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Aortic Stenosis

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Introduction

- Aortic stenosis (AS) is a condition where the opening of the aortic valve becomes narrower. The narrowing causes a resistance in blood flow from the left ventricle (LV) to the aorta, which results in a reduction of flow and higher pressures within the left ventricle (McCance & Huether, 2014).
- AS affects about 2% of adults over the age of 65 (McCance & Huether, 2014).
- The most common heart valve disorder in Europe and North America is AS due to calcification (Wald, Williams, Bangash, & Bestwick, 2018).

Importance

- AS is increasing in prevalence due to aging of the population and increased life expectancy (Kanwar, Thaden & Nkomo, 2018).
- Cardiac surgical intensive care unit (CVICU) nurses and certified registered nurse anesthetists (CRNA's) provide care to many patients with AS.
- Proper education of the underlying pathology and its significance, symptoms, and appropriate diagnosis and treatment is essential to provide high level nursing care.

Pathophysiology

- Narrowing of the aortic valve is generally due to three main causes: 1) Age associated calcification, 2) congenital bicuspid aortic valve and 3) Inflammation associated with rheumatic heart disease (McCance & Huether, 2014).
- Age associated AS is the end result of an inflammatory process caused by endothelial damage due to mechanical stress, lipid penetration leading to fibrosis, leaflet thickening, and finally calcification (Joseph, Naqvi, Giri, & Goldberg, 2017).
- In AS from all causes, the opening of the aortic valve narrows, causing diminished blood flow from the LV to the aorta (McCance & Huether, 2014).
- Pressure in the LV rises to overcome the outflow obstruction caused by the narrow valve, in an attempt to preserve stroke volume and cardiac output. LV hypertrophy develops due to an increased workload to get blood across the valve (Yurek, Jakub & Menacho, 2015).
- Increased jet velocity and mean pressure gradient develop across the valve, with decreasing valve area throughout progression of the disease. AS is generally graded as mild, moderate, or severe; and the grading determines the frequency of echocardiogram monitoring (Yurek, Jakub & Menacho, 2015).

AS Severity Grading

Indicator	Mild	Moderate	Severe
Jet velocity (m/s)[a]	<3	3 to 4	>4
Mean gradient (mmHg)[b]	<25	25 to 40	>40
Valve area (cm^2)[c]	>1.5	1 to 1.5	<1
Valve area index (cm^2/m^2)	—	—	<0.06
Two-dimensional doppler interval (years)	5	2	1

[a] *The speed blood flows across the aortic valve.*
[b] *The difference in pressure between the inferior (i.e., ventricular) and superior (i.e., aortic) surfaces of the aortic valve.*
[c] *A measure of the aortic valve opening.*

Table 1. Classification of Progressive Aortic Stenosis and Frequency of Echocardiogram Monitoring (Yurek, Jakub & Menacho, 2015)

Significance of Pathophysiology

- Hypertrophy increases myocardial oxygen demand and could lead to ischemia, dysrhythmias, myocardial infarction, and heart failure (McCance & Huether, 2014).
- AS is characterized by a relatively benign course in patients with asymptomatic disease but a rapid downhill course with the onset of symptoms (Kanwar, Thaden & Nkomo, 2018).
- AS holds a poor survival rate unless timely valve replacement is performed (Kanwar, Thaden & Nkomo, 2018).
- In the perioperative setting, patients with aortic stenosis are at high risk of experiencing cardiac complications. Safe administration of anesthesia requires prevention of any hemodynamic change that decreases cardiac output (Hines & Marschall, 2018).
- Cardiopulmonary resuscitation is typically ineffective in patients with aortic stenosis; thus, education on the disease and perioperative treatment is extremely important for nurse anesthetists (Hines & Marschall, 2018).

Signs and Symptoms

Classic Triad (Joseph, Naqvi, Giri, and Goldberg, 2017)

1. Heart Failure or exercise intolerance
2. Syncope
3. Exertion related angina

Kanwar, Thaden, and Nkomo (2018) described the following additional symptoms:

- Dyspnea occurs due to increased LV filling pressure or the inability to increase cardiac output during exercise
- Dizziness or syncope results from a reduction in cerebral perfusion
- Vague symptoms of tiredness or fatigue

