AORTIC STENOSIS is the most common adult heart valve condition in the Western world (Iung et al 2003). Of the estimated 25% of people aged over 65 years who have aortic sclerosis, about 16% will progress to moderate stenosis within seven years (Cosmi et al 2002). Aortic stenosis has been shown to increase sharply with age and around 3% of the population aged over 75 years has moderate or severe aortic stenosis (Lindroos et al 1993, Nkomo et al 2006). When this is applied to a predicted increase in life expectancy in the UK (Office for National Statistics 2009), the incidence of degenerative aortic stenosis is also likely to increase (Chukwuemeka 2008).

The Euro Heart Survey on Valvular Heart Disease (Iung et al 2003) identified that approximately 33% of patients with symptomatic aortic stenosis were not referred for surgery. However, it is difficult to obtain accurate information on aortic stenosis in the UK, as there appears to be limited epidemiological data for the prevalence of the disease, perhaps because of unknown numbers of patients with symptomatic aortic stenosis who are not referred for surgery or who are referred and then not operated on.

Ray (2009) estimated that about 600 patients who have been rejected for surgery each year could benefit from transcatheter aortic valve implantation by reducing their symptoms and improving their quality of life. When this figure is added to the possible 20% of high-risk surgical patients who might benefit from this procedure, an estimated 840 patients per year in England could benefit from this pioneering treatment (Ray 2009). This might reduce hospital admissions, which would have additional benefits for the health service.

Anatomy and physiology

The aortic valve consists of three half-moon shaped pocket-like flaps of delicate tissue, and lies between the opening of the left ventricle and the aorta. The aortic valve allows blood to flow into the aorta during ventricular contraction (systole) and then prevents blood from flowing back into the left ventricle during ventricular relaxation (diastole) (Vander et al 1990). The valve acts in a purely passive way. As the pressure rises in the left ventricle the pressure difference across the valve causes it to open; closure then occurs as the aortic pressure exceeds that of the left ventricle (Vander et al 1990).

Aetiology

In the majority of patients, the aetiology of aortic stenosis is degenerative calcific; over time, calcium deposits are laid down on the aortic valve leading to gradual deterioration with loss of function (Figure 1). In recent years the incidence of inflammatory aortic stenosis, usually caused by rheumatic heart disease, has decreased (Passik et al 1987, Iung et al 2003) perhaps because of antibiotic use, improved social conditions and a reduction in the virulence of streptococcus infection (Cilliers 2006).
Aortic stenosis may also be caused by a bicuspid valve. Approximately 1-2% of the population is born with a valve that has only two cusps rather than three (Nishimura 2002). A bicuspid valve is characterised by extended areas of leaflet (flaps) contact, which can lead to excessive folding and creasing that persists throughout the cardiac cycle. This may result in asymmetrical blood flow patterns and turbulence, predisposing the valve to stenosis (Robicsek et al 2004).

**Pathogenesis**

The pathogenesis of degenerative calcific aortic stenosis shares many characteristics with that of the atherosclerotic process (Tziomalos et al 2008). Atherosclerosis is a condition in which cholesterol and fatty material are deposited along arterial walls, leading to plaque formation, which can result in angina, myocardial infarction or stroke (Alexander et al 2001).

Although the similarities with atherosclerosis were recognised as long ago as 1917, they were largely disregarded until recently. Histological studies have now highlighted that the conditions share common features, while also confirming differences in the cellular and mineral components of the two lesions. The differences between the two conditions may, in part, explain why not all patients with severe aortic stenosis have significant coronary artery disease (Palta et al 2000, Branch et al 2002).

Degenerative calcific aortic stenosis is believed to share many of the risk factors identified for atherosclerosis. These risk factors are being targeted by public health and medical interventions, for example lipid lowering, smoking cessation, increasing physical exercise (Department of Health (DH) 1999, 2000a, 2000b, 2004, 2008). This may affect disease progression in the future, delaying the disease process and increasing the number of octogenarians who present with symptomatic aortic stenosis in the UK. At present, however, the evidence to support this is mixed, because differences have been identified in the disease progression of aortic stenosis and coronary artery disease (Aronow et al 2001, Novaro et al 2001, Bellamy et al 2002, Cowell et al 2005, Moura et al 2007).

