

## STATE-OF-THE-ART REVIEW

# A New Benchmark for Modern Management of Valvular Heart Disease

## The Whole-Life Cycle Management System



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## ABSTRACT

Valvular heart disease (VHD) is rapidly increasing in prevalence worldwide, affecting millions and significantly impacting global health care systems. Despite notable advancements in understanding VHD progression, perioperative management, imaging techniques, and transcatheter therapies over the past 2 decades, the condition has not received the attention it deserves from the public and policymakers. Many patients with VHD in low- and middle-income countries continue to experience low detection, intervention, and follow-up rates. Systematic care for elderly patients and those with severe comorbidities, as well as postoperative patients, remains insufficient, leading to higher mortality and morbidity rates. This review focuses on the deficiencies in VHD treatment within the Chinese health care system and discusses the modern management program, known as the whole-life cycle management system, that has been implemented to enhance the survival prognosis of VHD patients. (JACC Asia. 2025;5:609–632) © 2025 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The epidemiology and treatment of patients with valvular heart disease (VHD) have changed dramatically over the past few decades. An aging population has contributed to a rising prevalence of primary (or degenerative) disease. Simultaneously, advancements in cardiovascular imaging and the optimization of treatment regimens have resulted in improved survival rates among patients with heart failure, leading to an increased prevalence of secondary (or functional) manifestations of the disease.<sup>1</sup> However, the corresponding clinical management of VHD—from diagnosis to follow-up—is often fragmented across multiple stages and significantly deviates from international guideline recommendations.<sup>2</sup> This “incomplete and disparate”

approach may lead to suboptimal management, particularly in older populations with multiple comorbidities, ultimately contributing to increased mortality and morbidity and posing significant challenges to health care systems.<sup>3</sup>

Recent international guidelines have emphasized the necessity for a higher standard of care for patients with VHD, advocating for heart valve clinics (HVCs) that specialize in outpatient services and comprise experienced multidisciplinary cardiac teams.<sup>4</sup> In high-income regions, such as Europe and North America, the predominant model of HVCs is a consultative clinic where cardiologists and nurses collaborate. Trained nurses streamline basic measurements and questionnaire assessments of VHD

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## ABBREVIATIONS AND ACRONYMS

**AR** = aortic regurgitation

**AS** = aortic stenosis

**HVC** = heart valve clinic

**MR** = mitral regurgitation

**SDM** = specialized-diseases  
managers

**TAVR** = transcatheter aortic  
valve replacement

**TEER** = transcatheter edge-to-  
edge repair

**TR** = tricuspid regurgitation

**VHD** = valvular heart disease

patients, whereas cardiologists perform echocardiograms, evaluate the underlying conditions, and make the final decisions regarding referrals for interventional therapy.<sup>5</sup> This innovative health care model enhances care coordination, reduces fragmentation, limits costs, and ultimately improves outcomes for patients with VHD. However, significant disparities exist between the health care systems of middle- and low-income countries and those of high-income countries. Particularly, VHD patients often face lower socioeconomic status and health literacy, along with weaker primary health care systems and pronounced

regional health care disparities that exacerbate inequalities in care and treatment.<sup>6-9</sup> As such, this novel model may not be suitable for direct replication or scaling. Therefore, this review focuses on middle- and low-income countries and regions, highlights the current burden of care within the VHD population, identifies gaps and areas for improvement in the diagnosis and management of VHD patients, and concludes with recommendations tailored to improve the prognosis of VHD patients in the Chinese context.

## EPIDEMIOLOGIC SURVEY OF VHD

VHD results from the dysfunction of 1 or more heart valves. As the population ages, VHD is becoming an increasingly significant cause of morbidity and mortality, with an estimated overall prevalence of 5% to 10% in patients aged 65 to 74 years and 10% to 20% in those aged 75 years and older.<sup>10-12</sup> Calcific aortic valve disease, which encompasses a spectrum of disorders ranging from thickening and calcification of the aortic valve without hemodynamic effects to severe aortic stenosis (AS) that markedly affects hemodynamics, is the most prevalent age-related VHD. The prevalence of calcific aortic valve disease is estimated to be 2.8% in individuals aged 60 to 74 years and 13.1% in those aged 75 years and older.<sup>13</sup> AS has a prolonged symptomatic latency period during which morbidity and mortality are low. However, once symptoms such as angina, syncope, or heart failure manifest, mortality rates increase rapidly.<sup>14</sup> Both moderate and severe AS are associated with high morbidity and mortality rates, with 5-year mortality rates of 56% and 67%, respectively, reported in a large registry cohort study from Australia.<sup>15</sup> Mitral regurgitation (MR) is more heterogeneous than calcific aortic valve disease, with mild MR frequently detected in community-based screenings. The OxVALVE (Oxford Valvular Heart Disease Population Study) study screened 2,500

individuals aged 65 years or older without known VHD, revealing a prevalence of moderate to severe MR of 3.5%, rising to 7.7% in those over 75 years of age,<sup>16,17</sup> alongside an association with increased mortality.<sup>18</sup> Aortic regurgitation (AR) ranks as the third most common cause of VHD, stemming from primary valvular diseases (such as bicuspid aortic valve, rheumatic heart disease, connective tissue disease, or autoimmune disease) or aortic root dilatation.<sup>19,20</sup> The lifetime risk of developing AR is 13% in men and 8.5% in women.<sup>21,22</sup> The disease progression in patients with AR is typically slow and marked by eccentric myocardial hypertrophy and volume overload, resulting in structural changes and functional impairment of the left ventricle.<sup>23,24</sup> Severe AR is associated with significant cardiovascular morbidity and mortality, with a 10-year mortality or surgical intervention rate of 75%.<sup>25</sup> Tricuspid regurgitation (TR) has historically been “forgotten” because of its secondary nature and subtle symptoms.<sup>26</sup> Population-based studies indicate a prevalence of TR at 0.55%, which escalates with age (2.6% in individuals aged 65 years or older and up to 6.6% in those over 75 years),<sup>17,27</sup> and TR is strongly associated with increased mortality.<sup>28,29</sup> A national cross-sectional survey conducted in various provinces of China, which included a naturalistic population aged 35 years and older, revealed that 1,309 participants out of 31,499 had moderate and/or severe VHD, leading to a weighted prevalence of approximately 3.8% (with an overall prevalence of 7.6% for patients aged 65-74 years and 15.9% for those aged 75 years and older). This suggests the existence of approximately 25 million individuals with VHD in China.<sup>30</sup> Given the accelerating trend of population aging in China, VHD, which is closely associated with aging, is becoming an increasing health care concern.

## VHD INTERVENTION MODALITIES

VHD can be categorized into 2 main groups based on pathophysiological mechanisms. Primary VHD is characterized by the dysfunction of the valve and its associated structures. Stenosis and/or regurgitation are typically caused by degenerative changes (eg, calcification, rupture of tendon cords, or mucocoele infiltration), congenital anomalies (eg, bicuspid aortic valve or aortic root dilatation), or infectious processes (eg, rheumatic heart disease or infective endocarditis). In contrast, secondary VHD results from the dysfunction of neighboring cardiac structures,<sup>31</sup> such as altered ventricular or atrial geometry,<sup>32</sup> which leads to an imbalance of forces between valve closure and opening, primarily affecting the mitral and

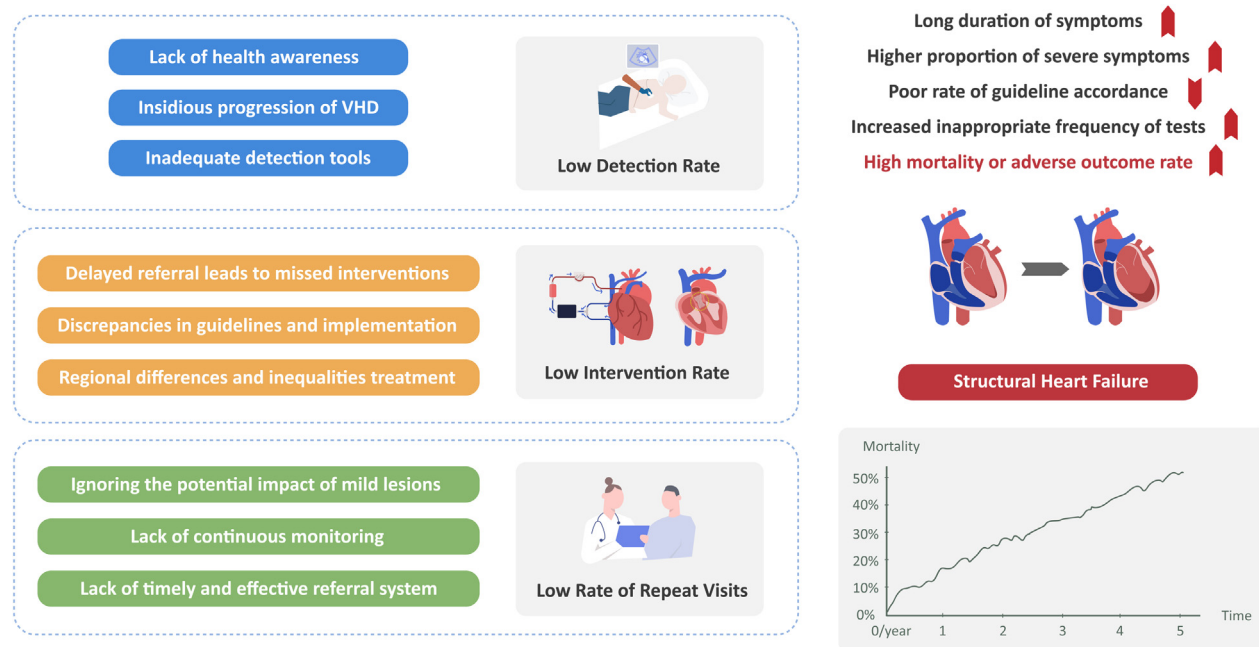
tricuspid valves located upstream in the heart. Recently, annular dilatation secondary to chronic atrial fibrillation and elevated atrial pressure caused by diastolic dysfunction have been increasingly recognized as distinct entities, referred to as atrial MR or TR.<sup>33,34</sup> The pathophysiological mechanisms involved in the disease progression of different VHDs are crucial for selecting appropriate interventions. Except for infective endocarditis, which can be treated with appropriate antibiotics,<sup>35</sup> no pharmacologic therapy exists to prevent or slow the progression of primary VHD lesions. Anti-heart failure medications, including  $\beta$ -blockers,<sup>36</sup> sacubitril-valsartan,<sup>37</sup> renin-angiotensin system inhibitors, and mineralocorticoid receptor antagonists,<sup>38</sup> are the standard first-line therapeutic agents for heart failure associated with ventricular dysfunction, alleviating symptoms secondary MR or TR. However, these medications do not directly address the underlying disease. The presence of heart failure-related symptoms or left ventricular dysfunction warrants a Class I recommendation for surgical intervention.<sup>4,39</sup> Rhythm control strategies, including antiarrhythmic medications,<sup>40</sup> electrical cardioversion,<sup>41,42</sup> radiofrequency ablation,<sup>43</sup> and cardiac resynchronization therapy,<sup>44</sup> can improve heart failure symptoms and reduce mortality in patients with secondary MR and tricuspid regurgitation TR. Regular clinical and imaging follow-ups should be maintained for patients with VHD undergoing nonsurgical treatment to evaluate symptomatic improvement and disease severity, ensuring timely intervention when necessary.

