

Heart Valve Clinics, Centers, and Networks



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KEYWORDS

• Heart valve center • Valve clinic • Valve disease

KEY POINTS

- Heart valve clinics ensure that patients are cared for by cardiologists and other specialists who undertake to develop and maintain specialist knowledge and experience to improve care.
- Heart valve centers are defined by the standards of the facilities and organization, including individual operator and center volume, to optimize interventional results.
- The key is that every discipline and service, including imaging, has valve-specific expertise.
- Valve disease networks facilitate the transfer of patients across each level of care from community to district hospital to heart valve center.

INTRODUCTION

Specialist valve clinics^{1,2} were proposed because of limitations in the care of patients with heart valve disease. They represented a rallying call for developing a specialist interest in valve disease to improve clinical decision making and the organization of care.

A key aim of a valve clinic is to refer to a surgeon or interventional cardiologist appropriately but early in the natural history of the condition before the development of significant adverse left ventricle (LV) geometric and functional changes or major adverse clinical events such as sudden death. If a patient has no or minimal symptoms, it is particularly important that the intervention can be accomplished safely and effectively. This requirement is stated in the guidelines concerning repair of mitral prolapse^{3–5} but is equally relevant for patients with class II indications for surgery in aortic stenosis (AS). The need for excellent results led to a consensus statement on standards required for heart valve centers.^{3,4,6}

More recently the need to coordinate valve care at cardiac centers, referring hospitals, and the community has led to the concept of a valve care network. This network is intended to rationalize

the flow of patients to the center for treatment but then out to the community for follow-up.

This article discusses the makeup of valve clinics, heart valve centers, and valve networks.

WHY ARE SPECIALIST VALVE SERVICES NEEDED?

The prevailing arrangement had been for patients with heart valve disease to be cared for by physicians or cardiologists without specialist competencies in valve disease. Furthermore, there was a general lack of awareness of the frequency and importance of valve disease. These factors led to many limitations to care, which for AS were:

- Reduced detection rate. In the OxVALVE study,⁷ 4.9% of people more than 65 years of age had previously known moderate or severe valve disease of all types, but a further 6.4% had disease detected only by population screening. Approximately one-half of cases of severe AS detected at postmortem are known in life.⁸
- Difficulties of assessment. Physicians or cardiologists without specialist competencies may have difficulty in determining whether

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patients are truly asymptomatic. This problem applies particularly in AS, in which the first symptom is often a reduction in exercise capacity rather than overt breathlessness or chest discomfort. Many patients have multiple comorbidities, making it hard to determine whether the AS is the cause of symptoms. These comorbidities may also complicate the decision of when and whether intervention is indicated. The grading of AS is increasingly difficult, especially in patients with discordant echocardiographic results, and there is an increasing need to be aware of the value of nonechocardiographic imaging techniques and biomarkers.^{9,10} Decisions about surgery for coexistent mitral regurgitation or the advisability of replacing an aortic valve with mild or moderate stenosis at the time of coronary bypass grafting may also be difficult.

- Timing of surgery. Guidelines are frequently either not known or not followed,^{11–13} and about one-third of patients with AS are referred for intervention either too early or too late.¹² Approximately 50% have class III or IV symptoms, which increases the risk and reduces the success of surgery.¹⁴
- Access to appropriate intervention. In the United Kingdom¹⁵ there is major geographic variation in access to aortic valve replacement (Fig. 1). Penetration of transcatheter aortic valve implantation (TAVI) is similarly variable. Access is particularly poor for the elderly, at least one-third of whom with severe AS are not referred for surgery despite clear clinical indications.^{16,17} Developing a percutaneous valve program leads to increased rates of conventional surgery, suggesting the prior existence of clinically inappropriate perceptual barriers to referral¹⁸ (see Fig. 1).

HEART VALVE CLINIC

A valve clinic is a necessary part of a heart valve center but it is possible and desirable to have a valve clinic at a district general hospital (DGH) without surgery or other intervention. This clinic can refer either to the clinic at the cardiac center or directly to interventional services (Fig. 2, Table 1).