Statistics suggest that the number of older patients presenting with aortic stenosis is likely to increase, which will present new challenges for cardiologists in today’s medical climate of financial accountability and risk-averse behaviour (Bridgewater and Keogh 2008, Jung 2008). Estimated operative mortality rates for aortic valve replacement are affected by many factors, including patient age, left ventricular function and other cardiac and non-cardiac factors (McRae et al 2009).

**Signs and symptoms**

In the community aortic stenosis is usually noted first through clinical assessment. The clinical signs are a slowly rising carotid pulse and a mid-systolic ejection murmur, heard best over the ‘aortic area’ or right second intercostal space, with radiation into the right neck. These may trigger a diagnostic echocardiogram. However, many cases are missed because of variations in clinical skill among physicians and, more importantly, limitations in the clinical assessment of severe aortic stenosis (Das et al 2000).

Appropriate management at this stage includes patient education about the importance of seeking prompt medical attention once symptoms are present, periodic echocardiography to check left ventricular function, valve area and pressure gradient across the valve, and cardiovascular risk factor reduction such as lipid lowering, smoking cessation and exercise promotion (Ambler et al 2005). Chambers (2005) advocated a national screening strategy to ensure patients with noteworthy murmurs have echocardiography and routine follow up, so that the opportunity for surgery is not missed.

Although the asymptomatic patient generally has a good quality of life, once symptoms develop the mortality rate rises to 25% per year (Carabello and Paulus 2009). Over time, aortic stenosis causes progressive calcification and immobilisation of the valve flaps, resulting in thickening and stiffening of the cusps (Braunwald et al 2001). This scarring impairs the opening of the valve, which can result in syncope (often on exertion, because the cardiac output is reduced and can even become fixed and unable to increase in response to an increased workload (Zarco 2003)); this leads to a reduced blood supply reaching the brain.
The stenotic valve can affect the left ventricle, increasing left ventricular workload as it attempts to generate sufficient pressure to propel blood forwards. Over time this increased pressure and workload can cause the ventricle to dilate or hypertrophy, eventually leading to heart failure. The ventricle’s increased workload leads to an increase in the myocardial demand for oxygen and, if this demand is not met because of coronary artery disease, angina may result (Braunwald et al 2001, Zarco 2003). However, angina may also result from aortic stenosis in the absence of coronary artery disease, because of high systolic and diastolic wall stresses and a reduced cardiac output that undersupplies the coronary arteries (Julius et al 1997).

Patients with symptomatic aortic stenosis have a life expectancy of approximately two years without surgical intervention (Carabello 2002). Symptomatic aortic stenosis can lead to sudden cardiac death as a result of acute myocardial infarction, low-output heart failure and cardiac arrhythmias (Baptiste 2001).

**Diagnostic tools**

The echocardiogram is the recommended diagnostic tool for confirming and assessing valvular heart disease and predicting prognosis (Vahanian et al 2007). Measurement of the valve area provides a good clinical guide for the assessment of the valve, and this technique is used in symptomatic patients with impaired left ventricles (Swanton 2003).

In asymptomatic patients, jet velocity—a measure of blood flow across the valve—can provide better predictions of valve assessment and deterioration (Swanton 2003). In a normal aortic valve, the velocity is usually 1m/second. When the valve becomes narrowed as a result of stenosis, the blood flow must be accelerated for the same volume of blood to cross the valve during systole, therefore increasing its velocity (Kaddoura 2002).

**Hospital admissions**

Many patients with aortic stenosis report symptoms of lethargy, reduced mobility and breathlessness on minimal exertion. Severe dyspnoea can lead to numerous emergency hospital admissions for these patients, because of pulmonary oedema and heart failure. These symptoms occur as a result of increased left ventricular volume and pressure, which backs up into the left atria and pulmonary vasculature, raising pulmonary capillary pressure and increasing filtration out of the capillaries, resulting in pulmonary oedema (Vander et al 1990).

