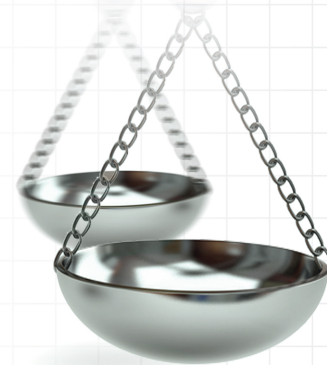




Incremental direct healthcare expenditures of valvular heart disease in the USA

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Aim: To quantify the healthcare expenditures for valvular heart disease (VHD) in the USA. **Patients & methods:** Direct annual incremental healthcare expenditures were estimated using multiple logistic and linear regression models. Results were stratified by age cohorts (18–64 years, ≥ 65 and ≥ 75 years) and disease status: symptomatic aortic valve disease (AVD), asymptomatic AVD, symptomatic mitral valve disease (MVD) and asymptomatic MVD. **Results:** A total of 1463 VHD patients were identified. The overall aggregated incremental direct expenditures were \$56.62 billion (\$26.48 billion for patients ≥ 75 years). Individuals ≥ 75 years with symptomatic AVD had the largest incremental effect on annual, per-patient healthcare expenditure of \$30,949. The annualized incremental costs of VHD were greatest for individuals ≥ 75 years with AVD. **Conclusion:** Identification of VHD at an earlier stage may reduce the economic burden.

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Keywords: healthcare costs • health economics • medical expenditures • valvular heart disease

Historically, the primary cause of valvular heart disease (VHD) in the USA was rheumatic heart disease [1]. However, due to improvements in overall health and lifespan, the primary causes of VHD are degenerative conditions associated with age [2,3]. The epidemiology of VHD is often associated with a latent asymptomatic period followed by an acute symptomatic period [4]. If left untreated, acute, symptomatic VHD may result in death within 2–3 years [4–7]. The American Heart Association and American College of Cardiology practice guidelines recommend surveillance for patients who are asymptomatic and intervention for patients with moderate to severe VHD because no approved medical management therapies currently exist [8,9]. Aortic valve disease (AVD) and mitral valve disease (MVD) are the most common forms of VHD, with aortic stenosis and mitral regurgitation representing the majority of VHD diagnoses [2,5]. Prevalence increases with age for AVD and MVD, from 0.4% of persons aged 18–64 years to as high as 12.4% of persons aged 75 years and above for AVD; and, from 0.6% of persons aged 18–64 years to as high as 9.5% of persons aged 75 years and above for MVD [10,11]. The current elderly population suffering from VHD, approximately 4.2 million, is expected to increase substantially with the aging the population of the USA [12].

Patients & methods

An observational analysis was conducted using retrospective data from the Medical Expenditure Panel Survey (MEPS), a large, nationally representative database developed by the Agency for Healthcare Research and Quality. The purpose of the study was to quantify individual and national estimates of healthcare insurer expenditures and patient-out-of-pocket (OOP) expenditures associated with VHD for four cohorts categorized according to valve disease type (aortic or mitral) and symptom status (symptomatic or asymptomatic), by age group. We focused on two cohorts: adults aged 18–64 years and adults aged 65 years and over. A subanalysis quantified expenditure for subjects aged 75 years and above.

This study is a retrospective database analysis where de-identified data were accessed in compliance with the Health Insurance Portability and Accountability Act. The Xavier University Institutional Review Board granted an exemption from Institutional Review Board review.

Data source

This study used data from the 1996 to 2015 MEPS, a subset of the National Health Interview Survey. This database provides information on healthcare utilization and expenditure, health status, health insurance coverage, and sociodemographic and socioeconomic characteristics for the civilian, non-institutionalized population in the USA [13]. The MEPS is a nationally representative database and one of the most widely used databases for quantifying healthcare expenditures.