A cardiac center must have clinics covering all aspects of valve care (see Table 1), including surveillance before surgery and care after intervention. It is not appropriate only to have a clinic dedicated, for example, to TAVI assessment, because this does not accommodate the many other types of valve disease.

However, it may not be appropriate to see patients who will never be suitable for intervention and who would be better seen in another clinic; for example, an elderly care clinic. Some patients may be better suited to a heart failure service, although this is more likely for secondary mitral regurgitation than AS.

ROLES OF A VALVE CLINIC

The medical and organizational aims of a heart valve clinic are given in Table 2. However, despite its name, its roles extend well beyond the outpatient department. The cardiologist running the valve clinic provides:

- Specialist inpatient opinions and care
- Education and training for doctors and patients, including keeping colleagues up to date
- Valve-specific protocols
- Specialist imaging services
- Links with the community to improve detection or valve disease
- Involvement with multidisciplinary teams

DISCIPLINES AND COMPETENCIES

The core specialist is the cardiologist, but disciplines involved depend on the nature of the clinic

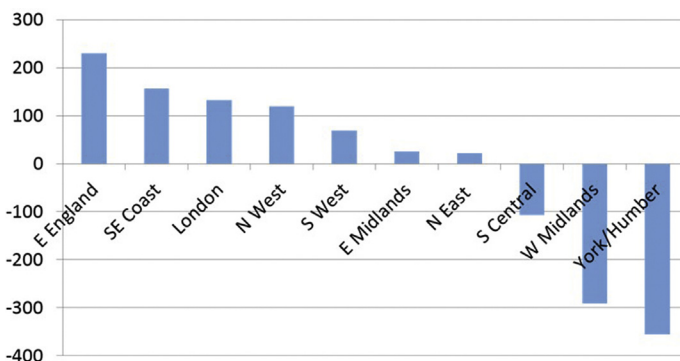


Fig. 1. Predicted versus observed age-adjusted and sex-adjusted aortic valve replacement 2005 to 2008. A comparison of rates of aortic valve replacement in the United Kingdom against estimated need found a variance between observed and expected ranging between -356 and $+230$. (Data from Bridgewater B, Kinsman R, Walton P et al. Demonstrating quality: the sixth National Adult Cardiac Surgery database report. Henley on Thomas UK. Dendrite Clinical Systems Ltd, 2009.)

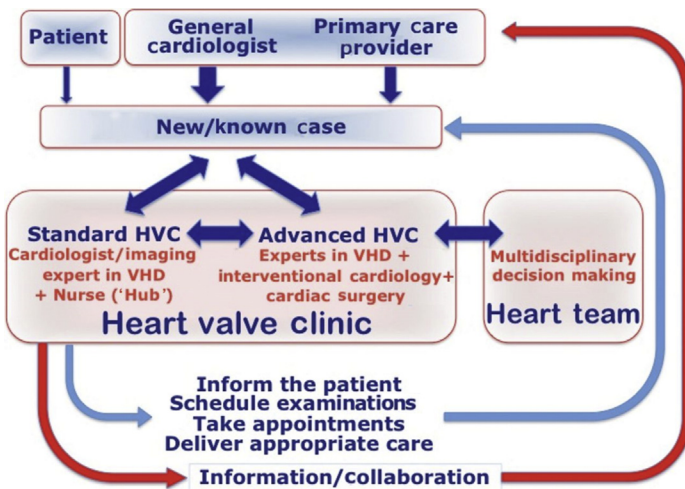


Fig. 2. Organization of a valve clinic. HVC, heart valve center; VHD, valvular heart disease. (From Lancellotti P, Rosenhek R, Pibarot P, et al. Heart valve clinics: organisation, structure and experiences. *Eur Heart J* 2013;34:1597-1606; with permission.)

and might include a surgeon or interventional cardiologist. Large centers are likely to have some clinics for general valve cases and others for patients referred for consideration of surgery or transcatheter procedures. In some countries (eg, the United Kingdom), some roles are devolved to scientist/sonographers or nurses (Table 3).^{19,20} All should have specialist competencies. As yet, there is no formal qualification to establish competency in valve disease for any medical discipline. However, for all disciplines, competencies should be based on the following areas.²¹

