RESEARCH

Clinical and echocardiographic follow-up of patients following surgical heart valve repair or replacement: a tertiary centre experience

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Abstract

International best practice guidelines recommend lifelong follow-up of patients that have undergone valve repair or replacement surgery and provide recommendations on the utilization of echocardiography during follow-up. However, such follow-up regimes can vary significantly between different centres and sometimes within the same centre. We undertook this study to determine the patterns of clinical follow-up and use of transthoracic echocardiography (TTE) amongst cardiologists in a large UK tertiary centre. In this retrospective study, we identified patients that underwent heart valve repair or replacement surgery in 2008. We used local postal codes to identify patients within our hospital's follow-up catchment area. We determined the frequency of clinical follow-up and use of transthoracic echocardiography (TTE) during the 9-year follow-up period (2009–2016 inclusive). Of 552 patients that underwent heart valve surgery, 93 (17%) were eligible for local follow-up. Of these, the majority (61/93, 66%) were discharged after their 6-week post-operative check-up with no further follow-up. Of the remaining 32 patients, there was remarkable heterogeneity in follow-up regimes and use of TTE. This variation did not correlate with the prosthesis type. In summary, the frequency of clinical follow-up and use of echocardiography is highly variable in contemporary practice. Many patients are inappropriately discharged back to their family doctor with no plans for hospital follow-up. These data further support the creation of dedicated specialist heart valve clinics to optimize patient care, ensure rational use of TTE and optimize adherence with best practice guidelines.

Key Words

- prosthetic valve
- transthoracic echocardiography
- valve clinics

Introduction

There has been renewed clinical and research interest in valvular heart disease (VHD) over the past decade, fuelled in part by innovations in percutaneous treatment options as well as advances in imaging that allow for more precise assessment of the impact of VHD on the myocardium. VHD patients have traditionally been seen in 'general cardiology' clinics, both before and after surgery. However, with significant advances in the use of imaging, stress testing and cardiac biomarkers to guide timing of intervention – coupled with growing transcatheter options for certain patients – the 'traditional' model of care for VHD patients has been re-evaluated and tested and new

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models of care and practice for valve disease surveillance and follow-up have been published, including specialist heart valve clinics (1, 2, 3).

Patients with prosthetic heart valves (PHVs) require lifelong specialist follow-up to monitor for short- and long-term complications including prosthesis failure. Although international guidelines (4, 5) exist recommending frequency of follow-up including utilization of echocardiography, follow-up regimes of PHV patients vary significantly between different centres and sometimes within the same centre.

Both the 2007 (6) and 2012 (6) versions of the European Society of Cardiology (ESC) guidelines on VHD recommended that '*all patients who have undergone valve surgery require lifelong follow-up by a cardiologist*', to detect early deterioration in prosthetic valve or left ventricular function or progressive disease of another heart valve. The guidelines also recommended that clinical assessment should be performed yearly – or as soon as possible if new cardiac symptoms occur. With regards to TTE, this was not required routinely for clinically stable patients with mechanical valves but was recommended, irrespective of symptom status, on an annual basis after the fifth year following implantation in patients with a bioprosthesis (6).

However, the 2017 update of the ESC VHD guidelines (4) recommend yearly clinical and echocardiographic follow-up after transcatheter and surgical bioprosthetic valve implantation. The changes and variability in the guidelines not only reflect emerging evidence and experience, but also emphasise the need for novel and flexible valve surveillance and follow-up models that are capable of adaptation to facilitate implementation of such changes and thus adhering to best-practice recommendations.

Accordingly, we conducted this study to determine follow-up practice and echocardiography utilization in PHV patients in a large tertiary centre in the UK (without a dedicated valve clinic) and audited this practice against the relevant ESC VHD guidelines.