The MEPS survey employs a complex design that includes clustering and oversampling of certain subgroups, such as minorities [14]. The MEPS collects comprehensive data on individuals, including comorbid conditions, sociodemographic characteristics, healthcare utilization and expenditures over a span of roughly 2 years. Response rates vary between 60 and 80%. Household survey data are obtained via computer-assisted personal interviews, with data supplemented by information collected directly from the medical providers used by survey participants. Insurance data are collected both from households as well as a separate survey of employers' business establishments, which collect information on health insurance provided by employers in the USA. While healthcare expenditure data in the MEPS are self-reported, medical providers help validate the self-reported data and resolve inconsistencies when they occur.

Study sample

Adults aged 18 years and over with diagnosis codes for AVD or MVD based on the International Classification of Diseases-9 diagnosis codes were identified (Supplementary Table 1 shows a list of the relevant codes). Individuals were stratified by age into two groups: persons aged 18–64 years and patients aged 65 years and above. We also examined a subgroup of the 65 years and older cohort; namely, those aged 75 years and above. We suspect that much of the costs of VHD are concentrated in this group due to the strong association between VHD prevalence and age. All individuals were further classified as symptomatic AVD, asymptomatic AVD, symptomatic MVD and asymptomatic MVD. These classifications were determined with clinical assistance and based, in part, on comorbidity information in MEPS (Supplementary Table 2 shows a list of these comorbidities).

Dependent variables: utilization & healthcare expenditures

Utilization was measured by a binary variable indicating whether the subject used any medical care (patients either utilized medical care [1] or they did not [0]). The expenditure data contained in the MEPS includes spending on physicians, hospital and outpatient services, medications, diagnostic testing and other medical services. This study used the total annual expenditure on these various healthcare services and grouped the total expenditure according to the amounts paid by healthcare insurers and patients' OOP payments.

Explanatory variables: clinical & sociodemographic characteristics

This study included a number of explanatory variables affecting expenditure, including major chronic diseases, sociodemographic characteristics, geographic region and year. The same explanatory variables were used in all multiple logistic and linear regression models. Chronic diseases were measured as binary variables (1, disease present; 0, disease absent) and included the four VHD cohorts, along with 31 other major chronic illnesses. These diseases were chosen based on their prevalence and clinical considerations. Categories of disease were as follows: cardiovascular, malignant neoplasm, digestive system, genitourinary system, musculoskeletal system, nervous system, respiratory system, skin and metabolic diseases.

Sociodemographic variables included age strata, education, race, income, marital status and health insurance type. Race variables included African-American, Hispanic, Asian and other, with Caucasian serving as the reference group. Insurance status was measured as a series of binary indicators: uninsured, Medicaid, Medicare, other public insurance, private nonhealth maintenance organization insurance and private health maintenance organization insurance (reference group). We also included variables indicating whether the subject was interviewed in English and whether the subject had a usual source of care. 'Usual source of care' is the particular medical professional, doctor's office, clinic, health center or another place where a person would typically go if sick or in need of advice about his or her health. Geographic variables included census region (midwest, south, west and northeast; with

northeast serving as the reference region) and whether a patient resided in a metropolitan statistical area. The year was measured as a series of binary variables, with 1996 serving as the reference year.

A wide array of explanatory variables were included due to prior research which demonstrated that failure to control for adequately for covariates might lead to substantial upward bias in the estimated expenditure impact of the disease of interest [15]. Further descriptions of these variables are included in the tables of results and Supplementary Tables 3 and 4.