Hemodynamics

Parameter	Definition		
Stroke volume (SV)	Volume of blood ejected from the ventricle with each contraction		
Cardiac output (CO)	Volume of blood ejected from the heart per minute CO = heart rate (per minute) × SV		
Preload	Volume of blood in the ventricle at end diastole (producing a stretch of ventricular muscle cells)		
Afterload	Resistance the heart must overcome to eject blood from the ventricle		
Systemic vascular resistance (SVR)	Resistance to blood flow in all systemic vasculature		
	Reflects	**Normal range**	**Effects of moderate to severe aortic stenosis**
Right atrial pressure	Right ventricular preload	2-7 mm Hg	Increases
Pulmonary artery (PA) pressure	Pressures in the pulmonary vasculature	Systolic 15-30 mm Hg Diastolic 4-12 mm Hg	Increases when PA systolic pressure >60 mm Hg (severe pulmonary hypertension)
Pulmonary artery occlusion pressure	Mean left atrial pressure (indirect reflection of LV preload)	2-12 mm Hg	May increase
Left ventricular pressure (LVP)	LV afterload (systolic) LV preload (diastolic)	Systolic 90-140 mm Hg Diastolic 5-12 mm Hg	Increases
Aortic pressure (AP)	SVR and preload	Systolic 90-140 mm Hg Diastolic 60-90 mm Hg	Decreased preload causes decreases in LVP and AP, increased SVR Increased preload causes increased LVP to maintain AP
Systemic vascular resistance (SVR)	LV afterload	700-1600 dynes · sec · cm^{-5}	Increases
Pulmonary vascular resistance	Resistance to blood flow in pulmonary vasculature	20-130 dynes · sec · cm^{-5}	Increases
Cardiac output/resting	Volume of blood ejected from the heart per minute	5-8 L/min	Decreases

[a] Based on information from Otto and Bonow.[1]

Table 2. Hemodynamic Parameters and the Effects of Aortic Stenosis (Cary & Pearce, 2013).

Treatment

Medical Management
- There is no effective pharmacologic treatment for AS (Joseph et al., 2017).

Balloon Valvuloplasty
- A balloon is placed across the stenotic valve and inflated/deflated several times to widen the valve area (Cary & Pearce, 2013)
- Used in patients who are not able to receive an aortic valve replacement due to comorbidities (Joseph et al., 2017).
- Can be used as a bridge to SAVR or TAVR in unstable patients with high surgical risk, but does not alter the pathology. The hemodynamic benefit lasts for only about 6 months. The chances of restenosis are high (Joseph et al., 2017).

Valve Replacement
- Aortic valve replacement is recommended in symptomatic patients with severe AS (Bhattacharyya et al., 2016)
- Standard treatments of severe AS are surgical aortic valve replacement (SAVR) and transcatheter aortic valve replacement (TAVR) (Joseph et al., 2017).

SAVR
- Through open heart surgery, the aortic valve is removed and a new valve is sewn into the orifice (Cary & Pearce, 2013).
- Considered the gold standard treatment of severe AS and performed with either mechanical or bioprosthetic valves.
- Surgical risk is calculated using the Society of Thoracic Surgeons (STS) score. Patients are classified as being high surgical risk if STS score > 8%, or if they have coexisting noncardiac conditions that predict poor survival.
- As compared with TAVR, the risk of major bleeding and new-onset atrial fibrillation are higher; however, the risk of a major stroke and a major vascular complications is less.

(Joseph et al., 2017)

TAVR
- The replacement valve is located inside a stent that is deployed over the diseased valve via a transcatheter approach (Cary & Pearce, 2013).
- Indicated for inoperable, high-risk, and intermediate-risk surgical patients as an alternative to SAVR.
- Less invasive as compared with SAVR
- Commonly performed in a hybrid operative room under general anesthesia, but can also be performed in the cardiac catheterization lab under conscious sedation.
- The most common approach for implantation is transfemoral (TF).
- Complications associated with TAVR include stroke, vascular access-site bleeding, paravalvular leak, and heart block requiring permanent pacing.

(Estes & Kalra, 2018)

Implications for Nursing Care

- About 39% of patients admitted with acute decompensation have no prior diagnosis, highlighting the need for increased identification of aortic stenosis (Wald et al., 2018). Nurses should incorporate assessment of AS signs and symptoms into their routine care; especially patients complaining of reduced exercise capacity.
- Teaching patients with AS to recognize and immediately report symptoms associated with the disease progression can reduce subjective denial of symptoms, time to treatment, and mortality (Yurek, Jakub & Menacho, 2015).
- Hospitalization with acute decompensation is an overlooked and life-threatening problem in patients with AS (Wald et al., 2018). Nurses need to be hyperaware of the hemodynamic status of patients with AS.
- Medication compliance following valve replacement is vital to successful recovery and maintenance. Medication education for the patient and family members is very important. As some medications can be expensive, nursing should consult case management for assistance to help ensure patient compliance (Estes & Kalra, 2018).