#### DIFFICULTIES IN DIAGNOSIS AND TREATMENT FACED BY THE VHD POPULATION

In 2021, individuals aged 65 years and older comprised 14.2% of China's population. It is projected that by 2050, there will be approximately 395 million people aged 65 years and older in China.<sup>45</sup> As the aging population increases, the prevalence of VHD, which is closely associated with age, is expected to rise, presenting a significant challenge to China's cardiovascular health care system.<sup>46</sup> The prevailing perspective suggests that conservative treatment may be appropriate for some elderly patients to avoid ineffective interventions caused by advanced age and comorbidities. However, extensive literature demonstrates the serious consequences of undertreatment of VHD, indicating that conservative treatment is not suitable for the majority of patients. For example, a study using a French administrative database found that of nearly 100,000 patients

admitted with MR, only 8% were referred for and received intervention within 1 year. One-third of those conservatively treated either died or were readmitted caused by heart failure.<sup>47</sup> Similarly, a survey of hospitalized VHD patients in China revealed that most patients faced delayed access to care, often presenting with severe cardiac insufficiency, and the overall surgical intervention rate was only 37.3%.<sup>48</sup> This disparity highlights a significant gap between existing guidelines for VHD treatment and their effective implementation. Many patients with VHD lack access to potentially life-saving treatments caused by factors such as limited health awareness, inadequate diagnostic tools, and unequal access to care (Figure 1).

**LOW DETECTION RATE. Lack of health awareness and effective medical behaviors.** Despite its high prevalence and significant impact on mortality and quality of life, awareness of VHD remains low. A survey assessing awareness of AS within a European population found that only 2% of 8,800 respondents were concerned about or aware of AS, a rate far lower than for cancer (28%), Alzheimer's disease (25%), and stroke (12%).<sup>49</sup> This low level of awareness is starkly at odds with the substantial burden caused by VHD. Additionally, a considerable body of evidence indicates that effective health-related behaviors are not widespread among older adults in China, resulting in inadequate treatment.<sup>6</sup> For instance, only 37.4% of rural adults aged 60 years or older receive an annual physical examination, and fewer than 30% of patients with chronic diseases obtain treatment.<sup>50,51</sup> Furthermore, older Chinese adults tend to prefer self-empirical treatment strategies over seeking health care assistance.<sup>52</sup> Several factors contribute to this phenomenon. First, primary health care organizations in China often suffer from insufficient government funding and lack incentives to provide public health services (eg, health promotion and disease awareness) that do not yield financial returns.<sup>7</sup> Consequently, older populations have limited access to disease awareness. Second, time and transportation costs hinder older adults from utilizing health care services.<sup>53</sup> Third, restrictions and financial difficulties regarding benefits and reimbursement rates for elderly individuals enrolled in medical insurance policies contribute to the underutilization of health care services.<sup>54</sup> Fourth, many older patients exhibit lower health literacy and poor self-management skills, leading to reduced utilization of preventive health care services.<sup>55</sup> Fifth, social and cultural values influence the health care needs of the elderly. This can manifest as a lack of self-worth, with elderly patients

**FIGURE 1** The Causes, Status, and Outcomes of Management Deficiencies in VHD

Valvular heart disease (VHD) patients encounter numerous challenges in the diagnosis and treatment process, primarily because of confusion surrounding medical management. First, the general lack of health awareness among elderly patients, combined with the slow and insidious progression of valvular lesions and the insufficient diagnostic tools, has resulted in a low detection rate. Second, delayed referrals often lead to missed interventions, while gaps between existing guidelines and their implementation, along with regional disparities, prevent some patients from receiving timely treatment, resulting in overall low intervention rates. Finally, public neglect of mild lesions, insufficient continuous monitoring and transitional of care, and ineffective referral systems contribute to low rate of repeat visits. Collectively, these factors contribute to the widespread development of structural heart failure in VHD patients, thereby increasing mortality rates.

often underevaluating their health status and feeling unworthy of treatment, which further diminishes their health care expectations.<sup>56</sup> Finally, although the growing health care needs of the population and advancements in the information age have led to the emergence of smart health care service models supported by technologies such as the Internet of Things, Big Data, and Cloud Computing,<sup>57</sup> these digital solutions often overlook the real needs of elderly patients. Consequently, a significant digital divide exists in the acceptance of smart health care among the elderly, resulting in cognitive biases and barriers to understanding their health conditions and available health care services.<sup>58</sup>

**Slow and insidious progression of valvular lesions.** In the OxVALVE study,<sup>16</sup> only 4.9% of individuals over 65 years of age were clearly diagnosed with moderate or severe VHD. This low percentage may be attributed to the fact that most patients do not exhibit significant symptoms and typically undergo only a basic medical examination. Previous studies have shown the limited effectiveness of relying solely on patient-

reported symptoms or findings from physical examinations to identify asymptomatic VHD.<sup>59</sup> Even experienced physicians without expertise in valvular disease may struggle to recognize VHD-related symptoms during initial assessments. For instance, the primary symptom of AS is often a decrease in exercise capacity rather than substantial dyspnea or chest discomfort. Furthermore, the heart tolerates volume overload from conditions like AR and MR better than it does pressure overload from stenotic valvular diseases.<sup>60</sup> Consequently, symptoms tend to develop more insidiously. The slow, insidious progression of valvular lesions, combined with their nonspecific nature, can lead patients to deny symptoms as they gradually adjust their activity levels over several years to accommodate the functional limitations imposed by the disease. This is particularly challenging in elderly patients with VHD, who often have multiple comorbidities (eg, chronic obstructive pulmonary disease, frailty, tumors), making it difficult to identify VHD as the primary cause of their symptoms.

Transthoracic echocardiography (TTE) is the standard diagnostic test for the initial evaluation of patients with known or suspected VHD, allowing for accurate assessment of valve anatomy, etiology, concomitant valve disease, and associated abnormalities. Once diagnosed with VHD, patients should undergo follow-up testing at intervals recommended by the American College of Cardiology (ACC)/American Heart Association (AHA) guidelines.<sup>14</sup> The onset of symptoms or changes in physical examination findings should raise concerns regarding cardiac responses related to valvular pathology and necessitate a repeat TTE. Comprehensive repeat TTEs can help determine whether symptoms result from progressive valvular dysfunction, volume or pressure overload, or other causes. Exercise stress echocardiography—assessing exercise capacity and blood pressure response—is especially predictive in patients with asymptomatic VHD and can provide valuable information regarding the optimal timing for intervention.<sup>61</sup>

**Inadequate detection tools.** Underdetection represents a significant challenge in the diagnosis of VHD. In the OxVALVE study, half of the patients with moderate or severe VHD were never tested or diagnosed, highlighting a systemic issue of under-detection at the population level.<sup>16,17</sup> Cardiac auscultation remains the simplest and most cost-effective method for diagnosing VHD. Although its sensitivity and specificity are not perfect, the availability, accessibility, and portability of auscultation are unmatched. Unfortunately, cardiac auscultation is not performed in nearly 50% of visits to general practitioners.<sup>49</sup> Surveys of clinical practice have also demonstrated underutilization of auscultation by physicians, including general practitioners.<sup>62</sup>

The heart center should possess a nationally or internationally recognized echocardiography department and a comprehensive TTE service for VHD patients. Additionally, the heart center must offer advanced imaging techniques, including computed tomography (CT), cardiac magnetic resonance imaging, and new imaging modalities.<sup>63</sup> However, surveys indicate that the necessary tests for confirming the diagnosis and assessing the severity of VHD are frequently overlooked.<sup>64</sup> Exercise stress echocardiography is available in only 53% of regional hospitals and 71% of heart center, while cardiac CT is offered in 59% of regional hospitals and 71% of heart centers, respectively, and cardiac magnetic resonance imaging is available in 35% of regional hospitals and 94% of heart centers. Although using TTE in accredited echocardiography departments for mass population screening programs presents logistical and cost challenges, point-of-care ultrasound (POCUS) and

handheld cardiac ultrasound devices are becoming increasingly accessible, allowing for simple cardiac ultrasound procedures.<sup>65,66</sup> Moreover, there is a growing recognition of the value of non-echocardiographic imaging techniques and biomarkers, particularly in areas with limited medical resources.<sup>63,67</sup> Several studies have demonstrated significant benefits in disease identification when these tests are incorporated into general physical examinations.<sup>68,69</sup> Importantly, advancements in artificial intelligence technology can help overcome barriers related to image acquisition and interpretation caused by operator inexperience.<sup>70</sup> VHD should be suspected in patients exhibiting cardiac auscultation murmurs, symptoms of VHD, and respiratory disorders that present with disproportionately severe dyspnea. Such suspicion allows for point-of-care ultrasound or TTE classification of the patient and prompt referral to an advanced cardiology center for further evaluation.<sup>71</sup> Early detection of VHD helps educate patients, modulate risks by optimizing chronic comorbidities, and ultimately avoid worse outcomes.

**LOW INTERVENTION RATES. Delayed referral leads to missed interventions.** VHD often presents with an insidious onset. Once symptoms related to heart failure manifest, careful monitoring and timely intervention are necessary to prevent irreversible consequences, particularly when employing a “watchful waiting” strategy.<sup>72</sup> Alarmingly, despite the well-documented association between prolonged waiting times and increased mortality,<sup>73</sup> consistent and appropriate follow-up programs and referral awareness are not widely adopted.<sup>74,75</sup> A significant percentage of patients with VHD remain untreated or receive interventions too late in the disease progression. Evidence is accumulating that highlights the survival benefits of early intervention for patients with asymptomatic severe AS or degenerative MR.<sup>76,77</sup> In many cases, late presentation correlates with increased morbidity and mortality, which may not be rectified even with successful intervention.<sup>78-80</sup> For example, in patients with symptomatic severe AS, delaying aortic valve intervention by just 3 to 6 months may significantly reduce survival rates. Unfortunately, patient referrals are often delayed, hindering timely access to effective interventions.<sup>81</sup> The EURObservational Research Programme Valvular Heart Disease II Survey, which included 5,219 patients with severe VHD from 28 countries, confirmed this issue of delayed referrals.<sup>82,83</sup> It was noted that one-half of the patients receiving interventions exhibited NYHA functional class III/IV symptoms, with one-sixth experiencing congestive heart failure.