Statistical methods

For each age cohort, investigators employed two-part models that separately estimated: the likelihood of incurring any expenditure by multiple logistic regression and the conditional expenditure by multiple linear regression [16]. Specifically, the analyses estimated the likelihood that a patient had medical expenditures; and, separate, conditional expenditure models were constructed for OOP expenses and insurer expenditures. The two-part model is frequently used in health economics research when many observations are clustered, and the remaining observations are right-skewed [17]. Expenditures were estimated by γ regression with a log link to normalize the distribution of the error terms. We first estimate:

$$\begin{aligned} \text{Logit}(p) = & \alpha_0 + \alpha_1 \text{AVD} + \alpha_2 \text{AVD}_{\text{symp}} \\ & + \alpha_3 \text{MVD} + \alpha_4 \text{MVD}_{\text{symp}} + \beta \text{Comorbidities} + \Theta X + \epsilon \end{aligned} \quad (\text{Eq. 1})$$

where p is the probability of expenditure and expressed as a binary variable equal to 1 if medical expenses were incurred and 0 otherwise; AVD and AVD_{symp} are binary variables indicating whether the subject has asymptomatic or symptomatic AVD, respectively; MVD and MVD_{symp} indicate asymptomatic and symptomatic MVD, 'comorbidities' denotes a vector of binary indicator variables for the presence or absence of other diseases; X is a vector of sociodemographic, economic, region and year variables; $\alpha_1 - \alpha_4$, β , and Θ are coefficients to be estimated; and ϵ is the error term. Equation 1 was estimated separately to ascertain the probabilities of healthcare insurer and OOP expenditures. Separate regressions were estimated for each subgroup: persons aged 18–64 years, 65 years and over, and 75 years and over. The effects of each VHD cohort on expenditure were measured relative to adult subjects without VHD, who served as the reference group.

In the second stage, conditional expenditure models were estimated by the following equation:

$$\begin{aligned} \ln \text{Expenditure} = & \alpha_0 + \alpha_1 \text{AVD} + \alpha_2 \text{AVD}_{\text{symp}} \\ & + \alpha_3 \text{MVD} + \alpha_4 \text{MVD}_{\text{symp}} + \lambda \text{Comorbidities} + \phi X + \epsilon \end{aligned} \quad (\text{Eq. 2})$$

where terms are the same as for Equation 1 except for expenditure, which represents the conditional healthcare expenditures. The models were, again, estimated separately for healthcare-insurer and patient-OOP expenditures. All analyses used survey procedures to obtain appropriate standard errors adjusted for the complex sampling method in MEPS. Expenditures were adjusted to 2017 US dollars using the medical care component of the Consumer Price Index [18]. All models were estimated using Stata version 11 (StataCorp LP, TX, USA).

We also performed a sensitivity analyses to address uncertainty in model input values. In particular, aggregate cost estimates were adjusted $\pm 25\%$ from the baseline estimates, which is a range commonly employed in burden-of-illness studies to provide reasonable ranges of estimates [19].

Results

Descriptive statistics

The 18- to 64-year-old cohort consisted of 89 individuals with AVD: 28 individuals with symptomatic AVD and 61 individuals with asymptomatic AVD. An additional 864 individuals were identified with MVD, consisting of 244 patients with symptomatic MVD and 620 individuals with asymptomatic MVD. A comparison group of 308,612 individuals without VHD was included to enable us to estimate the impacts of AVD and MVD on direct healthcare expenditures. The 65-year-old and over cohort included 119 patients (65 of whom were aged 75 years and above) individuals with AVD. Of the 119 patients with AVD, 54 were symptomatic (31 of whom were aged 75 years and above) and 65 were asymptomatic (34 of whom were aged 75 years and above). Among individuals with MVD in

Table 1. Descriptive Statistics for patients with aortic valve disease, with mitral valve disease, or without valvular heart disease.

