

# Are valve clinics a sound investment for the health service? A cost-effectiveness model and an automated tool for cost estimation

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## ABSTRACT

**Background:** Valve disease is using up an important, growing proportion of the resources allocated for healthcare. Clinical care is often suboptimal and while multidisciplinary clinics are the 'gold standard', their adoption has been patchy and inhomogeneous.

**Methods:** We hypothesised that adoption of valve clinics can deliver financial savings and set out to estimate differences in cost between a standard model in which the cardiologist sees every case and a multidisciplinary model in which some cases are devolved to sonographer-led or nurse-led clinics, assuming usage of various tests in accordance with practice at our institutions and to published data. We developed a tool that allows the modelling of limitless permutations in order to assess costs.

**Results:** Seeing 100 new patients in a valve clinic is more expensive than seeing them in the conventional set-up (excess cost £2700, \$4252). Follow-up of both patients with native valve disease (maximal savings/100 patients—£5166, \$8135) and with operated valves (maximal savings/100 patients—£5090, \$8015) is cheaper in a valve clinic than in a general cardiology clinic and the savings offset the increased cost of seeing new patients in the valve clinic.

**Conclusions:** The costing implications of valve clinics need to be worked out carefully. Our analysis suggests that important savings in healthcare costs could be achieved by their adoption. Clarifying the economic implications of this new model of care should become one of the priorities for the 'heart valve community'.

## INTRODUCTION

The incidence of degenerative valve disease is increasing as our populations age.<sup>1</sup> The population prevalence is about 2.5%, but may be as high as 13% in those aged 75 and older.<sup>2</sup> It is well recognised that the organisation of clinical care is suboptimal<sup>3</sup> with wide variations in access to appropriate medical care and surgery. Specialist multidisciplinary clinics are seen as best practice<sup>4 5</sup> with a hub in 'surgical centres of excellence'<sup>6 7</sup> and spokes in district hospitals or the community.

## KEY QUESTIONS

### What is already known about this subject?

- ▶ There is a burgeoning literature on valve clinics, but very little data on their financial implications for the healthcare system. No clear conclusions about their impact on hospital finances can be drawn from the available literature.

### What does this study add?

- ▶ In an age of austerity, this study looks at the impact of opening a valve clinic on the finances of a real-world department of cardiology, by modelling patient throughput as well as costs and savings.

### How might this impact on clinical practice?

- ▶ This paper is the starting point for a debate in the valve community regarding the practicalities and the financial implications of switching from the current model of care to a valve clinic-based one. The costing tool can be obtained from the authors and adapted for use in any clinical setting where valve clinics are operating or are being planned.

However, the uptake of such clinics is incomplete, 21% in the UK.<sup>8</sup> The UK has developed devolved surveillance in which senior nurses or sonographers monitor patients with uncomplicated valve disease before and after surgery (table 1). One obstacle in developing such services is the lack of cost-effectiveness analyses. Here, we estimate the cost-saving likely from a multidisciplinary model run jointly by a cardiologist, sonographer and nurse. This may provide an aid to developing a business case for a clinic.

## METHODS

### Staff levels

We estimated differences in cost of a standard model in which the cardiologist sees every case and two models for a



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**Table 1** Summary of roles in the valve clinic

Role	Staff
New visits. Referral for surgery if necessary	Cardiologist
Assessment of follow-up patient with alerts. Referral for surgery as necessary	Cardiologist
Follow-up history	Nurse/sonographer
Performing exercise test	Exercise physiologist
Supervision of exercise test	Nurse/sonographer/ cardiologist
Echocardiogram	Sonographer/ cardiologist
Brain natriuretic peptide test	Nurse/cardiologist/ sonographer

multidisciplinary clinic in which some cases are devolved to sonographer-led or nurse-led clinics (table 2).

In all models, we assumed that two administrative and clerical staff would be used, and we included costs for two healthcare support workers in the consultant-led, conventional model, to reflect current realities in UK clinics.