TRAINING

For cardiologists, study at a specialized center during training is useful and an essential criterion is attendance at valve-related training events formally designated by accreditation points from a representative national or international body. Surgeons will have received training in a recognized valve center and must be able to show adequate numbers and quality of results according to standards available in opinion articles and defined by national specialist societies.¹²

Table 1
Clinical and pathologic conditions evaluated in the heart valve clinic

Pathologic Conditions	Priority Criteria ^a
<ul style="list-style-type: none"> Moderate or severe native valve regurgitation Mild, moderate, or severe native valve stenosis Previous valve repair or replacement Previous infective endocarditis Thoracic aortic dilatation Previous percutaneous valve implantation or repair Marfan syndrome Combined valve disease Bicuspid aortic valve 	<p>Patient-related conditions</p> <ul style="list-style-type: none"> Unstable condition Discordance between symptoms and VHD severity Discordance between VHD severity and LV function Planned valve repair in asymptomatic patients <p>Valve-related conditions</p> <ul style="list-style-type: none"> Severe valvular regurgitation Severe valvular stenosis Severe dysfunction of prosthetic valve or valve repair Previous infective endocarditis Previous percutaneous valve implantation or repair Marfan syndrome with any degree of aortic dilatation

Abbreviation: VHD, valvular heart disease.

^a The priority criteria may be used to triage the patients eligible for the heart valve center (HVC) in case of limited resources and/or to refer the patients to an advanced HVC.

Table 2
Aims of a specialist heart valve clinic

Medical Aims	Organizational Aims
<ol style="list-style-type: none"> 1. Evaluate patients correctly using multimodality imaging, stress testing, and biomarkers (see Box 1, Table 3) and communicate a management plan including likely prognosis to all involved in the care of the patient 2. Monitor valve disease at appropriate intervals 3. Determine the correct timing of intervention 4. Determine which type of intervention is needed and refer to the appropriate surgeon or interventional cardiologist 5. Assess results after surgery 6. Importantly, educate and inform patients about valve disease both before and after surgery, including the symptoms of valve disease and of endocarditis 	<ol style="list-style-type: none"> 1. Short waiting times appropriate to clinical need 2. A 1-stop approach 3. Clear communication and collaboration with all health care professionals involved in the management of heart valve disease 4. More efficient use of resources; eg, rationalize tests according to international guidelines

Sonographers and nurses must have adequate experience and training; for example, ward-based or laboratory-based experience in cardiology. They should ideally have a higher degree in cardiology and may have attended hospital-based or national clinical skills courses and informal training in consultant-led cardiology clinics.

SPECIALIZED PRACTICE

There is a spectrum in valve-related activity between cardiologists and general practitioners (GPs) who have competencies in valve disease and those, usually at cardiothoracic centers, who subspecialize partly or wholly in valve disease. Specialized practice could be shown by supervision of a valve clinic, being part of the endocarditis

Table 3
Tasks in the standard model of the heart valve clinic

Tasks	Expert in VHD		
	Nurse	Sonographer	Cardiologist
Patient background	+	(+)	+
Blood pressure	+	—	+
Blood sample	+	—	—
12-lead electrocardiogram	+	—	+
Supervise exercise test	—	—	+
Echocardiography	—	+	+
Stress echocardiography	—	(+)	+
Referral to a surgeon/interventional cardiologist	—	—	+
Database entry	+	—	+
Letter to family physician	—	(+)	+
Fix appointments	+	—	+
Organize dental surveillance	+	—	+
Adapt oral anticoagulation therapy	—	—	+
Adapt medical treatment	—	—	+
Follow-up of complex cases	—	—	+

Parentheses indicate tasks that are allowed to be performed by a certified sonographer in some countries; for example, United Kingdom.

team, seeing inpatient referrals with valve disease, and writing departmental protocols. Ideal criteria include research or teaching in valve disease.

CONTINUING PROFESSIONAL DEVELOPMENT

All disciplines attend meetings with valve-specific scientific or educational components, many organized by national or international societies. Membership of a specialist society is encouraged; for example, the European Society of Cardiology Working Group in Valvular Heart Disease, the Society of Heart Valve Disease, or the British Heart Valve Society.