Patients aged 18–64 years	No VHD	AVD		MVD	
Patient is symptomatic?	N/A N = 308,612	Yes N = 28	No N = 61	Yes N = 244	No N = 620
Direct healthcare expenditures:					
– Any insurer expenditure	81%	100%	98%	98%	94%
– Any out-of-pocket expenditure	84%	100%	93%	99%	99%
– Insurer expenditure	\$5250	\$22,016	\$15,655	\$13,746	\$5730
– Out-of-pocket expenditures	\$948	\$1446	\$1191	\$2146	\$1620
Demographics:					
– Average age, years	40.8	53.5	49.1	48.9	45.9
– Percentage of females	56%	57%	36%	84%	80%
Patients aged 65 years and above	No VHD	AVD		MVD	
Patient is symptomatic?	N/A N = 76,837	Yes N = 54	No N = 65	Yes N = 163	No N = 228
Direct healthcare expenditures:					
– Any insurer expenditure	96%	100%	100%	100%	100%
– Any out-of-pocket expenditure	96%	100%	100%	99%	100%
– Insurer expenditure	\$11,183	\$34,756	\$10,323	\$14,763	\$10,306
– Out-of-pocket expenditures	\$1685	\$3562	\$3889	\$2480	\$1942
Demographics:					
– Average age, years	74.5	75.7	75.3	73.8	73.9
– Percentage of females	58%	69%	52%	77%	81%
Patients aged 75 years and above	No VHD	AVD		MVD	
Patient is symptomatic?	N/A N = 35,587	Yes N = 31	No N = 34	Yes N = 69	No N = 95
Direct healthcare expenditures:					
– Any insurer expenditure	97%	100%	100%	100%	99%
– Any out-of-pocket expenditure	96%	100%	100%	99%	100%
– Insurer expenditure	\$12,280	\$34,311	\$16,447	\$14,763	\$12,237
– Out-of-pocket expenditures	\$1873	\$4943	\$2385	\$2480	\$1865
Demographics:					
– Average age, years	80.7	80.1	80.2	80.1	80.4
– Percentage of females	51%	58%	68%	83%	85%

AVD: Aortic valve disease; MVD: Mitral valve disease; VHD: Valvular heart disease.

this age group, 163 were symptomatic (69 of whom were aged 75 years and above) and 228 were asymptomatic (95 of whom were aged 75 years and above). The comparison cohort without VHD included 76,837 individuals (35,587 of whom were aged 75 years and above). Descriptive statistics for the main study samples (e.g., 18–64 years, 65 years and older, and 75 years and older) are provided in [Table 1](#).

AVD and MVD patients were older compared with the no-VHD cohort. A high percentage of females had MVD. The probability of insurer and OOP expenditures was higher in all VHD groups compared with the reference cohort, as were conditional healthcare expenditures. Healthcare expenditures were highest in the symptomatic AVD group. Many of these individuals likely underwent aortic surgery.

[Table 1](#) provides descriptive statistics for the 65-year-old and over cohort. Compared with the subjects without VHD, we see that the VHD groups are older, more likely to utilize medical care, and have much higher expenditures. Compared with 18- to 64-year-old cohort, the 65-year-old and over cohort generally has higher healthcare expenditures. [Table 1](#) also provides the same data for the 75-year-old and over subgroup and is comparable with the 65-year-old and over group.

[Table 2](#) shows the estimated effects for insurer and OOP expenditures for all age groups. All of these results are based on the multivariable models described in [Equations \(1\) and \(2\)](#) above. Expected insurer expenditures in the 18- to 64-year-old group are higher for each VHD group compared with the reference cohort. The differences are

Table 2. Expected per-patient healthcare expenditures for patients with aortic valve disease, with mitral valve disease, or without valvular heart disease.[†]