Methods

In this retrospective study, we first searched hospital databases to identify patients that had undergone heart valve repair or replacement surgery from January to December 2008. As we are a regional tertiary centre for cardiac surgery, we then used postal codes to identify patients within our hospital's catchment area for follow-up and excluded patients referred in by our district hospitals, as they are responsible for the clinical follow-up of these patients. We excluded patients that had a pre-existing reason for clinical follow-up due to known cardiac disease, such as heart failure and congenital heart disease. We then used our electronic patient records system – and medical notes where necessary – to determine the frequency of clinical follow-up and use of TTE for each patient. We also used the hospital database system to identify mortality status amongst both the patients discharged from follow-up and those followed up by the hospital. For patients that died during the follow-up period of the study (2009–2016), we examined clinical and echocardiographic follow-up each year until their death to determine whether follow-up practice was appropriate (i.e. guideline-directed) whilst alive following surgery. Information on cause of death was documented when available. The follow-up practice and use of echocardiography were compared against the relevant ESC guidelines on management of patients with VHD. Local permission was sought and obtained to perform retrospective analysis of patient data.

Results

There were 552 adult patients who underwent valve surgery in our hospital during 2008, of which 93 (17%) patients were eligible for local follow-up. Patients were seen in the clinics of all ten adult cardiologists in our centre (five interventional cardiologists, three cardiac electrophysiologists, one heart failure specialist and one imaging specialist). Patients were seen by the consultant, a cardiology registrar or senior house officer (SHO). No patients were seen by a specialist nurse or advanced sonographer. If patients were seen by an SHO-level doctor, all cases were discussed with either the registrar or consultant if a change in management plan or discharge from clinic was proposed, as per our consultants' outpatient clinic policy. The baseline patient characteristics and types of surgery performed are listed in Table 1.

Two-thirds of all patients (61/93, 66%) did not have any follow-up after their 6-week post-operative check-up with the surgical team, at which point they were discharged back to their general practitioner (GP). In almost all these cases, we noted that the clinic letter to the patient's GP from the cardiac surgeons was not copied to the cardiologist that originally referred the patient for surgery. Of these patients, nine had mechanical valves and were all aged younger than 70 years. In total, 21/61 (34%) of the discharged patients were under 70 years of

Table 1 Demographic and operative details of the 93 patients.

Baseline characteristics							
Gender (%)	Females	35					
	Males	65					
Age (mean (s.d.))	73 (11)						
Valve intervention	**Mechanical AVR alone**	**Mechanical MVR alone**	**Tissue AVR**	**Tissue MVR**	**Tissue AVR and MVR**	**MV repair**	
n (%)	9 (9.7)	2 (2.1)	54 (58.1)	8 (8.6)	9 (9.7)	11 (11.8)	

age – their age range was 33–69 (mean ± s.d. = 58 ± 10 years) and 17 patients were under 65 years of age. Of these 61 patients, only 4 (2.4%) were re-referred to cardiology from primary care to re-instate clinical follow-up.

Of these 61 patients that were not followed up, there were 27 (44%) deaths during the study follow-up period (2009–2016 inclusive). Of those 27 patients, 14 died in our hospital after re-admission and 13 died in the community. Of the 14 that died in hospital, 13 had non-PHV-related deaths and 1 (1/14 = 7%) died after emergency re-do PHV surgery due to infective endocarditis. The patient that developed endocarditis had definite vegetations confirmed at surgery, although blood cultures, valve tissue culture and PCR analyses all failed to identify an organism. We were unable to ascertain if this patient had undergone dental treatment in the weeks preceding hospital admission. Of the 13 patients that died in the community, two were known to have metastatic cancer, one had an infected hip joint and was not deemed fit for operation and was transferred to a nursing home and the mode of death in the other ten patients is unknown.

Approximately one-third (32/93, 34%) of the patients had routine follow-up (Table 2). Of these patients, only 6/32 (19%) patients had annual clinical assessment, as recommended by the ESC guidelines. None of the patients had echocardiography as per ESC guidelines – specifically, none of the 29 patients with a bioprosthesis and who were clinically stable underwent echocardiography only after 5 years following valve insertion (i.e. after 2013). Indeed, 20/32 (62.5%) patients had a repeat echocardiogram 1 year after valve intervention. Of the three patients with mechanical valves, one patient had annual echocardiography (and follow-up) despite normal AVR and normal LV function at baseline; one patient had echocardiography every 2 years and the third patient had two echocardiograms during follow-up with no particular pattern and not related to a change in symptom status. There was no significant difference in age between the 'follow-up' and the 'no follow-up' groups (mean age ± s.d.: 70.6 ± 12.6 vs 73.4 ± 10.4 respectively; $P = 0.47$).