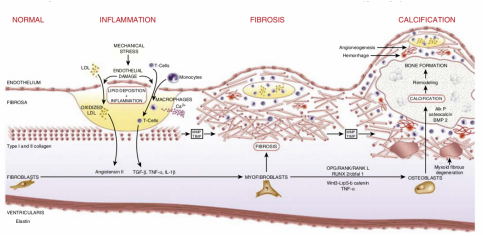

Figure 1. Summary of pathological processes occurring within the valve during AS (Hines & Marschall, 2018).

Conclusions

- It is anticipated that the prevalence of AS will double in the next 20 years (Hines & Marschall, 2018). Health care providers need to make understanding the pathophysiological processes, clinical manifestations, symptoms associated with the disease progression, treatment options, and nursing implications a priority.
- Proper management of patients with AS requires an understanding of the criteria used to define the disease severity (Joseph et al., 2017).
- With an increase in TAVR procedures for AS, nurses must expand their knowledge and scope to care for these patients. Better understanding of the procedure and possible complications leads to better nursing care and patient outcomes (Estes & Kalra, 2018).
- Early recognition and management of AS is of utmost importance because untreated symptomatic severe disease is universally fatal (Kanwar, Thaden & Nkomo, 2018).
- It is critical for nursing care to evolve and grow in tandem with the increased TAVR population to integrate the complex care of these patients to provide optimal care and improve patient outcomes (Estes & Kalra, 2018).

References

Bhattacharyya, S., Mittal, T., Abayalingam, M., Kabir, T., Dalby, M., Cleland, J. G., . . . Rahman Haley, S. (2016). Classification of aortic stenosis by flow and gradient patterns provides insights into the pathophysiology of disease. *Angiology, 67*(7), 664-669. doi:10.1177/0003319715611804

Cary, T., & Pearce, J. (2013). Aortic stenosis: Pathophysiology, diagnosis, and medical management of nonsurgical patients. *Critical Care Nurse, 33*(2), 58-72. doi:10.4037/ccn2013820

Estes, B. A., & Kalra, A. (2018). Contemporary nursing care in transcatheter aortic valve replacement. *Journal of Vascular Nursing, 36*(4), 186-188. doi:10.1016/j.jvn.2018.08.001

Hines, R. L., & Marschall, K. E. (2018). *Stoelting's anesthesia and co-existing disease* (7th ed.). Philadelphia, PA: Elsevier.

Joseph, J., Naqvi, S. Y., Giri, J., & Goldberg, S. (2017). Aortic stenosis: Pathophysiology, diagnosis, and therapy.*The American Journal of Medicine, 130*(3), 253-263. doi:10.1016/j.amjmed.2016.10.005

Kanwar, A., Thaden, J. J., & Nkomo, V. T. (2018). Management of patients with aortic valve stenosis. *Mayo Clinic Proceedings, 93*(4), 488-508. doi:10.1016/j.mayocp.2018.01.020

McCance, K. L., & Huether, S. E. (eds.). (2014). *Pathophysiology: The biologic basis for disease in adults and children* (7th ed.). St. Louis, MO: Elsevier/Mosby.

Toyota, K., Ota, T., Nagamine, K., Koide, Y., Nomura, T., Yamanaka, F., . . . Saito, S. (2016). Effect of transcatheter aortic valve implantation on intraoperative left ventricular end-diastolic pressure. *Journal of Anesthesia, 30*(6), 1051-1055. doi:10.1007/s00540-016-2229-7

Wald, D. S., Williams, S., Bangash, F., & Bestwick, J. P. (2018). Watchful waiting in aortic stenosis: The problem of acute decompensation. *American Journal of Medicine, 131*(2), 173-177. doi:10.1016/j.amjmed.2017.08.027

Yurek, L. A., Jakub, K. E., & Menacho, M. M. (2015). Severe symptomatic aortic stenosis in older adults pathophysiology, clinical manifestations, treatment guidelines, and transcatheter aortic valve replacement (TAVR). *Journal of Gerontological Nursing, 41*(6), 8-13. doi:10.3928/00989134-20150414-02

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