Cohorts	No VHD	AVD		MVD	
Patient is symptomatic?	N/A	Yes	No	Yes	No
Patients aged 18–64 years:					
– Number of patients	308,612	28	61	244	620
– Insurer expenditures	\$6018	\$29,340	\$20,986	\$11,791	\$7733
– Difference compared with no VHD	–	\$23,322	\$14,968	\$5773	\$1715
– Out-of-pocket expenditures	\$1078	\$1837	\$1784	\$1935	\$1628
– Difference compared with no VHD	–	\$759	\$706	\$857	\$550
Patients aged 65 years and older:					
– Number of patients	76,837	54	65	163	228
– Insurer expenditures	\$14,266	\$37,272	\$19,193	\$19,829	\$19,280
– Difference compared with no VHD	–	\$23,006	\$4927	\$5563	\$5014
– Out-of-pocket expenditures	\$1,991	\$3211	\$2968	\$2576	\$2829
– Difference compared with no VHD	–	\$1220	\$977	\$585	\$838
Patients aged 75 years and older:					
– Number of patients	35,587	31	34	69	95
– Insurer expenditures	\$15,068	\$43,727	\$19,008	\$21,072	\$19,866
– Difference compared with no VHD	–	\$28,659	\$3940	\$6004	\$4798
– Out-of-pocket expenditures	\$2247	\$4537	\$4082	\$2576	\$2835
– Difference compared with no VHD	–	\$2290	\$1835	\$329	\$588

[†]Per annum; calculated as the estimated probability of incurring expenditures multiplied by conditional expenditures. Estimates were adjusted for 31 comorbidities as well as sociodemographic, economic, region and year variables.

AVD: Aortic valve disease; MVD: Mitral valve disease; VHD: Valvular heart disease.

particularly high for the symptomatic AVD cohorts. It may be that these groups are more likely to be managed surgically, while the MVD cohorts are more likely to be managed medically. The OOP expenditures are also higher for each VHD cohort. The 65-year-old and over group reveals a similar pattern, with insurer and OOP expenditures higher for each VHD relative to the comparator cohort. The differences are, again, generally higher for the AVD cohort than for the MVD group.

Aggregate expenditures

Aggregate expenditures for each cohort were obtained by multiplying the incremental expenditures in Table 2 with the estimated aggregate number of patients in each group. The aggregate number of patients in each disease cohort was determined by multiplying their respective prevalence rates estimated from the literature [10] with a US population estimate for individuals by the following age groups: 18–64 years, 65 years and above, and 75 years and above. Aggregate expenditures in the USA for each cohort are provided in Table 3 for all age groups.

Aggregate expenditures were substantial for the 18- to 64-year-old group. This is especially true of patients with symptomatic AVD, where insurer expenditures total \$9.52 billion. Other cohorts carry even more substantial expenditures. In total, patients with VHD aged 18–64 years have expenditures of \$19.95 billion annually. Expenditures are even greater in the 65-year-old and older cohort. This reflects the much higher prevalence of VHD in this older age group. Expenditures are again the highest for the symptomatic AVD group. In total, expenditures are \$36.67 billion for this group – nearly twice that in the 18- to 64-years-old cohort. Aggregating across both age cohorts, VHD costs an estimated \$56.62 billion annually.

Interestingly, the 75-year-old and older subgroup incurs annual expenditures of \$26.48 billion. Thus, more than 72% (\$26.48b/\$36.67b) of the expenditures in the 65-year-old and older cohort is due to patients aged 75 years and over. This pattern of higher aggregate expenditures is particularly apparent among subjects with symptomatic AVD. For this group, 55% (\$14.47b/26.48b) of expenditures occur among the 75 years old with symptomatic AVD.

Table 3. Aggregate expected healthcare expenditures for patients with aortic valve disease, with mitral valve disease, or without valvular heart disease (in billions of dollars).[†]

Cohorts	AVD		MVD		Totals
Patient is symptomatic?	Yes	No	Yes	No	
Patients aged 18–64 years:					
– Insurer expenditures	\$9.52	\$5.53	\$2.24	\$1.33	\$18.62
– Out-of-pocket expenditures	\$0.31	\$0.26	\$0.33	\$0.43	\$1.33
– Total expenditures	\$9.83	\$5.79	\$2.57	\$1.76	\$19.95
Patients aged 65 years and older:					
– Insurer expenditures	\$14.54	\$2.84	\$5.71	\$9.97	\$33.07
– Out-of-pocket expenditures	\$0.77	\$0.56	\$0.60	\$1.67	\$3.60
– Total expenditures	\$15.31	\$3.40	\$6.31	\$11.64	\$36.67
Patients aged 75 years and older:					
– Insurer expenditures	\$13.40	\$1.67	\$3.60	\$5.57	\$24.24
– Out-of-pocket expenditures	\$1.07	\$0.55	\$0.14	\$0.48	\$2.24
– Total expenditures	\$14.47	\$2.22	\$3.74	\$6.05	\$26.48