Of the 32 patients that were followed up, there were 11 deaths during the study period. The mean time interval from date of operation to date of death was 1560 ± 822 days. There were five deaths in our centre and six deaths in the community. None of the five hospital deaths were related to the PHV and the mode of death in the six community deaths is unknown.

As stated earlier, 11 patients died during follow-up and 21 patients survived the 8-year follow-up period of 2009–2016 inclusive. Amongst these 21 patients, there was remarkable heterogeneity in the frequency of clinical assessment and use of echocardiography. Figure 1 illustrates the numbers of patients that had one, two, three, four, five, six, seven and eight follow-up clinic visits and echocardiograms.

Discussion

There are two principal findings of our study – firstly, most patients were discharged to their GP following heart valve surgery with no plans for any hospital follow-up. Secondly, outside of a dedicated specialist heart valve clinic, both the frequency of clinical assessment and of use of echocardiography are highly variable – even in large centres and differ from recommendations of international published guidelines in most cases.

Modern clinical cardiology has evolved into five distinct subspecialties over the past decade – interventional cardiology, cardiac electrophysiology, heart failure, adult congenital heart disease and cardiac imaging. Whilst this has undoubtedly led to wider provision of specialist and super-specialist care in many countries, there remain certain clinical conditions that do not neatly fit into one of these five categories – such as VHD. As an example, VHD patients may present to their GP with exertional dyspnoea, to an electrophysiologist with new arrhythmia (e.g. atrial fibrillation) or to a heart failure physician with advanced disease. Historically, patients with VHD have been seen in general cardiology clinics, and this practice has persisted in most hospitals even after subspecialisation (7).

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Table 2 Clinical and echocardiographic details of the followed up patients.

Patient no.	Operation	LV function	Died during F/U period	Annual clinical F/U	No. of F/U visits	No. of TTE studies
1	mAVR	Normal	No	No	5	2
2	mMVR	Normal	No	No	4	4
3	mMVR	Normal	No	Yes	8	8
4	MV Rep	Normal	No	No	6	6
5	MV Rep	Normal	No	Yes	8	7
6	MV Rep	Normal	No	No	5	5
7	MV Rep	Normal	No	No	1	3
8*	tAVR	Normal	Yes	No	1	1
9	tAVR	Normal	No	No	4	5
10	tAVR	Normal	No	No	5	4
11*	tAVR	Normal	Yes	No	0	0
12*	tAVR	Normal	Yes	No	0	0
13	tAVR	Normal	No	No	6	6
14*	tAVR	Mild ↓	Yes	Yes	3	1
15*	tAVR	Normal	Yes	Yes	5	4
16*	tAVR	Normal	Yes	No	4	2
17	tAVR	Normal	No	No	3	2
18*	tAVR	Normal	Yes	Yes	3	3
19	tAVR	Normal	No	No	1	1
20	tAVR	Mild ↓	No	No	6	6
21*	tAVR	Normal	Yes	No	1	4
22	tAVR/Root	Normal	No	No	5	5
23	tAVR/MVRep	Normal	No	No	7	7
24	tAVR/MVRep	Mild ↓	No	No	3	6
25	tAVR/tMVR	Normal	No	No	7	7
26	tAVR/tMVR	Normal	No	No	6	5
27	tAVR/tMVR	Normal	No	Yes	8	8
28*	tMVR	Normal	Yes	No	3	4
29*	tMVR	Normal	Yes	No	1	2
30	tMVR	Normal	No	No	7	7
31	tMVR	Normal	No	No	2	2
32*	tMVR	Normal	Yes	No	0	0

*Patients that died at some stage during the follow-up period (2009–2016).
F/U, follow-up; mAVR, mechanical aortic valve replacement; Mild ↓, mild reduction (in LV function); mMVR, mechanical mitral valve replacement; MVRep, mitral valve repair; tAVR, tissue aortic valve replacement; tMVR, tissue mitral valve replacement.