Older VHD patients with extended referral times often cannot withstand the burden of surgical interventions or may experience limited effectiveness compared with younger patients. This group of patients, unable to undergo surgical intervention, has been described as “Cohort C,” characterized by a Society of Thoracic Surgeons (STS) >20, such as long-term oxygen dependence, pulmonary hypertension, chronic renal or hepatic disease, extreme obesity, among other factors associated with a high mortality rate.<sup>84-87</sup> In the European Heart Survey, 33% of patients with severe symptomatic AS and 50% of patients with severe symptomatic MR were denied surgical intervention.<sup>74,88</sup> Optimal timing for intervention is critical. Therefore, the decision to refer a patient for intervention depends on various factors, including the severity of valvular dysfunction, structural and functional cardiac damage, comorbidities, and predictors of rapid disease progression. These factors can be difficult to assess and are often misinterpreted, leading to delays in patient referral. Outcomes of surgical and transcatheter interventions have improved significantly over the past decade.<sup>89</sup> While part of this improvement relates to technological advancements and increased operator experience, early referral to cardiac medicine centers has been a crucial component of this progress.

**Discrepancies between existing guidelines for VHD and effective implementation.** In recent decades, high surgical risk, inadequate perioperative management, and limited intervention modalities have resulted in surgery being performed only in selected cases, with most older patients receiving conservative treatment. However, the natural history of VHD is now better understood, and the impact of disease risk factors on outcomes is increasingly recognized. Moreover, significant advancements in surgical techniques and management have occurred, including valve repair, minimally invasive approaches, transcatheter interventions, and improvements in perioperative and postoperative care.<sup>90-92</sup> These advancements indicate a pressing need to shift from a ‘select the best case’ perspective to a philosophy of “treat all who need it.”

Currently, patients with VHD are often managed by general cardiologists or even primary care providers lacking specialized training in modern VHD management. In certain countries or regions, those living in suburban areas may struggle to receive proper follow-up and are frequently misinformed about their disease and treatment options. Additionally, there is often a lack of comprehensive assessment of frailty and comorbidities. This can lead to suboptimal risk stratification, prolonged hospital stays, and, in some instances, unjustifiable risks to patients.<sup>93</sup> As

highlighted by the Euro Heart Survey,<sup>2</sup> a significant gap exists between established guidelines and their effective implementation. Recently, there has been substantial and sustained growth in the VHD knowledge base, particularly in risk stratification and the use and interpretation of diagnostic methods. Furthermore, a novel intervention modality, transcatheter valve interventions, has rapidly developed an evidence base, leading to an exponential increase in the number of procedures performed.<sup>94</sup> Several international investigations have underscored the clinical benefits of transcatheter valve interventions compared with conventional open-heart surgery and demonstrated a progressive trend toward early intervention.<sup>82</sup> Additionally, the advantages of transcatheter edge-to-edge repair for patients with secondary MR<sup>95,96</sup> and TR<sup>97</sup> have been highlighted. It is challenging for primary care providers to fully appreciate this rapidly evolving field.<sup>98</sup> Consequently, a substantial proportion of patients with VHD are not treated in accordance with existing guidelines.

**Regional differences and inequalities in VHD treatment.** Significant disparities persist in the medical resources available for treating VHD. Access to surgical or transcatheter interventions is severely restricted in many regions worldwide because of the high costs of equipment and insufficient manpower and expertise. Statistics indicate that high-income countries have approximately 7.15 adult cardiac surgeons per 1 million people, while low-income countries have only about 0.04 adult cardiac surgeons per 1 million.<sup>99</sup> In terms of VHD screening, transesophageal echocardiography is performed less frequently in hospitalized patients in China compared with data from the Euro Heart Survey (6.6% vs 18.6%), and cardiac CT is also less commonly conducted.<sup>2,48,82</sup> Additionally, advancements in technology have exacerbated existing disparities, particularly with the availability of new transcatheter valve interventions.<sup>9</sup> For instance, transcatheter aortic valve replacement (TAVR) was performed in only 7.5% of AS cases in China, significantly lower than the rates observed in Europe (39% in 2017), the United States (43% in 2016), and Germany (59% in 2015).<sup>82,100,101</sup> Beyond national and regional disparities, many low- and middle-income countries face significant within-country inequalities. For example, the low density of cardiac surgeons and limited per capita surgical volume in western, northeastern, and rural China has resulted in an average of only 23 cardiac surgeries per surgeon each year.<sup>102</sup> Furthermore, the inadequate number of anesthesiologists, intensivists, and extracorporeal circulation perfusionists with specialized training to

manage VHD further limits the capacity to provide safe, high-quality care.

**LOW RATE OF REPEAT VISITS. Ignoring the potential impact of mild lesions.** The progression of VHD describes a continuum from a functioning valve to mild, moderate, and ultimately severe lesions. To date, most studies have concentrated on the relationship between moderate to severe VHD and clinical outcomes,<sup>16,103</sup> neglecting the cardiovascular implications associated with mild valvular lesions or comorbid risk factors. Notably, individuals with isolated aortic sclerosis demonstrate an increased long-term risk of major adverse cardiovascular events, likely associated with concurrent atherosclerotic vascular disease, compared with those without VHD.<sup>104</sup> Matsushita et al<sup>105</sup> followed 15,792 community adults for up to 25 years. One of the study's objectives was to explore the relationship between mild VHD lesions—specifically aortic sclerosis, trace or mild AR, and MR—and key clinical endpoints. The findings indicated that each form of mild VHD was independently associated with at least 1 outcome in a dose-response manner, even after adjusting for potential confounders.

Health screening programs that facilitate early disease detection are essential for effective follow-up and for preventing disease progression to advanced stages, which often result in poorer outcomes. An important objective should be to enhance awareness among the public, health care professionals, and other stakeholders regarding the burden and consequences of VHD, as well as the significance of early detection and screening. Comprehensive campaigns targeting the public are necessary to inform individuals that VHD is a significant cause of morbidity and mortality. Early detection and prompt treatment can substantially reduce these risks. Medical societies should spearhead these initiatives in collaboration with patient organizations. Additionally, testimonies from VHD patients should be highlighted, and supporters recruited from political, artistic, and business spheres, similar to other disease awareness campaigns. When patients recognize and appreciate the importance of VHD, they will take the initiative to remind health care providers to set screening.

**One successful valve intervention is not the end of the line.** Valve repair and replacement have become routine cardiac interventions, with improved safety, durability and clinical benefits. However, despite these positive clinical outcomes, survivors of VHD remain at risk for structural valve deterioration, valve thrombosis, and prosthetic valve endocarditis, all of which may lead to adverse cardiovascular events such as bleeding, stroke, and conduction block. A single

successful valve intervention does not eliminate the long-term effects of VHD. Patients require ongoing evaluations to identify early postoperative complications, manage long-term medications, monitor prosthetic valve's function or valve repairs outcomes, address concomitant cardiovascular diseases, and alleviate persistent symptoms or functional limitations.

Many patients continue to experience poor quality of life and adverse outcomes following VHD interventions. Maladaptive ventricular remodeling and dysfunction caused by pressure or volume overload may not fully resolve after valve surgery and are linked to worse prognostic outcomes. Additionally, any comorbidities may lead to persistent symptoms and increase the risk of postoperative complications. Centers for Medicare and Medicaid Services, the Joint Commission, and the Institute of Medicine have consistently highlighted those inadequate transitions of care—where patients move between health care providers, settings, and home—can adversely affect patient prognosis.<sup>106</sup> Regular follow-up by a physician knowledgeable about VHD, timely interventions at specialized centers, and access to a comprehensive range of therapeutic options are essential for achieving optimal outcomes. Currently, however, there is insufficient evidence to guide postoperative pathways and risk stratification, nor to support the development of patient-centered follow-up programs in an increasingly diverse VHD population. There is an urgent need for research focused on strategies to address patient vulnerabilities during early recovery and to optimize transitions of care within the health care system to enhance outcomes. These factors underscore the importance of continuity of care following VHD interventions and the seamless management of the complexities associated with VHD to ensure that patients receive the intended therapeutic benefits.

**Lack of timely and effective referral system.** Patients with VHD require regular appointments with cardiologists, as clinical deterioration may occur without their knowledge.<sup>39</sup> However, maintaining continuity of care after VHD surgery remains a global challenge. Clinicians should educate patients at each encounter about the importance of regular follow-up and encourage self-management, which can facilitate early detection of symptomatic changes, potential complications, and functional deterioration.<sup>107</sup> After the initial evaluation of patients with VHD, whether they undergo intervention or not, clinicians should continue to provide regular TTE follow-ups, ideally in a heart center with appropriate expertise. The frequency of repeat echocardiograms should be

determined based on the type and severity of the valvular lesion and its effect on the affected ventricular function.<sup>14</sup> The primary objective of follow-up is to prevent irreversible consequences of severe VHD, with at least an annual history and physical examination being necessary.

In current medical practice, the diagnosis, treatment, and follow-up of VHD are often fragmented across multiple steps, which may lead to suboptimal patient management, particularly for elderly patients or those with significant comorbidities.<sup>93</sup> To address this issue, a clear and centralized point of contact should be established to report any changes in a patient's condition during the monitoring phase, which can extend over several years.<sup>84</sup> Linking community hospitals and primary care centers with a local heart center is vital for ensuring continuity of care for VHD and is recognized as an essential aspect of effective "Heart Valve Networks."<sup>60</sup> This approach enables patients to maintain close communication with referring hospitals and community facilities, ensuring the timely sharing of up-to-date information and immediate re-referral for new symptoms.<sup>108</sup>

China's health care system operates within a hierarchical framework, categorized into tertiary, secondary, and primary levels. This structure aims to optimize health care resource allocation, improve diagnostic and treatment efficiency, and create a more equitable and effective health system.<sup>8</sup> Tertiary hospitals handle the majority of comprehensive diagnostic and treatment tasks and are equipped with a wide range of medical and surgical departments, as well as modern diagnostic equipment. They are in large- and medium-sized cities. In contrast, secondary hospitals typically include general hospitals in smaller cities and counties, in addition to specialized hospitals. Primary care services are mainly provided by community health centers in urban areas and township hospitals in rural areas.<sup>109</sup> Although China's national policy promotes a hierarchical approach to diagnosis and treatment, there is no legal requirement for patients to adhere to the hierarchy of medical institutions. Additionally, patients' mistrust of primary health care centers hampers their potential role as the first point of contact, undermining the goal of facilitating 2-way referrals.<sup>110</sup> This offers patients sufficient flexibility in selecting health care services, but also leads to the underutilization of primary health care centers and overcrowding in tertiary hospitals.<sup>111</sup> Current estimates suggest that the treatment rate in primary hospitals ranges from only 40% to 80%,<sup>8</sup> while critically ill patients, who genuinely require life-saving interventions, struggle to receive timely care at these facilities.<sup>112,113</sup>

