

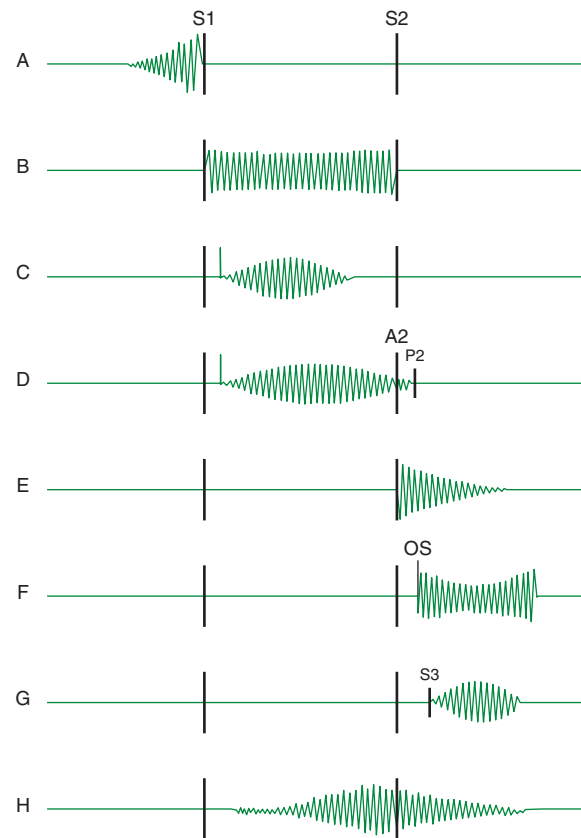
The differential diagnosis of a heart murmur begins with a careful assessment of its major attributes and response to bedside maneuvers. The history, clinical context, and associated physical examination findings provide additional clues by which the significance of a heart murmur can be established. Accurate bedside identification of a heart murmur can inform decisions regarding the indications for noninvasive testing and the need for referral to a cardiovascular specialist. Preliminary discussions can be held with the patient regarding antibiotic or rheumatic fever prophylaxis, the need to restrict various forms of physical activity, and the potential role for family screening.

Heart murmurs are caused by audible vibrations that are due to increased turbulence from accelerated blood flow through normal or abnormal orifices, flow through a narrowed or irregular orifice into a dilated vessel or chamber, or backward flow through an incompetent valve, ventricular septal defect, or patent ductus arteriosus. They traditionally are defined in terms of their timing within the cardiac cycle (Fig. 51e-1). *Systolic murmurs* begin with or after the first heart sound ( $S_1$ ) and terminate at or before the component ( $A_2$  or  $P_2$ ) of the second heart sound ( $S_2$ ) that corresponds to their site of origin (left or right, respectively). *Diastolic murmurs* begin with or after the associated component of  $S_2$  and end at or before the subsequent  $S_1$ . *Continuous murmurs* are not confined to either phase of the cardiac cycle but instead begin in early systole and proceed through  $S_2$  into all or part of diastole. The accurate timing of heart murmurs is the first step in their identification. The distinction between  $S_1$  and  $S_2$  and, therefore, systole and diastole is usually a straightforward process but can be difficult in the setting of a tachyarrhythmia, in which case the heart sounds can be distinguished by simultaneous palpation of the carotid upstroke, which should closely follow  $S_1$ .

**Duration and Character** The duration of a heart murmur depends on the length of time over which a pressure difference exists between two cardiac chambers, the left ventricle and the aorta, the right ventricle and the pulmonary artery, or the great vessels. The magnitude and variability of this pressure difference, coupled with the geometry and compliance of the involved chambers or vessels, dictate the velocity of flow; the degree of turbulence; and the resulting frequency, configuration, and intensity of the murmur. The diastolic murmur of chronic aortic regurgitation (AR) is a blowing, high-frequency event, whereas the murmur of mitral stenosis (MS), indicative of the left atrial–left ventricular diastolic pressure gradient, is a low-frequency event, heard as a rumbling sound with the bell of the stethoscope. The frequency components of a heart murmur may vary at different sites of auscultation. The coarse systolic murmur of aortic stenosis (AS) may sound higher pitched and more acoustically pure at the apex, a phenomenon eponymously referred to as the *Gallavardin effect*. Some murmurs may have a distinct or unusual quality, such as the “honking” sound appreciated in some patients with mitral regurgitation (MR) due to mitral valve prolapse (MVP).

The configuration of a heart murmur may be described as crescendo, decrescendo, crescendo-decrescendo, or plateau. The decrescendo configuration of the murmur of chronic AR (Fig. 51e-1E) can be understood in terms of the progressive decline in the diastolic pressure gradient between the aorta and the left ventricle. The crescendo-decrescendo configuration of the murmur of AS reflects the changes in the systolic pressure gradient between the left ventricle and the aorta as ejection occurs, whereas the plateau configuration of the murmur of chronic MR (Fig. 51e-1B) is consistent with the large and nearly constant pressure difference between the left ventricle and the left atrium.

**Intensity** The intensity of a heart murmur is graded on a scale of 1–6 (or I–VI). A grade 1 murmur is very soft and is heard only with great



**FIGURE 51e-1** Diagram depicting principal heart murmurs. **A.** Presystolic murmur of mitral or tricuspid stenosis. **B.** Holosystolic (pansystolic) murmur of mitral or tricuspid regurgitation or of ventricular septal defect. **C.** Aortic ejection murmur beginning with an ejection click and fading before the second heart sound. **D.** Systolic murmur in pulmonic stenosis spilling through the aortic second sound, pulmonic valve closure being delayed. **E.** Aortic or pulmonary diastolic murmur. **F.** Long diastolic murmur of mitral stenosis after the opening snap (OS). **G.** Short mid-diastolic inflow murmur after a third heart sound. **H.** Continuous murmur of patent ductus arteriosus. (Adapted from P Wood: *Diseases of the Heart and Circulation*, London, Eyre & Spottiswood, 1968. Permission granted courtesy of Antony and Julie Wood.)

effort. A grade 2 murmur is easily heard but not particularly loud. A grade 3 murmur is loud but is not accompanied by a palpable thrill over the site of maximal intensity. A grade 4 murmur is very loud and is accompanied by a thrill. A grade 5 murmur is loud enough to be heard with only the edge of the stethoscope touching the chest, whereas a grade 6 murmur is loud enough to be heard with the stethoscope slightly off the chest. Murmurs of grade 3 or greater intensity usually signify important structural heart disease and indicate high blood flow velocity at the site of murmur production. Small ventricular septal defects (VSDs), for example, are accompanied by loud, usually grade 4 or greater, systolic murmurs as blood is ejected at high velocity from the left ventricle to the right ventricle. Low-velocity events, such as left-to-right shunting across an atrial septal defect (ASD), are usually silent. The intensity of a heart murmur may be diminished by any process that increases the distance between the intracardiac source and the stethoscope on the chest wall, such as obesity, obstructive lung disease, and a large pericardial effusion. The intensity of a murmur also may be misleadingly soft when cardiac output is reduced significantly or when the pressure gradient between the involved cardiac structures is low.

**Location and Radiation** Recognition of the location and radiation of the murmur helps facilitate its accurate identification (Fig. 51e-2). Adventitious sounds, such as a systolic click or diastolic snap, or abnormalities of  $S_1$  or  $S_2$  may provide additional clues. Careful attention to the characteristics of the murmur and other heart sounds