However, in recent years, there has been renewed interest in VHD and in particular regarding the widespread variation in care offered to VHD patients, both before and after cardiac surgery. The expanding cohorts of patients undergoing transcatheter and surgical valve implantation and repair, and emerging new imaging technologies and surgical techniques have led to wider discussions about the best methods to optimize patient care and their clinical outcomes. New relevant guidelines and expert consensus documents have been published outlining new models of surveillance and follow-up of VHD including specialist heart valve clinics and the concept of specialist Heart Valve Centres (2, 8).

Published studies have demonstrated the value and benefits of such specialist valve clinics, especially when incorporating other healthcare professionals for patient review. Almost a decade ago, Taggu *et al.* (9) reported that the introduction of a sonographer-led specialist valve clinic in their hospital dramatically reduced the need for review by a cardiologist and also reduced unnecessary echocardiography. Parkin *et al.* published a study illustrating the benefits of a nurse-led clinic for review of PHV patients; as in our study, they also found that many patients are discharged from cardiac follow-up after surgery (33% in their study, 66% in ours) (10). The authors reported that such clinics are instrumental for monitoring adherence to anticoagulation regimes for patients with mechanical PHVs, reminding patients on the need for antibiotic prophylaxis and ensuring regular dental surveillance (10).

However, in an era of prolonged austerity, it is important to question the clinical value and cost-effectiveness of routine follow-up of PHV patients after their surgery. This issue has been raised in two previous

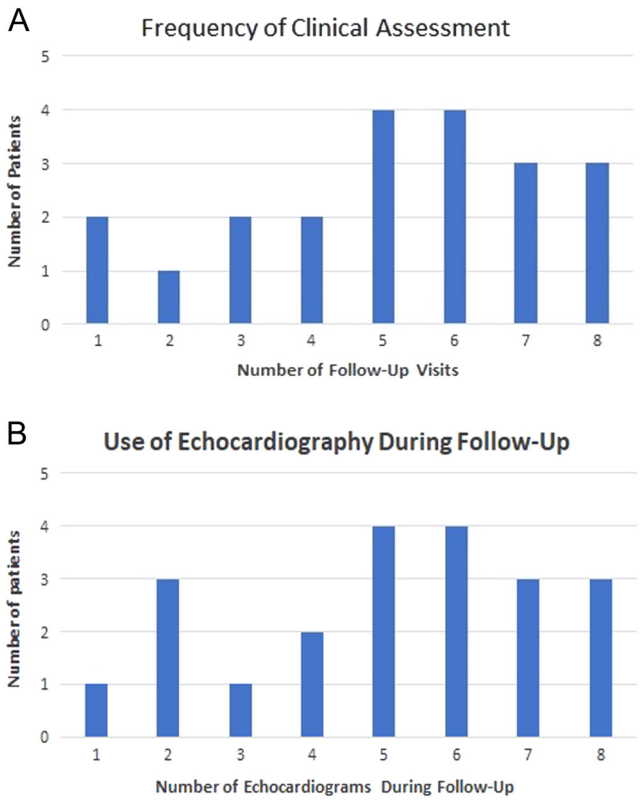

Figure 1
Graphs showing variation in practice for clinical assessment (panel A) and use of echocardiography (panel B) amongst the 21 patients that were alive during the entire follow-up period (2009–2016). The bars represent the numbers of patients that had 1, 2, 3, 4, 5, 6, 7 or 8 follow-up visits (panel A) and echocardiograms (panel B).

