Aortic stenosis (AS) is the most frequent indication for valve replacement in Europe and North America, and correct diagnosis and timing of surgery are critical. Although it is evident that patients with symptoms attributable to severe AS require prompt valve replacement, there remain some unresolved issues in clinical decision making (1).

First, symptomatic AS patients occasionally do not fulfill the criteria of severe stenosis, yet have no cause for symptoms other than apparently moderate AS. In other patients, currently recommended diagnostic criteria may be inconsistent: for example, valve area is in the severe range but pressure gradient is low, even with normal left ventricular (LV) function (2). These cases raise the question of whether the current criteria used to define severe AS are optimal or whether we need to do more than simply look at valve areas, transvalvular velocities, and pressure gradients (3).

Second, when to operate on asymptomatic patients with hemodynamically severe AS remains a controversial issue. Although the risk of surgery and the long-term risks of a prosthetic valve may not justify valve replacement in all of these patients, some of them are at increased risk of adverse events and may indeed benefit from elective surgery. Thus, risk stratification of asymptomatic severe AS remains an unresolved issue.

In this issue of the Journal, Hachicha et al. (4) present interesting new data with respect to both issues. This group previously proposed the new parameter of valvuloarterial impedance ($Z_{va}$) as a more robust descriptor of AS hemodynamics and a better predictor of LV dysfunction, compared with standard measures of stenosis severity (5). Now, based on a retrospective analysis of 544 consecutive patients with at least moderate AS, they show that $Z_{va}$ is a strong independent predictor of clinical outcome.

The $Z_{va}$ is calculated by dividing the estimated LV systolic pressure (systolic arterial pressure + mean transvalvar gradient) by stroke volume index; thus $Z_{va}$ represents the pressure “cost” (in mm Hg) for each milliliter of blood pumped by the LV during systole, indexed for body surface area. This index accounts for the fact that reduced arterial compliance is a frequent finding in patients with AS and independently contributes to increased afterload (6). Indeed, the LV faces a double load, valvular and arterial, particularly in hypertensive patients, which comprise about 50% of AS patients in current clinical practice (7).

It is a reasonable hypothesis that symptoms and LV dysfunction, as well as adverse events, may better correlate with this measure of global LV burden compared with standard measures of AS severity. For example, a high $Z_{va}$ may explain why a patient with moderate AS is symptomatic. More importantly, a high $Z_{va}$ may confirm severe AS in a patient with a small valve area but low gradient despite a normal ejection fraction. Such patients are not uncommon in the elderly AS population, frequently presenting with LV hypertrophy and a history of hypertension but a normal or pseudo-normal blood pressure. Closer evaluation may identify a low stroke volume despite normal ejection fraction. This entity, only recently recognized, is called paradoxical low-flow AS. Such patients may be misdiagnosed with nonsevere AS; recent reports indicate a poor outcome without valve replacement (8). Paradoxical low-flow AS may be one of the reasons for the worse outcome of patients with high $Z_{va}$ in the present study.

Some questions remain unanswered in this publication (4). Cause of death could not reliably be identified in all patients; the analysis of mortality was retrospective, often based on death certificates. Furthermore, little is known about the disease course and patient management after the index echocardiogram, including symptom onset and appropriateness of medical therapy for hypertension. The high mortality rate with medical therapy is surprising, suggesting that some patients may have developed symptoms or other indications for valve replacement. In particular, it remains unknown how many patients were not referred to surgery because of advanced age, comorbidities, or failure to report symptoms to the physician.

In addition, $Z_{va}$ has some intrinsic limitations. Although reflecting global LV burden, $Z_{va}$ does not account separately for the valvular versus arterial component. A patient with severe hypertension, reduced cardiac output, and only mild AS may present with the same $Z_{va}$ as a patient with severe AS. Whereas the first requires intensive blood pressure control, the second requires valve replacement. Thus, the individual components of valvuloarterial impedance are critical for patient management rather than the proposed new parameter itself. Another limitation of $Z_{va}$ is that pressure recovery is not considered in this measurement: $Z_{va}$ significantly overesti-
mates total LV load in patients with a relatively small aorta (i.e., <30 mm diameter) because kinetic energy is converted back into potential energy with a significant increase in aortic pressure distal to the stenosis (9). In this case, \( Z_{va} \) overestimates the LV load. In addition, \( Z_{va} \) is not a stable parameter but varies with spontaneous or treatment-related blood pressure changes. The clinical consequence of this effect is evident by simply looking at the components required for \( Z_{va} \) calculation. For example, a symptomatic patient with nonsevere AS, based on valve area and velocity/gradient measurement, but with hypertension should have adequate blood pressure control before calculation of \( Z_{va} \).

Instead of introducing a new parameter such as \( Z_{va} \), with its own limitations, we propose an integrated approach to evaluation of the patient with AS that not only incorporates standard parameters of stenosis severity (aortic jet velocity, mean pressure gradient, and valve area), symptom status, and LV function but also carefully considers stroke volume and blood pressure for correct data interpretation and patient management (3). However, the concept of \( Z_{va} \), as illustrated in this study by Hachicha et al. (4), highlights important messages for assessment and treatment of AS:

1. Arterial hypertension requires special attention in AS. Hypertension is frequently present in AS patients, particularly in elderly patients, and increases the already-high load faced by the LV. Hypertension also is likely to worsen clinical outcome. Appropriate blood pressure control is critical even though management is complicated by the limited data on antihypertensive treatment and patient management (3). However, the concept of \( Z_{va} \), as illustrated in this study by Hachicha et al. (4), highlights important messages for assessment and treatment of AS:

2. Paradoxical low-flow AS, a relatively low transvalvular gradient despite a normal ejection fraction, should be considered, especially in elderly AS patients with a history of hypertension and a small valve area. Although these patients may benefit from valve replacement, they may be misdiagnosed as having nonsevere AS.

3. Symptomatic patients with AS who are found to have moderate AS, defined by valve area and gradient, with concurrent high blood pressure (or high valvuloarterial impedance) require antihypertensive treatment, with repeat evaluation of AS severity when normotensive. Whether these patients should have early surgery when symptoms persist despite treatment requires further research.

We now recognize that a complete description of the hemodynamics of aortic valve obstruction includes consideration of the LV response to pressure overload, the severity of valve narrowing, and the total systemic vascular load. However, in everyday clinical practice we can continue to rely on currently recommended measures of stenosis severity as long as we also consider blood pressure and cardiac output.

Reprint requests and correspondence: Dr. Catherine M. Otto, Division of Cardiology, Box 356422, University of Washington, Seattle, Washington 98195. E-mail: cмотto@u.washington.edu.

REFERENCES


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