## OPTIMAL MANAGEMENT OF VHD DISEASE: HEART VALVE CLINIC SUPPORTED BY A MULTIDISCIPLINARY TEAM

The prevalence of VHD is steadily increasing because of the aging population.<sup>30,46</sup> However, current management practices often rely on general cardiologists or even primary care physicians who may lack the requisite expertise in this area, resulting in many patients not being accurately diagnosed or receiving appropriate treatments.<sup>2</sup> Furthermore, advancements in the understanding of VHD, combined with the numerous comorbidities frequently found in elderly patients, can significantly impact both the timing and risk associated with interventions. This complexity complicates VHD assessment and the determination of the appropriateness and timing of surgical interventions, often resulting in unwarranted delays in decision-making. Without timely and suitable care, patients with VHD are more susceptible to developing irreversible myocardial damage, which can lead to increased morbidity and mortality compared with those who receive optimal follow-up and management.<sup>114,115</sup> Conversely, the long-term outcomes for patients who have undergone surgical or transcatheter interventions are influenced by factors such as prosthetic valve hemodynamics, durability, and thrombogenicity. Therefore, maintaining a high quality of life for individuals with VHD necessitates the development of an optimal valve intervention program before surgery, as well as whole-life follow-up management.<sup>116,117</sup>

## THE EMERGENCE OF THE HEART VALVE CLINIC AND ITS FUNCTIONS.

In 2012, Rotter et al<sup>118</sup> proposed clinical pathways (CPs) as a contemporary, patient-centered, and integrated approach to health care. The implementation of CPs facilitates coordinated care, reduces fragmentation, limits cost, encourages specialists to adhere to international guidelines, and establishes internal control mechanisms that ultimately lead to optimal patient outcomes, including improved survival rates, reduced morbidity and readmissions, and enhanced quality of life. Consequently, the HVC was developed,<sup>98</sup> incorporating essential components such as structured clinical reviews, echocardiography for determining disease etiology and severity, patient education, access to additional diagnostic tests, multidisciplinary meetings for complex case reviews, construction of personalized health profiles, and the development of lifelong follow-up plans.<sup>119</sup> Additionally, HVC serves as the hub of the heart valve network, responsible for initiating and coordinating care among the heart



TABLE 1 Comparing Outcomes of Valvular Heart Disease Patients Participating in Standard of Care vs Heart Valve Clinic					
First Author	Adverse Event	Waiting Time	Severe Symptom Onset	Guidelines Compliance Rate	Imaging Examination
Taggu et al <sup>120</sup>	NA	NA	NA	Best practice guidelines 157 (41%) vs 354 (92%) Endocarditis prophylaxis advice 338 (88%) vs 373 (93%)	Echocardiogram 1 (1-5)/y vs 2 (1-10)/y
Chambers et al <sup>121</sup>	NA	NA	NA	Management guidelines 62% vs 97%	Inappropriate echocardiography 85% vs 1.6%
Zilberszac et al <sup>122</sup>	NA	Time to symptom detection 352 ± 471 d vs 76 ± 75 d	NYHA functional class III/IV 61% vs 34%	NA	NA
Paolisso et al <sup>123</sup>	1-y all cause death 11.3% vs 2.6% 1-y heart failure 23.1% vs 15.4%	Time indication to AVR 3.3 ± 1.3 mo vs 1.9 ± 1 mo	NYHA functional class III/IV 66.1% vs 45.7%	NA	Exercise stress 0.2 ± 0.4/y vs 0.5 ± 0.3/y Computed tomography 12.8% vs 26.3%
AVR = aortic valve replacement; NA = not applicable.					

center, secondary hospitals, and community health care facilities. The primary goal of HVC is to ensure consistent monitoring of VHD patients before they develop severe ventricular remodeling, subsequent decompensation, or adverse clinical events, facilitating timely referrals to a multidisciplinary heart valve team for the most appropriate interventions.<sup>108</sup> A growing body of evidence indicates that HVC provides superior care, enhances adherence to guideline recommendations, ensures more timely referrals for surgery, and improves patient education compared with standard of care<sup>120-123</sup> (Table 1). These findings strongly support the establishment of HVCs in the heart center to enhance the prognosis of patients with VHD.

**MULTIDISCIPLINARY HEART VALVE TEAM.** The increasing prevalence of VHD and the broad spectrum of treatment options necessitate the standardization of organizational structures. Recent international guidelines have expanded the concept of HVC in conjunction with multidisciplinary heart valve teams to include designations such as “Heart Valve Centre of Excellence”<sup>124</sup> or “Heart Valve Centre”<sup>125</sup> (Figure 2).

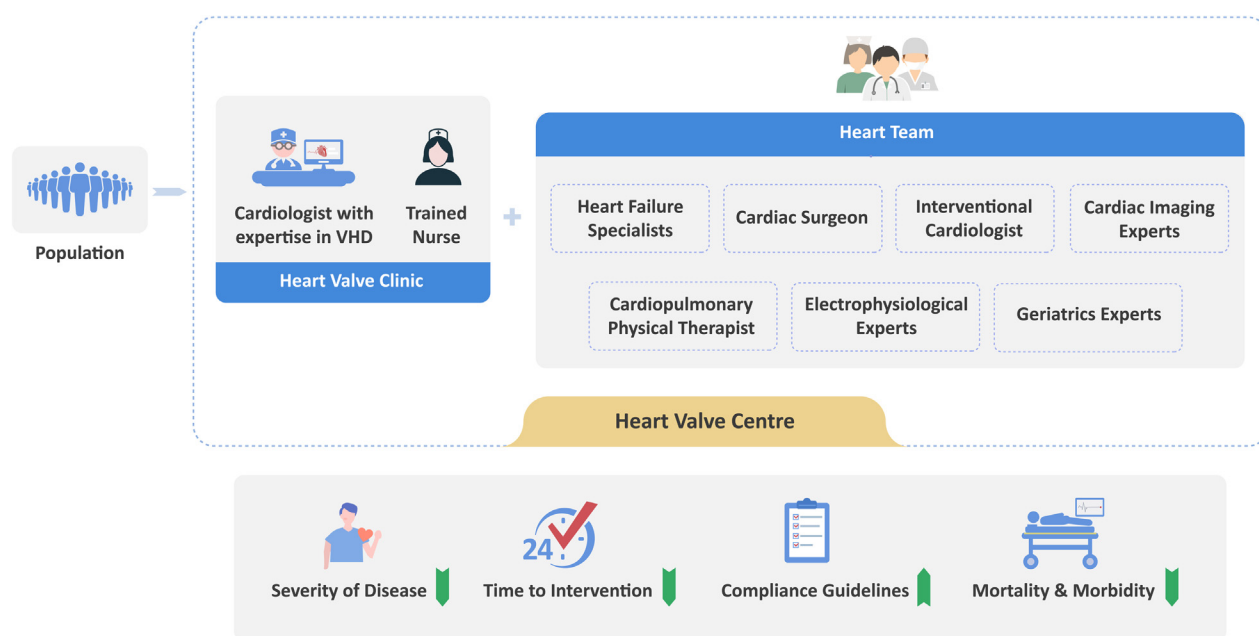
The multidisciplinary team represents a novel approach to treating cardiovascular disease, aimed at formulating optimal treatment plans for individual patients. This concept originated with the development of treatment strategies, such as coronary artery bypass grafting or percutaneous coronary intervention, for patients with coronary artery disease.<sup>111</sup> A cardiac multidisciplinary team enables risk stratification of patients through a shared decision-making process involving both physicians and surgeons. This collaborative approach allows various specialties to jointly analyze a patient’s symptomatology and disease progression, reducing the inherent biases that can arise when complex decisions are made in isolation. For older patients with multiple comorbidities,

the combined expertise of the cardiac team fosters the development of a more comprehensive assessment and integrated treatment plan.<sup>126</sup> For instance, in cases of severe AS, a joint decision can be made regarding the use of TAVR, surgical aortic valve replacement, or conservative treatment (ie, medical treatments that do not involve surgery or invasive procedures, including medication, lifestyle modifications, and continuous monitoring). Members of the multidisciplinary heart valve team may include but are not limited to heart failure specialists, cardiac surgeons, interventional cardiologists, cardiac imaging experts, cardiopulmonary physical therapist, electrophysiologists, geriatrics experts, and specialized-diseases managers (SDMs).<sup>98</sup> Notably, SDMs serve as facilitators, acting as support staff who contact patients, schedule diagnostic tests, address daily concerns, and coordinate appointments with clinicians and the multidisciplinary team. The heart team specializing in VHD form the cornerstone of HVC, and the integration of these cardiologists should be actively promoted.<sup>127,128</sup>

**COMMON HVC MODELS AROUND THE WORLD.**

The concept of HVC has been widely established and accepted, resulting in the development of various models tailored to different health care regulatory systems, local needs, facilities, personnel, and infrastructure worldwide.<sup>98</sup> The standard HVC model functions as a counseling clinic where cardiologists collaborate with trained nurses. Nurses are tasked with recording anthropometric parameters, completing 12-lead electrocardiograms, assessing patients’ functional status through questionnaires, and scheduling clinic appointments. A cardiologist, typically a cardiac imaging specialist, performs an echocardiogram (or supervises an echocardiographer), initiates assessments, writes reports, adjusts medications, and optimizes the management of