FACILITIES AND LINKS

Echocardiography is the key investigation and should be available as a 1-stop service. Individual operators and departments should be accredited by national or international systems.²² Other imaging techniques and biomarkers must be available (**Box 1**). Exercise testing is particularly useful in AS²³ for revealing symptoms but remains underused.¹²

DO VALVE CLINICS WORK?

It is obvious that a team with an interest and competencies in valve disease is likely to achieve better results than one without. There is a little published information to support this based on clinical results,²⁴ cost, and patient satisfaction, as discussed next.

CLINICAL

Specialist valve clinics make watchful waiting safe in severe mitral regurgitation²⁵ but also deliver better care in severe AS, with symptoms detected earlier and when less severe in a valve clinic compared with those referred from general clinics.²⁶

COST

The cost of specialist valve clinics is lower than for conventional clinics, predominantly because of a reduction in unnecessary echocardiograms.¹³ In devolved clinics there are also cost savings because salaries for nurses or scientists are less than for physicians.²⁷ A protocol-driven scientist-led clinic for AS²⁸ saves money on unnecessary visits, and a multidisciplinary clinic estimated a saving of €45,000 per 100 patients per year.

PATIENT SATISFACTION

Feedback is mainly informal, with patients valuing seeing the same person each time, and 1-stop

Box 1 Tests needed for valve clinic

B-type natriuretic peptide (BNP): a BNP level 3 times the upper limit of normal is a class IIa indication for aortic valve replacement,¹ but it is not used routinely. It is most useful when there are multiple causes of breathlessness to help differentiate the effect of valve disease and noncardiac conditions.

Renal function: this is needed to interpret the BNP level because renal dysfunction causes an increase as a result of reduced clearance.

C-reactive protein: as a test for infection if infective endocarditis is suspected.

Hemoglobin: anemia as an alternative cause of breathlessness.

Lung function: for the investigation of breathlessness of uncertain origin.

Stress echocardiogram: this is indicated for a patient with symptoms despite moderate AS.

Computed tomography: this is needed for the assessment of the aorta, particularly if the echocardiographic images are suboptimal.

Magnetic resonance scan: this is useful to assess aortic diameter, branch pulmonary artery stenosis, or right ventricular volumes in severe pulmonary regurgitation. It is occasionally useful if mitral or aortic regurgitation is of uncertain grade.

visits with reduced waiting times. Patients also value shared decision making with their surgeons on the type of valve replacement²⁹ and this leads to better quality of life after surgery.³⁰ (**Table 4**).

HEART VALVE CENTER

The components of a heart valve center are summarized in **Table 4**. In addition to a heart valve clinic these are discussed next.

MULTIDISCIPLINARY HEART TEAMS

A multidisciplinary approach is recommended for AS as for all types of valve disease, including infective endocarditis.^{1,2} Individuals with areas of expertise (eg, TAVI) should be named. Nurses and case managers, depending on local arrangements, are also involved in the multidisciplinary team. Assessment by relevant noncardiac specialists (elderly care physician, pulmonologist and so forth) should be available for patients with significant comorbidities. There should be regular heart team meetings to discuss the indications for and timing of intervention together with necessary procedural details.

