B. How to Assess Aortic Stenosis (Tables 1 and 2)

B.1. Recommendations for Standard Clinical Practice (Level 1 Recommendation 5 appropriate in all patients with AS) The primary haemodynamic parameters recommended for clinical evaluation of AS severity are:

- AS jet velocity
- Mean transaortic gradient
- Valve area by continuity equation.

B.1.1. Jet velocity. The antegrade systolic velocity across the narrowed aortic valve, or aortic jet velocity, is measured using continuous-wave (CW) Doppler (CWD) ultrasound.[8–10] Accurate data recording mandates multiple acoustic windows in order to determine the highest velocity (apical and suprasternal or right parasternal most frequently yield the highest velocity; rarely subcostal or supraclavicular windows may be required). Careful patient positioning and adjustment of transducer position and angle are crucial as velocity measurement assumes a parallel intercept angle between the ultrasound beam and direction of blood flow, whereas the 3D direction of the aortic jet is unpredictable and usually cannot be visualized. AS jet velocity is defined as the highest velocity signal obtained from any window after a careful examination; lower values from other views are not reported. The acoustic window that provides the highest aortic jet velocity is noted in the report and usually remains constant on sequential studies in an individual patient.

Occasionally, colour Doppler is helpful to avoid recording the CWD signal of an eccentric mitral regurgitation (MR) jet, but is usually not helpful for AS jet direction. Any deviation from a parallel intercept angle results in velocity underestimation; however, the degree of underestimation is 5% or less if the intercept angle is within 15° of parallel. 'Angle correction' should not be used because it is likely to introduce more error given the unpredictable jet direction. A

Table 3 Recommendations for classification of AS severity

	Aortic sclerosis	Mild	Moderate	Severe
Aortic jet velocity (m/s)	≤2.5 m/s	2.6–2.9	3.0–4.0	>4.0
Mean gradient (mmHg)	–	<20 (<30[a])	20–40[b] (30–50[a])	>40[b] (>50[a])
AVA (cm^2)	–	>1.5	1.0–1.5	<1.0
Indexed AVA (cm^2/m^2)		>0.85	0.60–0.85	<0.6
Velocity ratio		>0.50	0.25–0.50	<0.25

[a]ESC Guidelines.
[b]AHA/ACC Guidelines.

dedicated small dual-crystal CW transducer is recommended both due to a higher signal-to-noise ratio and to allow optimal transducer positioning and angulation, particularly when suprasternal and right parasternal windows are used. However, when stenosis is only mild (velocity <3 m/s) and leaflet opening is well seen, a combined imaging-Doppler transducer may be adequate.

The spectral Doppler signal is recorded with the velocity scale adjusted so the signal fills, but fits, on the vertical axis, and with a time scale on the x-axis of 100 mm/s. Wall (or high pass) filters are set at a high level and gain is decreased to optimize identification of the velocity curve. Grey scale is used because this scale maps signal strength using a decibel scale that allows visual separation of noise and transit time effect from the velocity signal. In addition, all the validation and interobserver variability studies were done using this mode. Colour scales have variable approaches to matching signal strength to colour hue or intensity and are not recommended unless a decibel scale can be verified.

A smooth velocity curve with a dense outer edge and clear maximum velocity should be recorded. The maximum velocity is measured at the outer edge of the dark signal; fine linear signals at the peak of the curve are due to the transit time effect and should not be

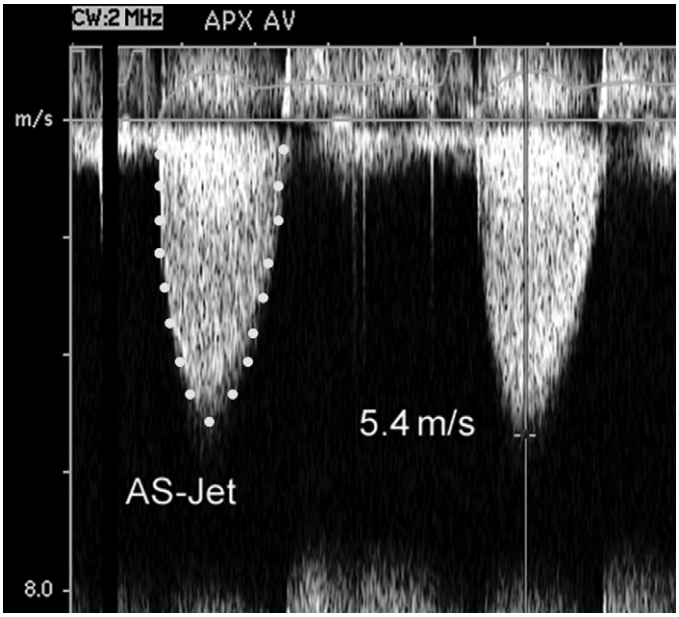

Figure 2 Continuous-wave Doppler of severe aortic stenosis jet showing measurement of maximum velocity and tracing of the velocity curve to calculate mean pressure gradient.

included in measurements. Some colour scales 'blur' the peak velocities, sometimes resulting in overestimation of stenosis severity. The outer edge of the dark 'envelope' of the velocity curve (Figure 2) is traced to provide both the velocity–time integral (VTI) for the continuity equation and the mean gradient (see below).

Usually, three or more beats are averaged in sinus rhythm, averaging of more beats is mandatory with irregular rhythms (at least 5 consecutive beats). Special care must be taken to select representative sequences of beats and to avoid post-extrasystolic beats.

The shape of the CW Doppler velocity curve is helpful in distinguishing the level and severity of obstruction. Although the time course of the velocity curve is similar for fixed obstruction at any level (valvular, subvalvular, or supravalvular), the maximum velocity occurs later in systole and the curve is more rounded in shape with more severe obstruction. With mild obstruction, the peak is in early systole with a triangular shape of the velocity curve, compared with the rounded curve with the peak moving towards midsystole in severe stenosis, reflecting a high gradient throughout systole. The shape of the CWD velocity curve also can be helpful in determining whether the obstruction is fixed or dynamic. Dynamic subaortic obstruction shows a characteristic late-peaking velocity curve, often with a concave upward curve in early systole (Figure 3).