[†]The aggregate number of patients in each disease cohort was determined by multiplying their respective prevalence rates estimated from the literature with a US population estimate for individuals for each age group [10].

AVD: Aortic valve disease; MVD: Mitral valve disease; VHD: Valvular heart disease.

Table 4. Sensitivity analysis results for all patients with valvular heart disease (in billions of dollars).

Patient age (years)	Baseline costs (\$)	High estimate (\$)	Low estimate (\$)
All	56.62	70.78	42.47
18–64	19.95	24.94	14.96
≥65	36.67	45.84	27.50
≥75	26.48	33.10	19.86

Sensitivity analysis

As noted earlier, uncertainty in model input values motivated the need for sensitivity analysis. The results of this analysis are shown in [Table 4](#), and repeats the overall aggregate cost estimates as well as aggregate estimates for each group and provides high- and low-cost estimates. One can see from [Table 4](#) that the aggregate costs of VHD could range from \$42.47 billion to as high as \$70.78 billion annually. And the 75-year-old and over cohort accounts for the largest share of these costs – some 47%.

Discussion

Our study used a large, nationally representative database and found that the incremental, direct healthcare expenditures of VHD exceeded \$56 billion per year (range: \$42.47–\$70.78 billion). Moreover, individuals over 75 years of age accounted for 47% of these expenditures. Although insurers paid the majority of these expenditures, the patients' OOP expenditures were substantial (\$4.93 billion).

A recent study by Moore *et al.* (2016) estimated the incremental expenditures related to VHD at \$23.4 with a range as high as \$36.8 billion in 2011 dollars [20]. After adjusting for inflation between our study and Moore *et al.* (2016), reported ranges in the sensitivity analyses overlap. In addition, our results are further influenced by the difference in reported prevalence rates, increased sample size and a larger US population. Further, the rapid advent of new diagnostics and interventions for VHD may enable larger numbers of people having access to care than before [21–23].

To provide context for our results, we examined published estimates of direct healthcare expenditures of stroke, hypertensive disease and all cardiovascular disease from the MEPS database. The 2018 American Heart Association Heart Disease and Stroke Statistics found the direct healthcare expenditures for cardiovascular disease, hypertensive disease and stroke to be \$199.2 billion, \$48.9 billion and \$23.6 billion respectively [2]. According to the estimates for all cardiovascular disease, VHD accounts for approximately 28% of all direct healthcare expenditures. The VHD's burden is higher than hypertensive disease and about twice the burden on the healthcare system compared with stroke.

The population aged 75 and older is expected to grow nearly 20% by 2030 (US Census), and the number of the population with VHD will be over 5 million, further increasing the burden of healthcare expenditures. Surgical intervention with the newer technologies for valve repair and replacement offer the potential for restorative treatment, improved quality of life and increased lifespan [24]. However, many individuals are asymptomatic and undiagnosed. These individuals often present at a moderate-to-severe state, which limits treatment options [25]. Echocardiographic screening of at-risk individuals – 75 years or older, atrial fibrillation, coronary heart disease, chronic obstructive pulmonary disease – may allow for monitoring of disease progression, increased interventional options and optimal timing of interventions [26].