**FIGURE 2 Multidisciplinary Heart Team**



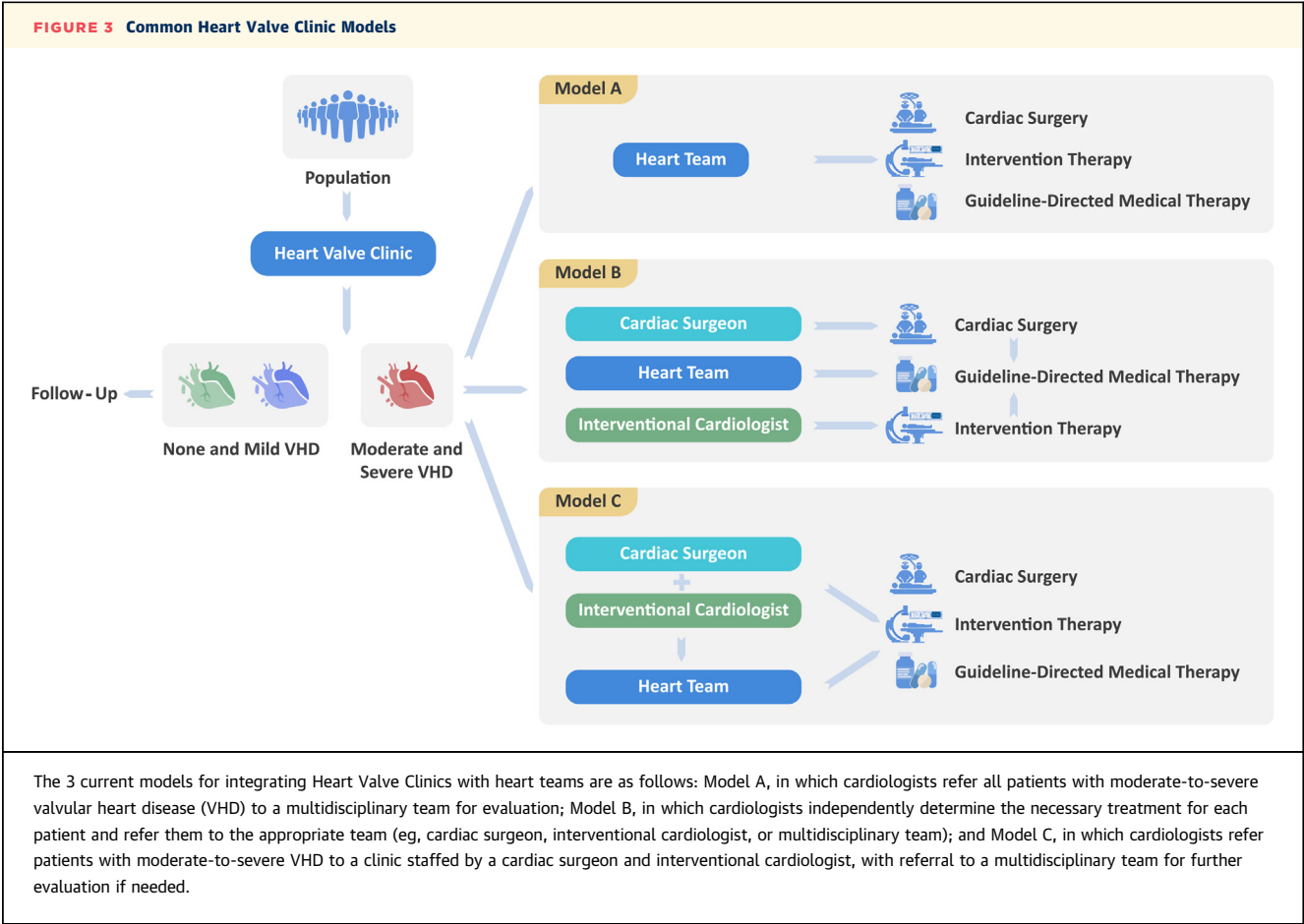
Heart Valve Clinics usually consist of cardiologists with expertise in valvular heart disease (VHD) and trained nurses. The heart team is a new concept in the treatment of cardiovascular disease that aims to develop the best treatment plan for the patient. Team members include heart failure specialists, cardiac surgeon, interventional cardiologist, cardiac imaging experts, cardiopulmonary physical therapist, electrophysiological experts and geriatrics experts. The Heart Valve Clinic combined with the heart team together form the Heart Valve Centre. Through shared decision-making among team members, we can comprehensively analyze patient symptoms and disease progression, reduce decision-making bias, decrease disease severity, shorten waiting times for interventions, increase guideline adherence, and ultimately reduce mortality.

comorbidities. Finally, a determination is made regarding the need for referral to a cardiac surgeon and/or interventional cardiologist, along with the development of a subsequent treatment plan.<sup>120,129</sup> Patients presenting with more complex or high-risk VHD may be referred to a multidisciplinary heart valve team for comprehensive evaluation, planning, and implementation of specific surgical or transcatheter interventional treatments, or for arranging noncardiac surgical interventions.<sup>5</sup>

Antonides et al<sup>126</sup> summarized 3 current models for enhancing the integration of HVCs and multidisciplinary heart valve teams based on patient populations, local medical facilities, and available human resources (Figure 3). The first 2 models<sup>126,130</sup> are better suited for community health care centers establishing referral connections with secondary and tertiary hospitals, while the third model<sup>5,131</sup> is more appropriate for large comprehensive hospitals coordinating departments to form an integrated care system (Table 2).

## VHD WHOLE-LIFE CYCLE MANAGEMENT SYSTEM BASED ON CHINESE CONDITIONS

VHD clinical pathways should be implemented in accordance with local constraints, population density, and existing diagnostic and treatment systems.<sup>123</sup> Specific clinical pathways or diagnostic and treatment models employed in high-income countries may not be effectively transferable to the Chinese health system, which is relatively deficient in primary care resources. It is imperative for China to formulate a viable strategy aimed at enhancing longitudinal follow-up, survival rates, and overall quality of life for the growing and aging VHD population. This can be achieved through collaboration between community hospitals and large comprehensive hospitals, alongside the involvement of a diverse range of cardiology specialists, to provide accessible and effective care for VHD patients within the framework of the current health system.



**CREATING AN ACCESSIBLE AND AFFORDABLE LIFELONG CARE MODEL FOR VHD PATIENTS IN CHINA.** In 2022, the West China Hospital of Sichuan University (WCHSCU) developed a lifelong care model for patients with VHD in alignment with the “Strengthening the Health Management of Major

Chronic Diseases” initiative from the 20th Communist Party of China National Congress.<sup>132</sup> The hospital established the Integrated Care Management Center,<sup>133</sup> which leverages its multidisciplinary strengths in internal medicine, surgery, radiology, and ultrasound to provide continuous standardized

TABLE 2 Common Heart Valve Clinic Models and Suitability				
Primary Care Provider	Referral Teams	Advantages	Disadvantages	Suitability
Model A: Cardiologists <sup>130</sup> (determine whether to refer)	Multidisciplinary Heart Team <sup>3</sup> (decision-making)	Comprehensive consideration; minimizing the risk of conflicts of interest	Time-consuming; costly; substantial human resources	Primary hospitals (referral to advance hospital)
Model B: Cardiologists <sup>3,126</sup> (determine where to refer)	A. Cardiac surgeon (decision-making) B. Interventional cardiologist (decision-making) C. Multidisciplinary heart team (decision-making/support)	Provides a “fast track” for surgical interventions; preselection of patients for multidisciplinary discussions	Disciplinary divisions; inequalities in care	Primary hospitals (referral to advance hospital)
Model C: Cardiologists <sup>5,131</sup> (determine whether to refer)	Cardiac surgeon + interventional cardiologist <sup>4</sup> (decision-making) Multidisciplinary heart team (support)	Cardiac and interventional cardiologists work together to evaluate patients and make optimal intervention decisions	Limited human resources; difficulty in departmental teamwork	Heart center

<sup>a</sup>Representatives play a central role in the patient care process.

management throughout the patient care process. This is achieved through interconnectivity of data across multiple hospital districts and intelligent support from the triage system. Additionally, by utilizing the established “Internet +” Hospital platform, they harness digital health care tools such as online consultations, artificial intelligence-driven follow-ups, and electronic patient management to deliver continuous health care services and facilitate effective communication between patients and health care teams. As an articulation service platform, the Integrated Care Management Center appoints SDM who are involved throughout the entire diagnosis and treatment process. These managers serve as a “bridge,” facilitating communication between patients and the medical team. They guide patients through consultations, standardized diagnosis and treatment management, periodic follow-ups, as well as offering health guidance, emotional support, and psychological services. Their primary objective is to eliminate barriers between specialties and departments, thereby forming a cooperative team comprising medical, nursing, technical, and management personnel within the multidisciplinary treatment system. This model ensures comprehensive, personalized, and continuous services for patients with chronic diseases. This management framework clarifies and specifies the responsibilities of each team member involved in the diagnosis and treatment of specialized diseases, enhancing the standardization and efficiency of care. Consequently, it improves the continuity of medical services, patient adherence, quality of life, and overall satisfaction with services.

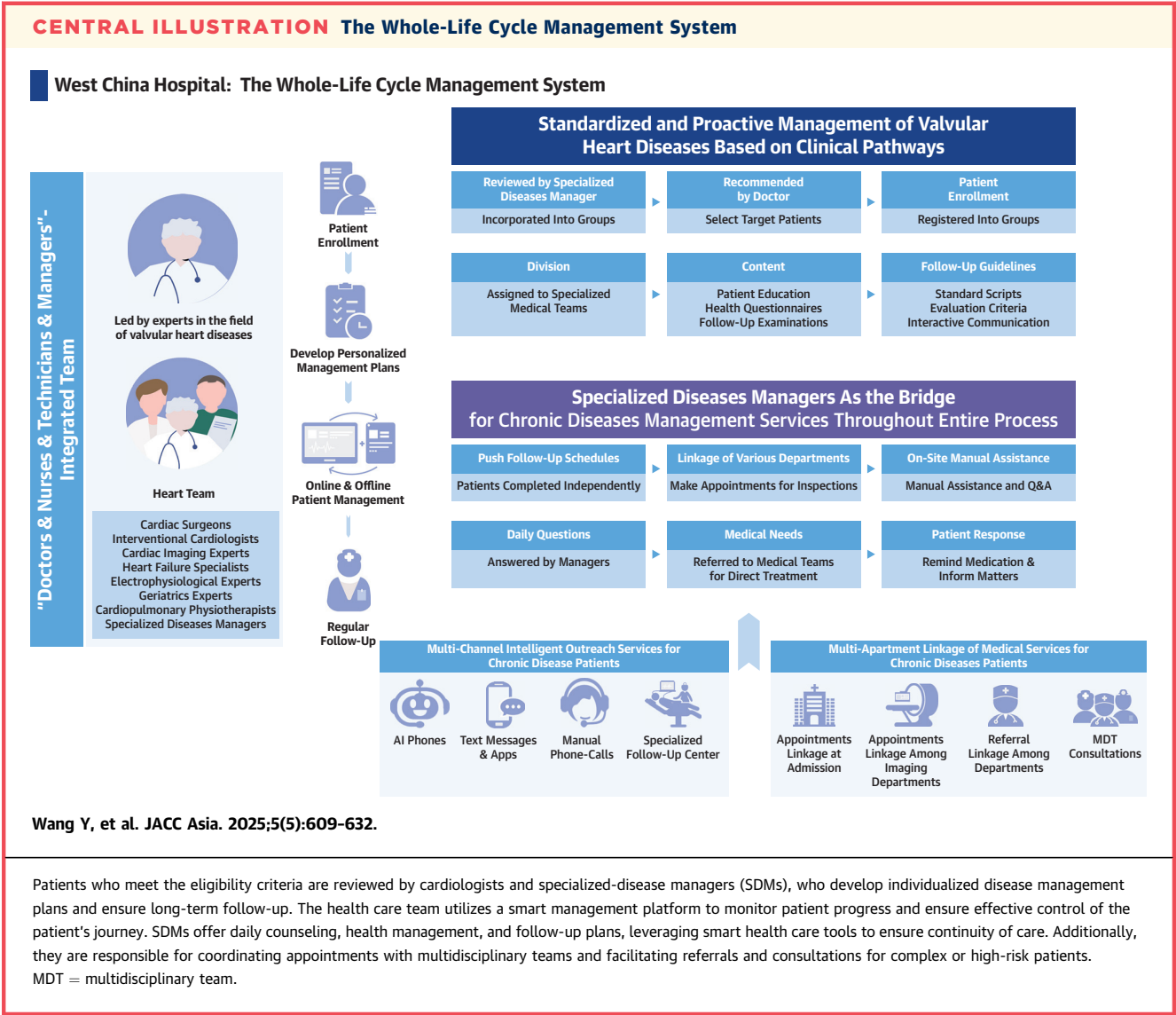
The Department of Cardiovascular Surgery at WCHSU, in collaboration with the National Clinical Medical Research Center for Elderly Diseases, proposed a VHD Whole-Life Cycle management system,<sup>134</sup> relying on established VHD diagnostic and treatment theories and the hospital’s integrated management platform. The goal is to create an accessible and affordable lifelong care model for VHD patients in China, enabling them to “live better and live longer.” The core principles of standardized proactive management for VHD based on clinical pathways include proactive detection, intervention, and follow-up of affected populations. These strategies aim to facilitate early diagnosis and treatment, maximize treatment efficacy, and enhance the standardized diagnosis and treatment rate as well as the long-term survival rate of VHD patients. Individuals who meet the enrollment criteria will be assessed by cardiologists and SDMs, and subsequently included in

a management cohort, receiving personalized disease management plans tailored to their specific health conditions, alongside long-term monitoring (**Central Illustration**).