Pulmonary oedema causes dyspnoea because it creates increased diffusion distance between the alveoli and capillaries, which leads to a reduction in oxygen transfer (Swanton 2003). Patients are generally treated with oxygen therapy to support oxygenation and increased myocardial oxygen demand. Morphine is administered to reduce pain and anxiety; decreasing pain and/or anxiety can reduce the amount of work and oxygen consumption of the myocardium. Diuretics are used to offload the extra fluid volume (Opie 1997).

**Treatment options**

The National Institute for Health and Clinical Excellence (NICE) publishes recommendations on the treatment of chronic heart failure, including that caused by valve disease (NICE 2003). Medical therapy for patients with heart failure is aimed at reducing excessive cardiac pressures carefully while maintaining left ventricular pressure so that blood can be pushed across the valve without causing a build up and backlog of pressure that results in pulmonary oedema.

In aortic stenosis the problem is obstruction. Extreme caution is advocated in these patients, as reducing preload (pressure in the left ventricle) can lead to difficulty in blood flow across the diseased valve because of an increased pressure gradient. This may result in further deterioration in the patient’s condition as cardiac output is reduced. Nitrates are generally contraindicated in aortic stenosis for this reason (Opie 1997). However, the use of angiotensin-converting enzyme (ACE) inhibitors – contraindicated in aortic stenosis for many years – is now supported by growing evidence. The potential benefits of ACE inhibitors include prevention of left ventricular hypertrophy, improved diastolic function, reduction of arrhythmias and preservation of left ventricular function (Routledge and Townend 2001). However, NICE (2003) does not recommend ACE inhibitors for use in aortic stenosis.

Medical treatment for aortic stenosis is not curative, and surgery is the preferred option for symptomatic patients. Open chest aortic valve replacement (AVR) has been used to treat these patients since the early 1960s (Chukwuemeka 2008). However, surgical operative mortality risk is high in patients with additional comorbidities; for example, an 80-year-old man with coronary disease, previous cardiac surgery and renal dysfunction could have a predicted mortality of 24% (Ambler et al 2005). However, in low-risk, carefully selected patients, the operative mortality risk is estimated at less than 5% (Mortasawi et al 2000, Sundt et al 2000, Kolh et al 2001).
Assessment of a patient’s risk of mortality from open chest AVR often involves the use of a cardiac multivariate score. An example of one such tool is the EuroSCORE (European System for Cardiac Operative Risk Evaluation 2008). These tools assess a patient against the many factors that have been identified to increase operative risk, such as age, left ventricular function and other cardiac and non-cardiac factors, and generate a mortality risk score (McRae et al 2009). They offer compromise between wide applicability and the surgeon’s judgement (Geissler et al 2000, Nilsson et al 2004).

Discrepancies between predicted and observed outcomes in octogenarians have been identified (Collart et al 2005, Grossi et al 2008), and all assessment scores appear to have limitations when dealing with older patients. There seems to be no reliable method to identify who will derive the greatest benefit from AVR (American College of Cardiology et al 2006) and the treatment process for older people often relies predominantly on the surgeon’s clinical judgement.

Many older patients are declined surgery by cardiac surgical teams because of haemodynamic instability and significant comorbidities (Iung et al 2005). These discrepancies will probably never be quantified fully in today’s culture of financial accountability and risk-averse behaviour. Although hospital and surgical league tables are produced using non-risk adjusted data, they are having increasing influence over ‘medical markets’; in other words, people are using the internet and other sources to access clinical data to choose where they want treatment (Bridgewater and Keogh 2008). A large number of older patients are refused conventional surgery (Iung et al 2005), even when aortic stenosis has progressed to a critical point and the prognosis with medical management alone is poor (American College of Cardiology et al 2006, Vahanian et al 2008).

The refusal of surgical intervention is critical for these patients, because it reduces their life expectancy (Carabello 2002). However, just as important for many patients is the effect that symptoms have on quality of life. Although the effects on quality of life can be measured objectively by the number of hospital admissions and physical limitations, this does not account for social, recreational and leisure activities, and the subjective effect on patients’ relationships and personal happiness.