For each of the models, we assessed the costs for seeing the following categories of patients:

- A. New patients, who all need to be seen by the consultant, as in the current 'conventional' model, but we specified that instead of the 5% who currently

have exercise tests, a much higher proportion (50%) should have exercise tolerance tests (ETTs);

B. Follow-up patients with native valve pathologies;

C. Follow-up patients with operated valves.

In groups (B) and (C), we devolved a substantial proportion of patients to follow-up by non-medical staff. We specified that a lower proportion (10%) of patients in group (C) would need to see the cardiologist than in group (B)—25%, as the valve operation generally removes the risk of progression of valve pathology, and we assumed that 5% of all patients being followed up would need ETT during follow-up in order to assess objectively any new symptoms that may have developed during follow-up.

We used standard national tariffs for costing the echocardiograms and the exercise tests, and top of the scale figures for the salaries of the various staff categories involved. We specified a senior (band 8) sonographer for the sonographer-led clinic, and a senior nurse (band 8) working with a band 6 sonographer for the nurse-led clinic.

Final cumulative costs are given in GB£ and in US\$, rounded to the nearest decimal. The main savings are expected to be the cost of cardiologist time and in reducing unnecessary echocardiograms.<sup>9</sup>

Taggu *et al*<sup>8</sup> showed that physician visits fell by 97%, from 998 to 31 in a year. However, 5% of patients from the surveillance clinics need to be seen by the cardiologist because of a new symptom or change in echo,<sup>10</sup>

**Table 2** Assumptions regarding proportion of patients undergoing different tests and requiring consultant review in each of the models

New cases (N=100)			
	Old model Consultant-led	New model Sonographer-led	
See cardiologists	100	100	
Have echo	100	100	
Have ETT	5	50	
See other staff	0	0	
Native valve disease (N=100)			
	Old model Consultant-led	New models Sonographer-only	Sonographer and nurse
Follow-up cases (N=100 for each category, ie, native and operated valve disease)			
See cardiologists	100	25	25
See nurse	0	0	75
See sonographer	0	75	0
Have echo	100	25	25
Have ETT	5	5	5
Operated valve disease (N=100)			
	Consultant-led	Sonographer only	Sonographer and nurse
See surgeon/cardiologist	100	10	10
See nurse	0	0	90
See sonographer	0	90	0
Have echo	100	25	25
Have ETT	5	5	5

**Table 3** Staff-related costs for *one follow-up consultation* in the valve clinic, in each of the three models

Staff involved	Gross cost	Cost/productive hour	Consultant	Senior sonographer	Sonographer and staff nurse
			0.25 h WTE needed	0.75 h WTE needed	0.75 h WTE needed
Band 6 sonographer	44 570	26			1 19.38
Band 8a nurse	60 780	35			1 26.43
Band 8b sonographer	72 934	42		1 31.71	
Consultant	120 000	109	1 27.21		
A&C 2	22 492	13	2 6.52	2 19.56	2 19.56
HCSW 2	22 492	13	1 3.26		
SpR	57 751	37	1 9.17		
Consultation cost			46.16	51.27	65.36

We allocated 15 min of consultant time and 45 min of non-consultant staff time per patient, expressed staff requirements as WTE and specified two healthcare assistants only for the consultant-led clinic, but clerical support for all. These time-indexed costs are used to calculate follow-up costs/100 patients with native or operated valve disease. The differences in the cost of valve clinic follow-up for patients with native versus operated valves arise from the different proportions assumed to need consultant review.

A&C, admin and clerical staff; HCSW, healthcare support worker; SpR, specialist registrar (cost does not include banding); WTE, working time equivalent.

although the cardiology time needed is usually less than for a full visit as a result of the prior assessment by the sonographer or nurse. A further 10% require brief discussion by the sonographer or nurse with the cardiologist. A proportion of patients require follow-up with the cardiologist because of complex disease or proximity to thresholds for surgery.<sup>11</sup>

### Echocardiograms

Compliance with guidelines is patchy and echocardiograms tend to be performed unnecessarily<sup>12–14</sup> particularly after valve replacement. In some centres,<sup>9</sup> all replacement valves are examined annually. We modelled the cost of an echocardiogram at £74 (\$117) which is the National Health Service (NHS) tariff, and we assumed that 100% of patients would have echos in the conventional model compared with 25% of those seen in a valve clinic.