small retrospective studies. In a single-centre UK study, Mahy *et al.* (11) prospectively studied 100 consecutive follow-up visits after mechanical valve replacement surgery. They found that a change in clinical management was necessary in only 20% of patients and, of these, the majority (13/20, 65%) had developed new symptoms. Echocardiography was performed in almost half the study cohort. In a retrospective manner, they also examined re-do valve surgery operations in their centre over a 7-year period. Of the eight patients requiring re-do surgery, none had abnormalities picked up during their routine follow-up. The authors concluded that routine follow-up of patients with mechanical heart valves had a low clinical yield for detecting abnormalities and that an individualized approach was likely to be required in the absence of a randomized trial, which the authors correctly surmised would never be undertaken to guide clinical follow-up. In a separate two-centre study, Mahmood *et al.* (12) studied follow-up practice in 170 patients with PHV (85% mechanical valves) and found that just 4.2% patients developed problems with the PHV during follow-up and 3.5% developed significant disease of (unoperated) native valves. These authors also concluded that routine follow-up of such patients is associated with a low yield of abnormal findings and likely to be wasteful of finite resources.

However, both these studies were conducted in an era when mechanical valves were the prosthesis of choice for most patients – the past two decades have witnessed a significant growth in the use of bioprosthetic valves (13), which have a shorter longevity and greater risk of premature structural degeneration. Thus, the applicability of these studies' findings to contemporary practice is questionable. More recently, the issue of cost-effectiveness has been addressed directly by Ionescu *et al.* (14) who used economic modelling to demonstrate that although setting up a valve clinic is more expensive for reviewing new patients, in the longer-term valve clinics would provide significant cost savings by reducing the frequency of echocardiography and the need for patient review by consultant cardiologists (14).

Overall, there remains significant under provision of specialist heart valve clinics within the United Kingdom, and there is a five-fold difference between tertiary cardiac centres and district general hospitals according to a UK study (7). Studies have suggested that surveillance in a specialist valve clinic improves adherence to international guidelines and reduces unnecessary echocardiograms (9). Important savings in costs can also be achieved by adopting valve clinics models (14).

The latest edition of the ESC VHD guidelines, published in 2017, contained one very significant change from the 2007 and 2012 guidelines with regards to the use of TTE in follow-up of PHV patients. Whereas the 2007 and 2012 guidelines recommended annual TTE only after 5 years in patients with bioprosthetic valves, the 2017 guidelines now recommend *annual* echocardiography in all patients with bioprosthetic valves. This change has been made on the basis of expert consensus recommendations (15, 16); research data supporting the clinical efficacy and cost-effectiveness of such an approach are currently lacking. If this guidance were followed, however, it would have a significant impact upon echocardiography departments across the United Kingdom. Logistically speaking, this is unlikely to be feasible but, within a dedicated valve clinic, specific parameters/criteria for post-operative echocardiography could be devised to maximize appropriate use of TTE during follow-up. These recommendations for annual echocardiography are also at odds with the American guidance on VHD; in

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an attempt to rationalize this, the European Association of Cardiovascular Imaging has released appropriateness criteria for the use of cardiovascular imaging in patients with heart valve disease (17). In this document, frequencies for surveillance TTE for patients that have undergone replacement or repair surgery and have had a normal post-operative baseline TTE are suggested.

There are certain limitations of our study which we acknowledge, including its retrospective and single-centre design and associated small patient numbers. However, as a demonstration of 'real-world' clinical practice outside of a dedicated specialist heart valve clinic service, we believe the data are a true reflection of practice in many UK hospitals. With regards to the data available on follow-up of patients, we also acknowledge that mortality is not the only clinical outcome of interest and that due to the retrospective nature of this study, further information on clinically relevant end points are not available.

Conclusion

This study demonstrates the significant loss to follow-up for PHV patients after surgery as well as highly variable practice amongst cardiologists in those patients that do receive follow-up including use of echocardiography. Our data underline the need for a standardized follow-up of patients with PHV. This could be achieved by wider implementation of specialist heart valve clinics, to standardize care for patients, ensure adherence to the guidelines, regulate utilization of echocardiography and thus improve cost-efficiency.

Declaration of interest
The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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