Transcatheter aortic valve implantation

Leading interventional cardiologists and heart surgeons have pioneered alternative therapeutic options for older patients with severe aortic stenosis who have been refused conventional surgery, with the aim of improving their quality of life and life expectancy (Cribier et al 2004, Feldman 2006, Grube et al 2006, Munt and Webb 2006, Iung 2008). Transcatheter aortic valve implantation is one such promising alternative technique for patients who are refused conventional surgery and, in selected symptomatic patients, can improve quality of life (American College of Cardiology et al 2006).

According to NICE (2008): ‘Transcatheter aortic valve replacement may be carried out under general anaesthesia or under local anaesthesia with sedation. Access to the aortic valve can be achieved transluminally, via the femoral artery or vein (using the percutaneous or endovascular approach), or surgically, via a minithoracotomy and apical puncture of the left ventricle (transapical or transventricular approach).’ The procedure involves first dilating the existing valve to allow replacement of the stenosed aortic valve with a new valve mounted on a stent. The placement of the new valve, which may be either self-expanding or balloon inflated, is achieved using a guidewire. When the new prosthetic valve is deployed, this obliterates the stenotic valve. Although data and information on the procedure are limited at present, Davidson and Baim (2008) stated that the procedure is likely to develop rapidly over the next few years, guided by clinical results.

Nursing implications

The authors’ experience has been with patients who have undergone a transfemoral approach using a CoreValve (Figure 2), a system that consists of porcine pericardial tissue sutured into a self-expanding nitinol (an alloy of nickel and titanium) stent. The patient selection process involves a number of tests to assess suitability for the procedure. Following selection, the risks
TABLE 1

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<tr>
<th>Post-procedure care of patients undergoing transcatheter aortic valve insertion using the femoral site</th>
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<tr>
<td><strong>Cardiac monitoring</strong></td>
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<td><strong>Radial arterial catheter</strong></td>
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<td><strong>Temporary pacing wire</strong></td>
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<td><strong>Central venous catheter</strong></td>
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<td><strong>Urinary catheter</strong></td>
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<td><strong>Femoral wound management</strong></td>
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<td><strong>Neurological observations</strong></td>
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<td><strong>Electrocardiogram (ECG)</strong></td>
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<td><strong>Respiratory status/oxygen</strong></td>
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<td><strong>Anticoagulants</strong></td>
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<td><strong>Blood tests</strong></td>
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<td><strong>Antibiotics, proton pump inhibitors, antiplatelet therapy</strong></td>
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<td><strong>Pain</strong></td>
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<td><strong>Mobility</strong></td>
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<td><strong>Patient discharge</strong></td>
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Transcatheter aortic valve replacement is subject to many of the risks that have been identified for percutaneous implantations and heart valve surgery. The procedure is carried out in the catheter laboratory, and the patient is then nursed for a short period on the intensive care unit to allow recovery from the general anaesthetic. The time period for this has varied with each case, but the aim is to return the patient to the cardiology ward within six to 12 hours. The general areas of patient care are outlined in Table 1.

As transcatheter aortic valve replacement is at an early stage of development it remains difficult associated with the procedure are discussed with the patient.
to assess the risks and benefits of this intervention in older, high-risk patients, when compared with natural progression (Iung 2008). However, a position statement released by NICE (2008) supports appropriate use of this intervention.

The patient generally stays in hospital between four and seven days. The nursing care that supports the patient undergoing transcatheter aortic valve replacement will be developed continually as processes are expanded, and medical and surgical clinical teams continue their collaborative work and drive future developments that offer selected patients an alternative when conventional surgery is not an option.

**Conclusion**

Given the predicted increase in life expectancy in the UK, the incidence of degenerative calcific aortic stenosis can also be expected to rise. Many older patients with aortic stenosis are denied surgery as a result of haemodynamic instability and significant comorbidities. Although transcatheter aortic valve replacement, a pioneering procedure, is still in its infancy, it has delivered promising results for patients who previously had no surgical option, and compares favourably with conventional AVR in these selected high-risk patients.

The multidisciplinary approach and frameworks that have been developed to support safe patient care around transcatheter aortic valve implantation at the University Hospital of South Manchester NHS Foundation Trust, will provide a foundation for future developments. It is hoped that this work will begin to make a valuable contribution to this pioneering area of cardiology.

**References**


