective survey (level 2c)</td>
<td>45 patients who underwent valve replacement for infective endocarditis were selected out of 5001 patients with valvular heart disease enrolled onto the Euro Heart Survey between April and July 2001</td>
<td>Choice of valve replacement</td>
<td>– Bioprosthesis: 21%&lt;br&gt;– Mechanical: 63%&lt;br&gt;– Homografts: 5%</td>
<td>The most frequent reasons for using the mechanical valve were young age in 90%, physician’s preference in 75%, other indication for treatment with an anticoagulant in 15% and renal failure in 10% The limited number of patients does not allow for robust conclusions to be made</td>
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<td>Fedoruk et al., (2009), J Thorac Cardiovasc Surg, Canada, [9] Retrospective cohort study (level 2b)</td>
<td>358 patients having had valve replacement for native valve endocarditis between 1975 and 2000</td>
<td>Unadjusted survival at 20 years</td>
<td>– Mechanical: 56.5±8.1%&lt;br&gt;– Bioprosthetic: 26.4±4.9%&lt;br&gt;(P=0.007)</td>
<td>This paper concludes that the type of prosthesis implanted does not influence long-term outcome, however, the unadjusted survival rates would suggest that this study provides evidence for better long-term survival with mechanical prostheses</td>
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<td>Prosthesis type as predictor of reoperation</td>
<td>Not predictive when separated from IV drug use/HIV (hazard ratio 3.268, P=0.088)</td>
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<td>Nguyen et al., (2009), Eur J Cardiothorac Surg, France, [10] Prospective cohort study (level 1b)</td>
<td>167 patients were identified who underwent aortic valve replacement for aortic valve endocarditis between December 1998 and March 2000</td>
<td>Five-year mortality</td>
<td>– Bioprosthesis: 58.1%&lt;br&gt;– Homograft: 14.8%&lt;br&gt;– Mechanical: 24.4%&lt;br&gt;(P=0.0004)</td>
<td>The conclusions of this study are that patients receiving a bioprosthetic valve had a significantly lower overall five-year survival rates than those patients receiving a mechanical valve. This finding was more pronounced in patients ≥65 years, but not proven in patients ≥65 due to</td>
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<td>Early mortality</td>
<td>– Bioprosthesis: 19.4%&lt;br&gt;– Homograft: 7.4%&lt;br&gt;– Mechanical: 10.1%&lt;br&gt;(P=0.27)</td>
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6. Results

Sweeney et al. [2] reviewed 185 patients who had undergone valve replacement for active bacterial endocarditis, 88 had a bioprosthetic valve and 97 a mechanical valve. Three-quarters of patients with mechanical valves were aged 60 years old, whereas only about 25% of bioprosthetic valve patients were over 65 years old. There was a significant reduction in recurrent infection leading to reoperation in the mechanical valve group, compared to bioprosthetic (3.3% vs. 7.4%, P<0.01). The actuarial rate of freedom from reoperation was also higher for mechanical at four years (94.6% vs. 75% bioprosthetic, P<0.01), as was four-year actuarial survival rate (87.4% mechanical vs. 78.7% bioprosthetic, P<0.05).

Wos et al. [3] found similar results when reviewing 71 patients with valve replacements following endocarditis. There was a statistical difference in the recurrence rate of endocarditis, with higher rates in the patients with bioprosthetic valves, compared to the patients with mechanical valves (28.6% vs. 8.5%, P=0.028), with concurrent higher rates of reoperation (21% vs. 4.2%, P=0.022).

Fedoruk et al. [9] found that unadjusted survival rates at 20 years were greater for patients with mechanical valves (56.5±8.1% vs. 26.4±4.9% for bioprosthetic valves, P=0.007), but overall they concluded that prosthesis type was not an independent predictor of reoperation. The key independent predictors of outcome were age, intravenous (IV) drug use/human immunodeficiency virus (HIV) and surgical technique.

Similarly, Renzulli et al. [7] found that the choice of valve substitute used in patients with infective endocarditis did not affect recurrence rate of infection. Instead, the multivariate analysis demonstrated that prosthetic endocarditis (P=0.00001), positive valvular cultures (P=0.0039), and persistence of postoperative fever (P=0.00001) were independent risk factors for recurrence of endocarditis.

Edwards et al. [4] investigated determinants of reoperation for prosthetic valve endocarditis (PVE) and found that age was the only significant independent predictor in outcome (specifically in 30-day mortality, P=0.04), with no evidence to suggest that one type of prosthesis was superior in determining survival or freedom from reoperation.

Moon et al. [6] investigated further into the effects of age in valvular replacement following endocarditis and found survival was independent of type of prosthesis used (P>0.27). The different rates of linearised reinfection or residual endocarditis after five years between mechanical and bioprosthetic were insignificant among the collective group (P>0.25). There was also no difference in medium and long-term survival with mechanical or bioprosthetic valves (four-year survival 82±6% vs. 79±3% and 20 years 46±10% vs. 41±6%, P>0.50). Among those patients under 60 years old with a biological valve, the long-term freedom from reoperation was low (51±5% at 10 years, 19±6% at 15 years), there for leading to the conclusion that mechanical valves are most suitable for young patients with endocarditis. In the older age group (>60 years old), however, there were similar results with freedom from reoperation at 15 years with both bioprosthetic and mechanical valves (84±7% vs. 74±9%).

Nguyen et al. [10] concluded that a bioprosthetic valve replacement for infective endocarditis is associated with a lower five-year survival than the use of a mechanical valve in patients >65 years old [adjusted hazard ratio (HR) 4.14, P=0.018], but no such statistical significant relationship was observed in patients >65 years old. Hammermeister et al. [5] explained similar findings as due to a greater rate of primary valve failure with bioprosthetic valves compared to mechanical valves in patients <65 years old, but not in those aged ≥65 years.

None of the papers are randomised controlled trials (RCTs), but more importantly despite attempts to adjust for differences in the patient populations in many of the papers, the groups of endocarditis patients receiving biological and mechanical valves are often quite different. Young patients receiving biological valves may more often be current IV drug abusers, or the patients may have incompletely treated endocarditis and both of these factors may in themselves cause an increased rate of infection whatever type of valve is used.

7. Clinical bottom line

Out of the studies that include statistical comparisons, in mechanical valve replacement the average endocarditis recurrence rate ranged from approximately 3 to 9% and in biological valves from approximately 7 to 29%. Out of the studies that specifically compared the outcomes of the two valves, 50% concluded there to be no significant difference when separated from other risk factors and 50% recommended a mechanical valve for lower recurrence and higher survival rates. It is worth noting that the older studies compare mechanical valves to first-generation bioprosthetic...
etropic valves, such as Ionescu–Shiley pericardial valves, which were removed from the market due to clinical failure and replaced with improved second-generation bioprosthetic valves.

Three of the studies in the search specify that for patients under 60–65 years old, a mechanical valve has greater benefit, but this was not found to be true for the over 65 years. It can be concluded that for patients under 65 years old, a mechanical valve may offer greater freedom from reoperation and increased long-term survival when compared to a bioprosthetic valve (assuming no other comorbidities), although this divide is narrowing with the use of newer generation bioprosthetic valves and has to be offset against potential bleeding risks. For patients over 65 years, other important variants need to be considered including patient choice, correct protocols of antibiotics and radical debridement.

References