A potential policy option to address this is via a more rigorous effort around detection, possibly through a covered screening program for individuals at risk for VHD, which is not without precedent. In 2005, the United States Preventive Services Task Force recommended screening for abdominal aortic aneurysms (AAA) in men aged 65 to 75, who have ever smoked [27]. The US government passed the Screening Abdominal Aortic Aneurysms Very Efficiently Act, which mandated The Centers for Medicare and Medicaid Services to cover a one-time ultrasound scan in men aged 65 to 75 who have ever smoked beginning in 2007 [28]. The promotion and screening for AAA has been shown to improve clinical outcomes while being cost-effective [29,30]. The clinical and economic benefits from AAA screening may translate to similar benefits for those at risk of VHD.

Strengths & limitations

This study has several strengths. The statistical methodology used to estimate the increment expenditures is both widely accepted and robust because it adjusts for patients who do not have any expenditures [17,31]. The ability to access restricted MEPS files allowed for the researchers to obtain detailed International Classification of Diseases-9 diagnosis codes to stratify the patients by disease severity. The inclusion of one relevant comorbid conditions allowed us to control for potential confounding effects. Finally, by including a sensitivity analysis using a range of VHD prevalence estimates, this study addressed the tendency for prevalence rates to be underreported in surveys, a major methodological challenge recognized in survey research [32].

Important limitations must be noted. First, relevant factors that are related to healthcare expenditures may have been omitted. However, given that the study included 31 comorbidities and several sociodemographic factors, the effect of any omissions may have been attenuated. Second, this study was based on self-reported data collected as part of a national household survey. Therefore, the potential for respondent-recall bias exists. However, the MEPS survey design attenuates recall bias through validation with physicians and insurers. Third, our overall AVD sample size was small, in particular for symptomatic AVD subjects. It may be possible that our individual results were influenced by several subjects with very high healthcare expenditures. If so, this will also be reflected in the aggregated results. However, the reported results in the sensitivity analysis will mitigate this concern. Further, we used certain indicator conditions as a proxy for whether the patient would be regarded as symptomatic, and any proxy measure is subjected to some error. However, the pattern of higher expenditures for symptomatic versus asymptomatic patients is consistent with prior expectations.

VHD is a significant public health concern in the USA. The costs of VHD were substantial for each of the cohorts examined. Per capita, healthcare expenditures were greatest for the symptomatic AVD cohort. With a growing and aging population, the prevalence of VHD is expected to rise, further increasing the public-health burden of the disease. Effective valve repair or replacement requires identification of VHD at an early stage to allow increased treatment options and optimal planning for the intervention. Policies that support the early identification of VHD may mitigate the burden of VHD.

Supplementary data

To view the supplementary data that accompany this paper please visit the journal website at: www.futuremedicine.com/doi/suppl/10.2217/cer-2019-0007

Author contributions

All authors contributed to revising the manuscript have approved the final version of the manuscript, and are accountable for all aspects of the work. PJ Mallow drafted the manuscript; PJ Mallow, J Chen and JA Rizzo were responsible for the design, analysis and interpretation of the economic model. M Moore and C Gunnarsson contributed to the concept of the economic model and interpretation of the model.

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No writing assistance was utilized in the production of this manuscript.

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Summary points

- The large number of elderly individuals with valvular heart disease (VHD) has created a significant burden on the health system [10].
- There is limited evidence quantifying the economic burden of VHD in this cohort [2,8,20–23,33].
- Prior studies have generally focused on Medicare hospitalization costs or specific treatments for either aortic valve disease (AVD) or mitral valve disease.
- To our knowledge, no nationally representative estimates of direct healthcare expenditures for VHD by age cohort and disease severity exist.
- We used a nationally representative dataset to estimate the incremental direct healthcare expenditures for VHD and stratified by etiology (AVD or mitral valve disease), age and disease severity.
- Further, the estimates of healthcare expenditures were reported at the individual and population level, as well as, insurer and out of pocket.
- Individuals ≥ 75 years with AVD had the largest annual incremental per-patient healthcare expenditures.
- This evidence would be valuable to the healthcare system, in particular, for estimating the cost-effectiveness of screening and treatment for VHD.

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