#### **IMPROVEMENT MEASURES FOR THE WHOLE-LIFE CYCLE MANAGEMENT SYSTEM OF VHD.**

**Promote hierarchical medical care and build a specialized medical consortium.** A hierarchical medical system is inadequately implemented in China’s health care system. Many patients with chronic diseases tend to consult secondary and tertiary hospitals because of a lack of trust in primary care facilities and insufficient primary health care resources in their regions. This leads to chronic overload in large comprehensive hospitals, making it difficult for patients to access timely care and resulting in missed opportunities for optimal interventions. Furthermore, inadequate connectivity between large comprehensive hospitals and lower-level facilities, coupled with challenges in sharing medical information, has fostered uncoordinated referral behaviors among patients. Particularly for VHD patients requiring intervention, difficulties in outpatient follow-up and readmission for complications have been noted (**Figure 4A**). In response, the General Office of the State Council issued the Guiding Opinions on Promoting the Construction of a Hierarchical Medical System in 2015.<sup>135</sup> This policy document delineates the foundational model for China’s health care services, promoting a framework of “Emergency and Chronic Hierarchic Treatment, Primary First Care, Two-Way Referral, and Up and Down Linkage.”<sup>50,136</sup>

To implement the national “Hierarchical Medical Care” strategy, the outpatient department of WCHSCU established the Office of Hierarchical Diagnosis and Treatment and Two-Way Referral in 2015, which oversees the management of hierarchical diagnosis and referral processes.<sup>137</sup> Key initiatives include creating expedited referral pathways, optimizing the referral process, and ensuring convenient, prompt, and high-quality medical services for referred patients. In addition, the hospital is working on forming an urban medical service alliance, while creating a collaborative referral platform to enhance connections between tertiary hospitals and primary health care institutions. This initiative will promote the dissemination of high-quality medical resources to primary health care providers, enhancing their service capabilities and ensuring the principle of primary care first diagnosis. Efforts are also made on coordinating out-of-hospital health education and community clinics to accurately address the diverse health needs of various populations and improve



public health awareness and outcomes (Figure 4B). Furthermore, WCHSCU initiated the construction of a disciplinary alliance as early as 2016 to enhance regional specialty consistency, laying the groundwork for the subsequent establishment of the “1+X” specialized medical consortium.<sup>138</sup> This model positions tertiary hospital as the lead unit in the specialized medical consortium, enabling tertiary hospitals to utilize their expertise effectively and foster cooperative relationships among other consortium members in medical care, education, and research. These initiatives contribute significantly to the development of hierarchical diagnosis and treatment, 2-way referral systems, grassroots training and guidance, as well as enhancing information connectivity,

ultimately promoting equity and accessibility in basic health care services.

**Integration of professional institution and multidisciplinary teams.** One of the crucial steps in the clinician’s decision-making process involves determining the appropriateness of a procedure, which is intimately connected to the patient’s goals and preferences, as well as assessing the reasonable likelihood that the anticipated benefits will outweigh the risks.<sup>139</sup> Inappropriate or ineffective surgery generally falls into 2 primary categories:

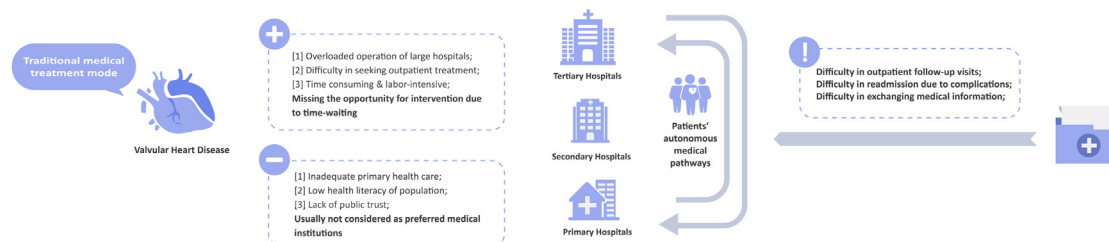
1. The presence of severe comorbidities and frailty—where, despite technical success, the patient may experience rapid mortality or a sustained



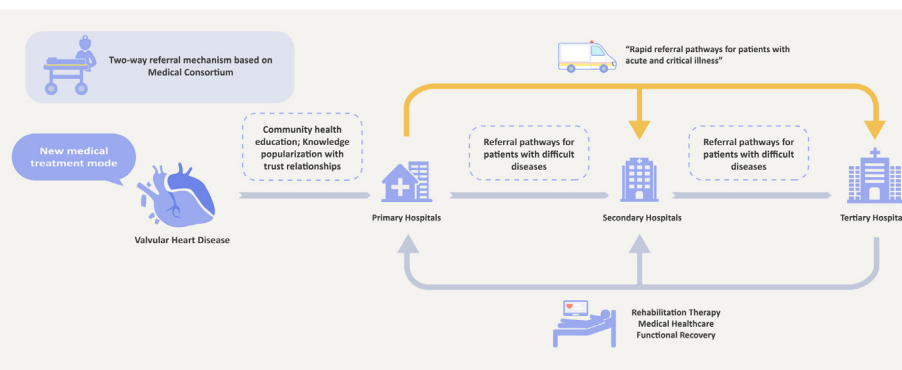
**FIGURE 4 Comprehensive Referral System**

**West China Hospital - Comprehensive Referral System**

**A**



**B**



(A) The traditional access model for the hierarchical medical system has several limitations; (B) The new access model developed by West China Hospital promotes hierarchical diagnosis and treatment through a two-way referral process.

decline in health. For instance, up to 30% of TAVR survivors in the PARTNER (placement of aortic transcatheter valve) study either died within one year or developed persistent NYHA functional III/IV symptoms.<sup>140</sup> The existence of comorbidities significantly influences the long-term success of the procedure, underscoring the importance of evaluating whether a patient will benefit from intervention as part of the preoperative multidisciplinary assessment, which necessitates consensus within the heart valve team.

2. Lack of responsiveness to valve surgery—where, even if the procedure is technically successful, it fails to enhance the patient's health, survival, or other goals. The impact of transcatheter valve interventions on atrial MR and TR remains largely unknown. It may be more effective to address disease severity through rhythm control strategies, such as electrical cardioversion,<sup>42</sup> radiofrequency ablation,<sup>43</sup> and cardiac resynchronization therapy.<sup>141</sup>

A critical aspect of the decision-making process is the formulation of an optimal lifelong strategy for

managing VHD. Understanding the etiology and pathophysiology is essential for determining the appropriate sequence of treatment. Surgery is not the first-line method for all eligible patients, TAVR is preferred in some and transcatheter edge-to-edge repair (TEER) is preferred over surgical intervention for functional MR and TR. Surgery, encompassing all invasive treatment options such as surgical intervention, TAVR, and TEER, is considered a primary treatment for patients with valve disease, because it addresses the underlying valve lesions. Compared with medical therapies that primarily manage heart failure symptoms, these surgical interventions provide a more definitive treatment approach. It is important to note that TAVR and TEER are preferred in certain cases, particularly for patients with functional MR and TR, because they represent a staged approach to treatment, progressively addressing valve pathology. In contrast, traditional surgical intervention typically offers a 1-step solution to valve disease. Therefore, the choice among these treatment modalities involves careful consideration of the individual patient's condition and the specific characteristics of their valve disease. Previous studies have

demonstrated that secondary MR improves by at least 1 grade in over 50% of patients undergoing TAVR.<sup>142</sup> The increasing use of bioprosthetic valves in patients over 50 years, along with the rapid advancement of TAVR, has prompted renewed attention to the life-long management of patients with VHD requiring repeat valve interventions through a carefully sequenced and well-planned program.<sup>143</sup> TAVR valve-in-valve in a degenerated surgical aortic valve bioprosthesis has become routine in many centers, yielding short-term outcomes superior to repeat surgical aortic valve replacement.<sup>144</sup> Although this procedure is appealing, the concept of continuous TAVR for patients at intervals of every 10 years is overly idealistic. For instance, the long-term durability of transcatheter heart valves is still undetermined;<sup>145</sup> continuous THV implantation, likened to “Matryoshka doll,” can lead to patient-prosthesis mismatch.<sup>146</sup> Additionally, multiple TAVR procedures complicate subsequent surgical or coronary interventions, increasing the risk of associated complications.<sup>143</sup> These concerns are particularly significant for younger patients, who may require 3 to 4 interventions, especially those with adult congenital heart disease who have previously undergone surgical or transcatheter interventions in infancy or childhood, as well as women of childbearing age seeking to avoid the risks linked with mechanical valves and the necessary anticoagulation during pregnancy. Therefore, the optimal lifelong strategy must consider clinical and anatomical factors, the choice among transcatheter, surgical, or hybrid approaches, the selection of valve type, the resolution of other comorbid cardiac conditions (such as coronary artery disease), and the patient’s preferences and values. Timely referral to a specialized cardiology center following a VHD diagnosis and indication for surgery is essential for developing an effective multidisciplinary follow-up treatment plan to achieve the best lifelong outcome.