Table 4 Requirements of a comprehensive heart valve center	
Minimum	Additional at Selected Centers
Specialist valve clinic ^{3,4}	—
Imaging	
Echocardiography: 2D/3D, stress, transesophageal, intraoperative ^{5,6} CMR, cardiac CT, CT-PET ⁷ Departments and individual imagers accredited by recognized national or international systems ⁸	—
Procedures Available	
Surgical: replacement of all valves, mitral valve repair, tricuspid valve repair, surgery for aortic root and ascending aorta, atrial fibrillation ablation Percutaneous: TAVI, mitral edge-to-edge procedures (eg, MitraClip) Links with hospitals offering superspecialist techniques	Surgical: Ross procedure, aortic valve repair, robotic mitral valve repair, heart transplant Percutaneous: balloon mitral valvotomy, closure of paraprosthetic regurgitation, developing mitral and tricuspid valve interventions
Collaborative services	
Other specialist cardiac services, including heart failure, and electrophysiology Intensive care (dedicated beds, extracorporeal membrane oxygenation) Extracardiac specialties: vascular surgery, general surgery, neurology, renal, stroke and elderly care medicine, psychology, genetics, and dental surgery	Percutaneous extraction of electronic devices
Processes	
Organization into multidisciplinary teams, including for endocarditis 24-h, 7-d cover allowing for annual leave and sickness Culture of safety (eg, World Health Organization checklist, review of complications) Training Job planning to include valve-related sessions, including continuing education	Research programs
Data Review	
Internal audit processes, including rates of repair and hemodynamic results, complications, durability of repair, and rates of reoperation assessed annually and summarized at 5 and 10 y Involvement in national databases with mandatory external review	—

Abbreviations: 2D, two-dimensional; 3D, three-dimensional; CMR, cardiac magnetic resonance; CT, computed tomography.

Meetings should take place weekly or at a frequency depending on annual hospital volumes. For emergent treatment, ad hoc multidisciplinary consultation should be possible.

The wishes of the patient inform the discussion of treatment options at multidisciplinary

meetings. The consensus of the meeting is communicated to the patient and, if desired, informs further discussion about the timing and nature of surgery. It may on occasion be appropriate to invite a patient to a discussion about the procedure.

COLLABORATIVE SERVICES

Centers require cardiologists with all relevant complementary expertise, including adult congenital disease, inherited cardiac diseases, heart failure, and electrophysiology. There must also be noncardiac specialists, including vascular surgery, general surgery, neurology, nephrology, microbiology and infection, stroke and elderly care medicine, and care of psychiatric illness.

The heart valve center must have a dedicated cardiac surgical department, including cardiac anesthesia,³¹ intensive care, and step-down unit. The option to use devices such as intra-aortic balloon pump and extracorporeal membrane oxygenation should be available.

PROCEDURES

The following procedures must be available at heart valve centers: replacement of valves in all 4 positions; mitral and tricuspid valve repair; atrial fibrillation ablation; TAVI; and surgery for the aortic root and ascending aorta. It is not possible to perform certain advanced techniques at every cardiac center, including aortic valve repair, the Ross procedure, percutaneous repair of paravalvular regurgitation, and heart transplants. There must be service-level agreements in place to allow transfer to centers that perform these techniques. New designs of valves requiring different implantation techniques should be introduced with the help of a proctor to minimize the learning curve.

PROCESSES

There need to be sufficient physicians and surgeons to allow for leave and sickness. There must also be sufficient beds for swift transfer of patients from peripheral hospitals and sufficient intensive therapy unit capacity to allow urgent surgery when clinically indicated. Operating schedules should allow urgent or emergent operations. There should be a safety checklist at the start of all procedures and a debriefing at the end.

SURGEON AND HOSPITAL VOLUMES

The relationship between case volume and outcomes of surgery and transcatheter interventions is complex. However, the literature suggests that mortalities for aortic valve replacement are lower for surgeons performing more than approximately 25 procedures per year^{32,33} and for hospitals performing more than 100 operations per year.^{33,34}

For aortic or combined aortic valve and root procedures, 1 study³⁵ found that mortality increased

exponentially in hospitals performing fewer than 40 procedures per annum.

For TAVI, better results (including early mortality and rates of readmission) have been shown for hospitals that undertake more than 20 procedures per year.^{36,37} However, all these studies are retrospective and registry data suggest that this threshold may be too low in current practice. Annual center volumes greater than 50 are currently recommended in France and the United Kingdom (and >75 in Holland).

The ability to show good results is more important than mandating volume targets. It is also likely that external audit of results will encourage good outcomes.