### Other tests

Exercise test are underutilised and requested in only about 10% of those in whom it would be indicated.<sup>15</sup> This means that allowing 100 new patients of whom 50 might have asymptomatic severe disease, 5 tests might be performed using the conventional model and 50 using the new model. We assumed the cost of an ETT to be £60 (\$94), according to the NHS tariff. Numbers of chest X-ray, brain natriuretic peptide (BNP) estimation, Holter, CT were assumed to be similar in all groups and were therefore not included in the analysis.

All costs are expressed per 100 patients seen in the clinic.

### Automated costing tool

We collated all the above information using a custom-made Excel table (MS Office, 2007) with input cells

corresponding to costs for individual components of each of the clinic configurations described, and with output cells configured to yield total costs in the various permutations of staff, access to tests and time needed to complete a consultation described above. The costing tool is available from the authors. Figures can be entered in the source cells, and the destination cells will update the costs accordingly (tables 3–7).

## RESULTS

### New patients

We found that the costs for seeing new patients were £16 811.34 (\$26 472.82) in the conventional model and £19 631.34 (\$18 838.47) in the valve clinic model (both consultant-led). The increase in cost was due entirely to the 10-fold increase in the proportion of patients referred to have exercise tests, in compliance with current guidelines.

### Follow-up: native valve disease

The lowest cost was achieved in the sonographer-led clinic (£7149.06, \$11 257.61) and the highest in the

**Table 4** Costs of seeing *new patients* in the conventional as opposed to the dedicated valve clinic

	Conventional model		Valve clinic model	
Consultant-led	100.00	9231.34	100.00	9231.34
Refer for echo	100	7400	100	7400
Refer for ETT	5	300	50	3000
Total cost		16 931.34		19 631.34

There is a 10-fold increase in the utilisation of ETT in the valve clinic, and the time allocated to the consultant for one consultation is 30 min as opposed to 15 min in the follow-up configuration.

**Table 5** Total costs incurred for seeing 100 follow-up patients with native valve disease in each of the models

	Model 1—consultant-led		Model 2—senior sonographer		Model 3—sonographer and nurse	
	Percentage of patients	Costs	Percentage of patients	Costs	Percentage of patients	Costs
S/B consultant	100	4615.67	25	1153.92	25	1153.92
S/B other staff	0	0	75	3845.14	75	4902.18
Referred for echo	100	7400	25	1850	25	1850
Referred for ETT	5	300	5	300	5	300
Total cost		12 315.67		7149.06		8206.10

ETT, exercise tolerance test; S/B, seen by.

consultant-led clinic (£12 315.67, \$19 393.49), with the nurse-led clinic in an intermediate position (£8206.10, \$12 922.14).

### Follow-up: operated valve disease

The same relative magnitude of costs was observed for postsurgical patients: To follow-up 100 such patients, the hospital would spend £7.225.73, \$11 378.36 in the sonographer-led clinic; £12 315.67, \$19 393.49 in the consultant-led clinic; and £8494.18, \$13 375.73 in the nurse-led clinic.

## DISCUSSION

This work shows that a multidisciplinary clinic is expected to save substantial sums. There is little previously published work. Extrapolating from the practice of one district general hospital gave an estimated yearly excess expenditure on unjustified echocardiograms in the UK of £4.6 million (£3 253 087; \$5 122 636).<sup>12</sup> Turpie *et al*<sup>13</sup> estimated that a surveillance clinic for aortic stenosis alone would achieve recurring savings in the UK amounting to >9000 avoided transthoracic echocardiographies (TTEs)/year suggesting a saving of some £2 million (\$3.14 million) if all types of valve disease are included. In the first study of this kind performed outside the USA, a survey of all the hospitals which perform echocardiography in Wales<sup>14</sup> found that 11% of scans were requested for inappropriate indications, with

‘routine’ follow-up scans after valve replacement, a common reason for unnecessary studies.

### Other potential savings

In a Canadian study,<sup>16</sup> the rate of adherence to American Heart Association (AHA) guidelines varied between only 2% and 30%, and adherence is also limited in the USA,<sup>17</sup> Europe<sup>15</sup> and the UK.<sup>9</sup> This means that surgery occurs late usually with class III or IV symptoms leading to prolonged intensive treatment unit and hospital stays, and very high costs incurred by the NHS along their care pathway. Specialist valve clinics detect symptoms earlier<sup>3</sup> and have the potential to reduce costs drastically in this patient population by allowing timely referral for treatment.