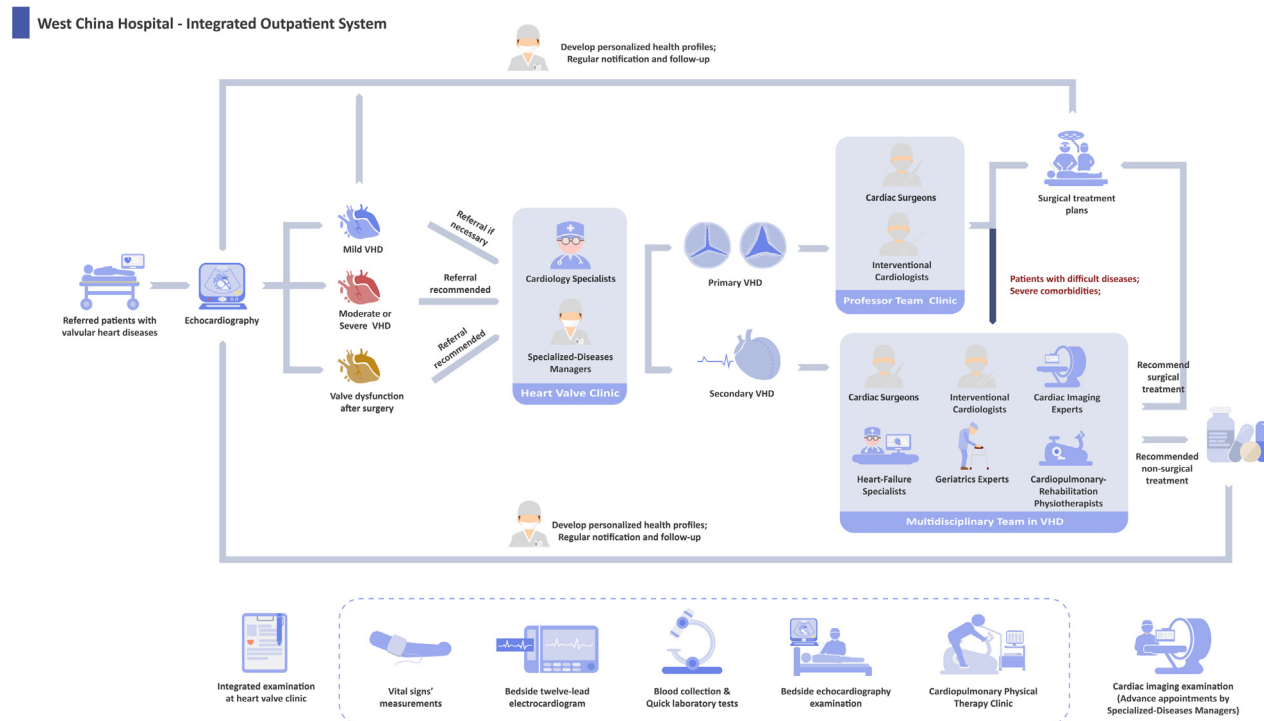
Patients with VHD in China who frequently visit large hospitals often experience repeated multiple visits, complicated appointments for specialized tests, high transportation costs, and difficulties in accessing multidisciplinary expert consultations. These challenges can ultimately hinder patients from receiving specialized treatment strategies. The HVC models adopted in developed countries, such as those in Europe and the United States, which recommends referrals based on the severity of a patient’s VHD, may not be feasible in regions where health care resources are limited.<sup>126</sup> Particularly within the Chinese health care context, characterized by weak community health care capacity and a lack of a family

physician system, the medical needs of patients with risk factors, mild VHD, or moderate VHD remain unmet. In response, the Department of Cardiovascular Surgery at West China Hospital of Sichuan University and the National Clinical Medical Research Center for Geriatric Diseases have proposed the establishment of an integrated VHD consultation system in large comprehensive hospitals.

In this model, patients with VHD are referred to the HVC for evaluation following an assessment of disease severity by echocardiography experts. A cardiologist develops a referral and follow-up plan based on the patient’s initial findings and the underlying disease mechanism (eg, primary or secondary VHD).<sup>111</sup> For patients with moderate or severe VHD or postoperative valvular dysfunction, a personalized health profile is created, and the SDM participates in the patient’s disease follow-up appointments, team clinics appointments, and hospital admissions process. Primary VHD patients are directed to the “Professor Team Clinic” consisting of cardiac surgeons and interventional cardiologists.<sup>147</sup> Secondary VHD patients are referred to a joint “Multidisciplinary Team Clinic.”<sup>148</sup> This mechanism minimizes unnecessary waste of medical resources and ensures that critically ill and complex VHD patients receive comprehensive evaluations and optimal interventions (Figure 5).

**Active interaction system and elderly-friendly medical services.** With the rapid development of an aging population, chronic health problems among older patients have become increasingly prominent, with the coexistence of multiple diseases becoming more severe. Data from China’s seventh population census indicate that approximately 264 million individuals are aged 60 and above, with nearly three-quarters having 1 or more chronic diseases.<sup>149</sup> This phenomenon heightens the risk of disability, diminishes quality of life, and adversely affects both the physical and mental health of older individuals.<sup>150</sup> Older adults with multiple chronic conditions typically present more complex needs and often require transitions between hospitalization and homebound status.<sup>151</sup> The process of transitioning from hospital to home can be intricate and fraught with risk, with approximately 20% of patients experiencing adverse events during this transition, including unplanned readmissions within 1 month of discharge, medication errors, and even death.<sup>152,153</sup> This situation is exacerbated by a disconnect in the continuity of care for elderly patients across tertiary hospitals, community-based organizations, and home settings. In China, the Family Doctor Contracting Service, prevalent in higher-income nations such as those in

**FIGURE 5 Integrated Outpatient System**

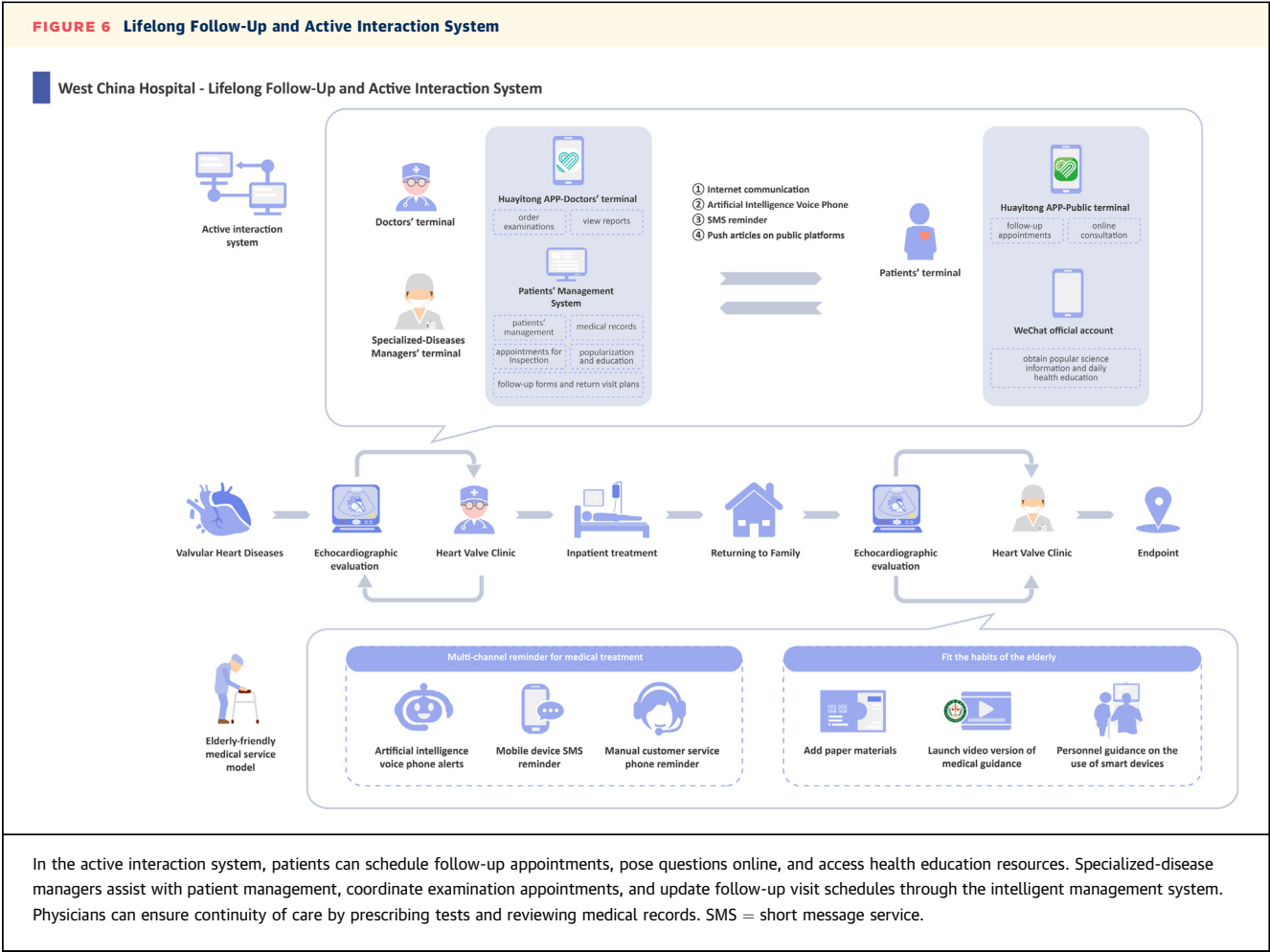


Valvular heart disease (VHD) patients are initially referred to a heart valve clinic staffed by cardiology specialists and specialized-disease managers, where they undergo an integrated examination following an echocardiogram to assess disease severity. Based on the initial findings and potential disease mechanisms, the cardiology specialist formulates a plan for further referrals and follow-up care. Specialized-disease managers are tasked with reminding patients with mild VHD to undergo regular reviews and coordinating follow-up examinations and treatment schedules for patients with moderate or more severe VHD, or those with postoperative valve dysfunction. Patients with primary VHD are referred to the "Professor Team Clinic," while those with secondary VHD are directed to the "Multidisciplinary Team Clinic". Additionally, patients with multiple comorbidities or those at high surgical risk may be referred to the "Multidisciplinary Team Clinic" for a comprehensive evaluation.

Europe and the United States to enhance the quality of primary health care services, remains in its developmental stages. Continuous management of elderly patients' post-hospital discharge in China is often fragmented,<sup>154</sup> typically limited to an oral version of health education provided before discharge. Furthermore, there is a significant lack of family physicians or their teams to deliver follow-up care to elderly patients, including medication management and wound care.<sup>155</sup>

Ensuring the patients with the timely, safe, and continuous health care services during transitional care -including discharge planning, referrals, follow-up, medication management, and self-education - is crucial for improving patients' long-term prognosis and enhancing the efficiency of health care resource utilization.<sup>156</sup> Furthermore, it is essential for both patients and health care providers to recognize the value of proactive involvement from patients and

their families in disease management, which is central to global health care initiatives.<sup>157</sup> The provision of information initiated by patients and families to health care providers, aimed at bridging information gaps, effectively supports safety and quality of care, particularly in the presence of dysfunctional communication systems and evolving organizational structures.<sup>158</sup> Consequently, there is a pressing need to integrate SDMs into the whole-life cycle management system for patients with VHD to act as intermediaries between patients and health care providers during transitional care<sup>159</sup> and to facilitate the implementation of a proactive interaction system. For instance, SDMs can help identify, anticipate, and mitigate barriers faced by patients during disease management, while also assessing the biological, psychological, social, and emotional needs of patients to reduce readmission rates and enhance overall safety in care. Notably, the advancement of



telemedicine technologies, such as telemonitoring and mHealth smartphone applications, is transforming the methodologies for disease follow-up and patient management.<sup>160</sup> Communication platforms like WeChat have the potential to alleviate financial burdens and time costs, improve medication adherence, and achieve higher satisfaction levels among family members compared with traditional outpatient follow-up appointments. Furthermore, public information platforms such as WeChat can be leveraged to disseminate health education information to patients and their families, thereby reducing anxiety associated with care management.<sup>161</sup>