DATA REVIEW

Robust internal audit²⁴ with regular outcome or morbidity and mortality meetings and reporting of near misses are essential. Events should be reported according to available recommendations.^{38–40} The center should report at least 30-day, and 1-year and 5-year mortalities (**Box 2**). Echocardiographic follow-up⁹ and clinical results must be available for internal and external review and ideally should be presented on the heart valve center Web site and made available to patients and referring clinicians. Universal recording of all valve procedures in an international or national database is essential where these exist. Commonly used risk scores (eg, Society of Thoracic Surgery [STS] score or Euroscore II), including frailty scores for transcatheter valve procedures, should be available to interpret outcome data at the level of individual patient risk despite their limitations. Data collection is a guide to early failure of new designs of replacement valve or repair techniques as well as identifying potential problems at individual centers.

TRAINING

Training is an essential role of heart valve centers and should be established, coordinated, and monitored by national cardiovascular professional societies with provision for surgeons, cardiologists, anesthesiologists, and other disciplines during their initial professional accreditation.

All members of the multidisciplinary heart team, including physicians, surgeons, and nurses, need to be involved in continuing education appropriate to their roles. National societies should organize valve-related training and teaching sessions. There is an expectation of involvement in clinical innovation and research.

Box 2**Example dataset for recording outcomes for audit****Preoperative**

Demographic data, comorbidities

Grading of valve lesion

Preoperative risk assessment and stratification using validated multivariate scores

Early clinical results

Operative mortality and morbidity at 30 days, including stroke, mediastinitis, myocardial infarction, acute kidney injury^{26,27}

Heart valve center repair rates based on preoperative multidisciplinary team classification for repair as likely, unlikely, or not feasible

Time on intensive therapy unit

In-hospital hemodynamic function²⁸

Transvalve velocity and mean gradient (all positions) and effective orifice area (aortic position) of replacement or transcatheter valves

Presence and grade of paraprosthetic regurgitation

Residual regurgitation and new obstruction after surgical or transcatheter repair or systolic anterior motion of the anterior mitral leaflet

Follow-up

Complications: infection, valve thrombosis

Mortality: at 1 and 5 years

Durability of repairs based on routine annual echocardiography (more frequent if significant regurgitation present); proportion per year developing moderate or worse regurgitation

Incidence and timing of structural valve degeneration and nonstructural valve degeneration

Rates of redo procedure per year

from a murmur in 127 patients but was unsuspected in 177 cases. Valve disease needs to be suspected in patients with a murmur but also cardiac symptoms, chronic obstructive pulmonary disease with disproportionate breathlessness, atrial fibrillation, and age greater than 75 years. Using these criteria to focus point-of-care scans, AS was found in 2% of patients in a GP practice.⁴³ A murmur clinic⁴⁴ allowing triage of patients to point-of-care echocardiography or standard echocardiography can make the best of scarce resources and also refer directly to a valve clinic.

- Better communication: this must occur at every level and depends on local arrangements. Conventional communication after outpatient meetings, tests, or inpatient visits must occur reliably to all involved with the patient's care in the community, district hospital, and cardiac center as well as to the patient. Some networks have patient passport. Case referrals and discussions can occur through regular teleconferences but more immediately using mobile phone-based digital communication systems (eg, MedShr).
- Faster transfers: it is important that patients with severe valve disease, particularly endocarditis or critical AS, are transferred from DGH to cardiac center quickly. It is important that GPs can refer patients directly to the valve service particularly for a new symptom or if endocarditis is suspected.

SUMMARY

Despite a lack of good-quality research there is reasonable consensus on important aspects of valve care. The major challenge is to ensure that these inform direct patient care because physicians and cardiologists in general clinics tend not to follow established guidelines. It is therefore vital that care is delivered by specialists with competencies in valve disease and that interventions are delivered at heart valve centers defined by recognized standards.

DISCLOSURE

The authors have no disclosures.

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VALVE NETWORKS

Networks are the organizational mechanism for linking district or local hospitals and cardiac centers with the community. In addition to the roles of the valve clinic, a network is expected to add:

- Improved detection: auscultation is performed variably with higher rates in France compared with Germany and the United Kingdom.⁴¹ However auscultation is insensitive. A survey of open-access studies⁴² found that significant valve disease was suspected

- quality in the delivery of care for patients with heart valve disease. *Heart* 2013;99:1714–6.
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