There would be savings from lesser utilisation of hospital transport (average cost £20 (\$32) per journey) for the patient savings on car parking, days off work, time waiting to be seen. Imponderable savings include less easily quantifiable financial implications of valve clinics:

Ensuring that patients who have valves suitable for mitral repair are referred to surgeons able to perform repairs (this would increase the rate of mitral valve repair, currently rather low at 67% in the UK,<sup>18</sup> and would avoid need for prolonged anticoagulation, with its associated morbidity and costs).

Better dental surveillance with prevention of infective endocarditis (with the attending savings from avoiding very expensive and prolonged hospital admissions);

**Table 6** Total costs incurred for seeing 100 follow-up patients with operated valve disease in each of the models

	Model 1—consultant-led		Model 2—senior sonographer		Model 3—sonographer and nurse	
	Percentage of patients	Costs	Percentage of patients	Costs	Percentage of patients	Costs
S/B consultant	100.00	4615.67	10.00	461.57	10.00	461.57
S/B other staff	0	0	90.00	4614.16	90.00	5882.61
Refer for echo	100	7400	25	1850	25	1850
Refer for ETT	5	300	5	300	5	300
Total cost		12 315.67		7225.73		8494.18

ETT, exercise tolerance test; S/B, seen by.



**Table 7** Summary of costs

	Conventional model	Valve clinic model 1	Valve clinic model 2
New patients	£16 811.34 (\$26 472.82)	£19 631.34 (\$18 838.47)	NA
Native valve follow-up	£12 315.67 (\$19 393.49)	£7149.05 (\$11 257.61)	£9020.10 (\$14 203.95)
Operated valve follow-up	£12 315.67 (\$19 393.49)	£7225.73 (\$11 378.36)	£9308.18 (\$14 657.60)

For new patients just one valve clinic configuration is considered (see text for explanation).

NA, not available.

Improved anticoagulation control. Less time off work and a shift of the care model towards keeping patients out of hospital.

### Potential causes of higher costs

We believe that there are few sources of increased cost except where corners are being cut by not following guidelines. If postoperative patients are discharged to the community, it will cost more in the short term to bring these to a clinic despite the prospect of longer term cost-savings provided by better care. Exercise testing is underutilised in Europe with approximately 10% of those suitable actually having a stress test. The time required for an echocardiogram may be longer in a valve clinic, typically 60 rather than 40 min.

### LIMITATIONS

This paper is meant to incite discussion and debate by trying to flesh out a more detailed assessment of costs and savings associated with heart valve clinics than the ones available so far in the literature. Because our figures are hypothetical, rather than derived from actual observation, they cannot be considered definitive. However, the assumptions we made are as close to the reality of contemporary UK clinical practice as possible. It was necessary to limit our findings to the UK context in order to be able to provide the level of detail that we were aiming for. This may make our findings somewhat parochial, but we think that the assumptions and the categories used in our calculations have the potential for generalisation in other systems, which the cost calculator should greatly facilitate.

We did not include outcome data because the primary focus of this paper was to analyse the financial implications of valve clinics; what little outcome data are available will be found in the references quoted.

### CONCLUSION

There is a growing body of observational and circumstantial evidence supporting the notion that patient-centred care is best delivered to heart valve patients within the framework of valve clinics. The costing implications of valve clinics need to be worked out carefully, through multidisciplinary collaborations, but the available evidence suggests that significant cost-savings can be achieved by avoidance of unnecessary echocardiograms and clinic visits, by the freeing of

consultant time, by reducing the likelihood of delayed surgery with its associated morbidities and prolonged hospitalisations, and by avoidance of costly complications such as infective endocarditis. Clarifying the economic implications of this new model of care should become one of the priorities for the 'heart valve community'.

**Contributors** JBC suggested the topic and wrote the first draft. CM designed the costing tool and performed the preliminary analyses. AI performed the analyses that were included in the final version of the paper and responded to the comments of the reviewers, rewriting the paper in the current format.

**Competing interests** None declared.

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**Data sharing statement** The authors would like to make available the automated costing tool (an Excel table with cells customised to provide cost estimates for a virtually limitless number of permutations of the 'ingredients' comprised in a valve clinic) to the readers of the Journal. The costing tool is available to anyone interested, for free, on request from the corresponding author.

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