We have developed an active interaction system tailored for the VHD population through the West China Hospital “Internet+” Platform. The active interaction system enhances patients’ perceptions of health care, improves their overall medical experience, increases outpatient follow-up and post-operative re-examination rates, and ultimately contributes to better long-term survival and quality

of life for patients (Figure 6). Additionally, we have developed intelligent patient management systems to assist SDMs in patient management, examination scheduling, and the development and updating of follow-up plans. Moreover, according to the China Internet Network Information Center, the internet penetration rate among individuals aged 60 and older is approximately 42%, revealing a significant digital divide.<sup>162</sup> In response to China’s digital inclusion policy,<sup>163</sup> SDMs must also fulfill the role of digital health facilitators, bridging this digital divide and supporting the elderly population in accessing digital services.<sup>164</sup> Additionally, an age-appropriate health care service model has been incorporated into our management system. Patients and their family members will receive consultation reminders through multiple channels (eg, smart voice telephone reminders, short messaging service notifications for mobile devices, and human customer service telephone reminders). Simultaneously, methods tailored to the preferences of the elderly are employed, such

as providing printed materials, releasing a video consultation guide, and using smart devices guided by personnel on-site at the outpatient clinic. Finally, there is a need for comprehensive modern health education campaigns. These initiatives include engaging specific populations through field experts in VHD<sup>165</sup> and utilizing China's unique app ecosystem (including WeChat, Alipay, and TikTok) to disseminate health education videos.<sup>166</sup> Tailoring these materials for the target audience aids in increasing the personal relevance of health messages, thereby enhancing engagement in health behavior change.<sup>167</sup>

**THE WHOLE-LIFE CYCLE MANAGEMENT SYSTEM ASSESSMENT INDICATORS.** Patient-centered health care is 1 of the 6 core goals outlined in the Institute of Medicine's seminal report, "Crossing the Quality Chasm: A New Health System for the 21st Century."<sup>168</sup> This report not only highlights the importance of aligning with individual patient preferences but also emphasizes providing patients with the best available scientific knowledge to facilitate evidence-based decision-making consistent with their values. On the one hand, the construction of a HVC framework and the integration of multidisciplinary teams help prevent deviations from clinical recommendations by compelling specialists to adhere closely to international guidelines during case discussions and practice (appropriateness). For instance, Pavone et al<sup>93</sup> demonstrated that geriatrician-led prehabilitation for frail VHD patients effectively improved short-term mortality in cardiac surgical patients by excluding groups unlikely to benefit from the program. On the other hand, a more rational and coordinated sequence of clinical events, facilitated by proactive interactions between SMDs and patients, reduces both time and economic costs without compromising patient management (effectiveness). Ultimately, the Whole-Life Cycle management system for VHD enhances the quality of care and services received by patients, accelerates appropriate diagnosis and treatment, improves outcomes and safety, and fosters better coordination and continuity of care across various settings.

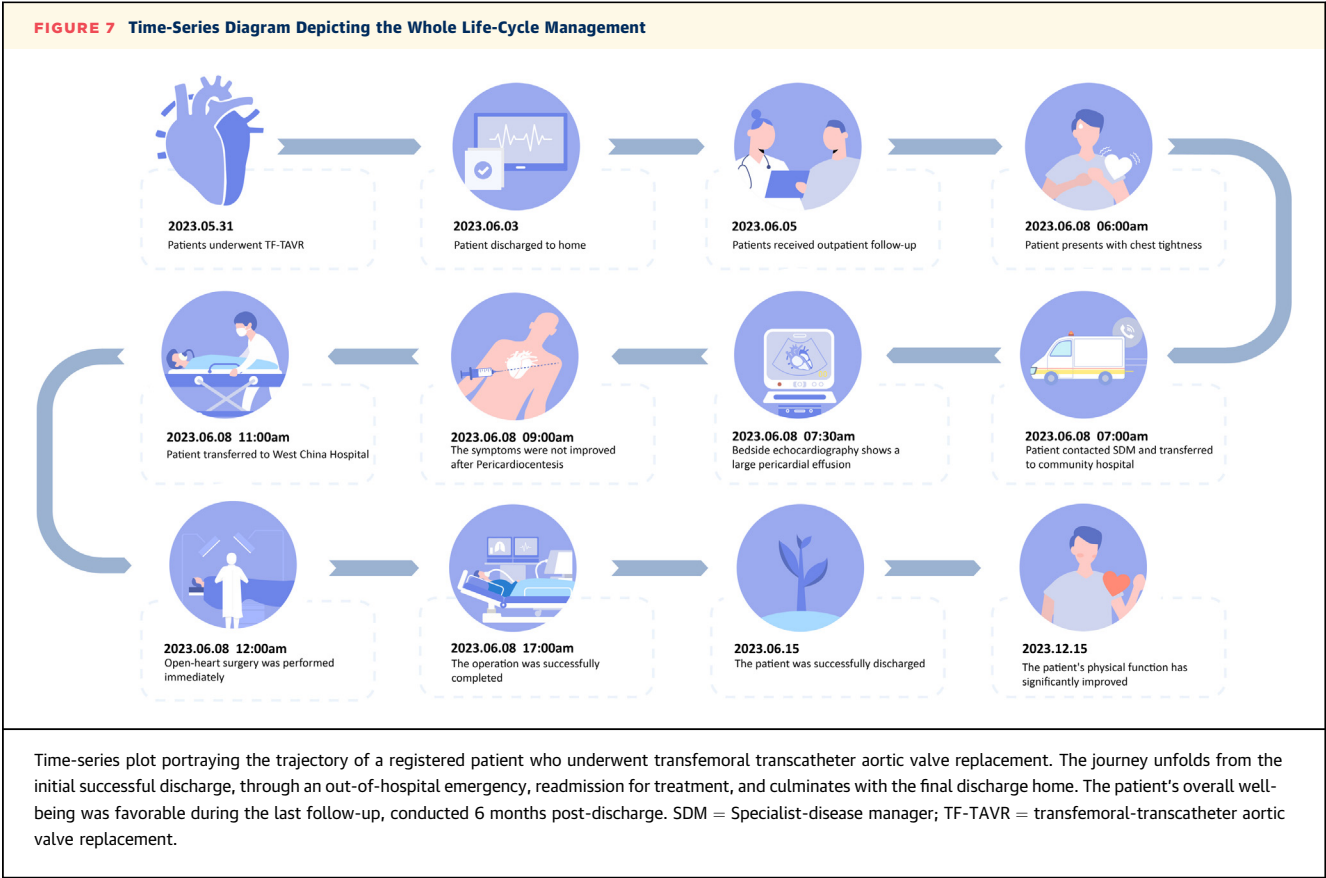
A robust audit process is essential for the Whole-Life Cycle management system.<sup>169</sup> However, there are currently no publicly available guidelines or consensus standards for auditing patients with VHD. Audit programs for HVC and CPs should prioritize patient-centered outcomes. General HVC audits ought to focus on aspects such as patient health education, patient satisfaction, referral wait times following symptom onset, and adherence to follow-up and intervention guidelines. Audits specific to

VHD patients may concentrate on individual valve disease progression outcomes, including the following: 1) all-cause mortality; 2) mortality caused by cardiovascular causes; 3) readmission for heart failure; 4) outcomes of surgical interventions (including residual regurgitation or stenosis); 5) long-term quality of life; and 6) cost-benefit analyses of intervention programs.<sup>98,131</sup> Scientifically, the Whole-Life Cycle management system for VHD provides an opportunity to develop large databases. The implementation of electronic health record systems can facilitate the creation of large registry databases and support prospective research frameworks. Furthermore, the data collected can be utilized to generate public health care insights, interpret outcomes based on individual patient risk levels, document the needs of VHD patients, and evaluate the impact of the Whole-Life Cycle management system on patient prognosis.<sup>98</sup> To enhance the allocation of health care resources for VHD patients in China, high-quality data are essential to characterize prevalence, disease severity, comorbidities, functional status, and health care resource utilization.

Establishing clinical registries within major hospitals of the Heart Valve Network represents a crucial first step in real-world data collection. Integration with administrative data sources, such as the National Mortality Surveillance Database, National Inpatient Record, and health insurance records, is vital for aggregating prognostic and health-related information. One successful implementation is the Patient Audit of Cardiac Disease conducted by the Society of Thoracic Surgeons National Database, which serves as a nationally mandated mechanism for gathering surgical data on cardiac diseases from Heart Center.<sup>170</sup> China could follow this model to launch a similar national program that fosters collaboration among health administrations, hospitals, physicians, and research departments. In the near future, such database programs will facilitate the translation of research evidence into clinical practice and policy development. It is recommended that these results, independently reviewed by the Cardiovascular Disease Disciplinary Societies as well as national societies, be published on the HMC's website and made accessible to patients and referring clinicians.

**THE WHOLE-LIFE CYCLE MANAGEMENT SYSTEM SUCCESSFULLY SAVES PATIENT'S LIFE.** Figure 7 illustrates the significance of Whole-Life Cycle management for VHD patients. Taking a patient who underwent transfemoral TAVR as an example, the patient's care process, beginning with their initial successful discharge from the hospital, exemplifies





the various facets of full lifecycle management. Although the patient had a life-threatening emergency 5 days after discharge, timely monitoring and effective communication facilitated their readmission for treatment, ensuring continuous improvement in their health status. This case not only demonstrates the effectiveness of a Whole-Life Cycle management system but also underscores the importance of hierarchical treatment and multidisciplinary teamwork. With the support of specialized agencies and the establishment of active interaction system, the patient received timely interventions and care throughout the treatment process, ultimately achieving good overall health at the last follow-up visit. This real-world case further highlights the necessity for an accessible and affordable lifelong care model and emphasizes the urgency and feasibility of promoting a Whole-Life Cycle management system for VHD in China.

**CONCLUSIONS**

The increasing prevalence of VHD and the limitations of the existing disease management model underscore the unmet medical needs associated

with this condition. Based on our institutional experience at West China Hospital, we have designed a patient-centered VHD whole-life management system that emphasizing early diagnosis, standardized treatment, regular monitoring and

**HIGHLIGHTS**

- The increasing prevalence of VHD highlights the urgent need for improved global management strategies.
- Heart valve clinics, supported by multidisciplinary teams, offer a promising solution for VHD management.
- A whole-life cycle management system for VHD emphasizes early diagnosis, standardized treatment, and regular follow-up.
- Future efforts should focus on scalable, affordable lifelong care models to reduce VHD-related mortality and morbidity.

follow-up, and continuous improvement tailored to the health care landscape in China and middle- to low-income areas.

We believe that establishing an accessible and affordable lifelong care model for all VHD patients in China and similar regions will contribute to the following: 1) enhanced patient care; 2) optimal utilization of validated diagnostic tests and therapies; 3) increased adherence to evidence-based guidelines; 4) comprehensive patient education regarding their condition; 5) reduced readmission rates, morbidity, and mortality; 6) improved quality of life; and 7) decreased overall health care costs associated with VHD.

From our perspective, China is poised to build such a model for the world's largest VHD population. The success of this initiative, grounded in our institutional experience, will not only empower VHD

patients in China to lead healthy, productive lives, but will also yield valuable insights for other countries facing similar challenges.

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**KEY WORDS** heart valve clinic, integrated, multidisciplinary team, valvular heart disease, whole-life cycle