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Signal-Averaged P Wave Duration and Atrial Fibrillation

Guidera and Steinberg (1) purport to show that duration of the P wave determined by time domain signal averaging is predictive of the development of paroxysmal or sustained atrial fibrillation. On the basis of a calculated positive predictive value of 92%, the authors imply that this test will be of value to identify patients at risk of future development of atrial fibrillation. They further state that "because the development of atrial fibrillation is associated with a significantly increased risk of morbidity and mortality, a means of identifying these patients well before the onset of atrial fibrillation could lead to . . . possibly a more aggressive approach to the treatment of the underlying cardiovascular disorder or a prophylactic intervention for atrial fibrillation." Aside from the absence of data to suggest that prophylactic therapy even for patients at high risk of atrial fibrillation (e.g., those with mitral stenosis) is either effective or valuable, we believe that their basic conclusions are flawed in terms of both design and statistics as detailed here.

The authors state that the single parameter of filtered P wave duration was chosen because of concern that terminal QRS voltages on the signal-averaged electrocardiogram are poorly reproducible. Reference to the article (2) quoted to support this indicates that, in that study, the QRS duration did show variability on consecutive tracings, particularly with regard to automatic detection of onset and offset. Certainly a study of P wave duration requires validation of the reproducibility and calculation of confidence intervals of measured values. Unfortunately, Guidera and Steinberg present no data to document reproducibility of P wave signal-averaged duration despite the fact that even a small variability would influence their conclusions, as described below.

The specificity of a test depends upon accurate definition of controls, yet the authors' definition of disease-matched controls is unclear. Eight are said to have had hypertensive heart disease, but no echocardiographic data are presented. Hypertension is a well known risk factor for atrial fibrillation, presumably because of impaired ventricular compliance in the hypertensive ventricle. As such, true disease-matching would need documentation of similar degrees of left ventricular hypertrophy in control patients and patients with fibrillation. Because it is unlikely that a diagnosis of hypertensive heart disease would be made in the absence of an echocardiogram it is puzzling why such data are omitted.

One third of the 15 patients reported on had had chronic atrial fibrillation requiring electrical cardioversion. Although it might be postulated that these patients were more likely to have pronounced abnormalities of the atrium, the authors justify their inclusion by citing a study by Cosio et al. (3), which they state demonstrated that patients with paroxysmal and sustained atrial fibrillation "share similar electrophysiologic abnormalities as determined by direct cardiac recordings." Again, their conclusion is faulty, as examination of this paper indicates that Cosio et al. studied 14 patients, only 1 of whom had had chronic atrial fibrillation—hardly a basis for such a statement.

Even if the preceding criticisms could be satisfactorily addressed, we believe the conclusion of Guidera and Steinberg to be seriously flawed, suggesting, as it does, that P wave signal averaging may be a useful screening test. The authors have incorrectly applied the concept of positive predictive value to their findings, resulting in an apparently impressive result. The predictive value of a test is critically dependent on the prevalence of the disease being studied in the general population and should not be calculated from an arbitrarily chosen number of control patients. The authors base their calculations on a 50% disease prevalence (15 patients and 15 control subjects) whereas a more reasonable prevalence, based on epidemiologic data, would be 1% to 2% for paroxysmal atrial fibrillation. Assuming a prevalence of 2% then, on the basis of data in their Figure 4, screening 1,000 patients would identify 16 of 20 at risk of paroxysmal atrial fibrillation (80% sensitivity) while finding 69 false positive results (93% specificity) with a positive predictive value of 18.9%. Assuming a very small variability in P wave measurement, a 3.2% decrease in the lower cutoff rate from 155 ms to 150 ms would decrease specificity to 75%, increase sensitivity to 85% and result in a predictive value of 6.5%—certainly not a useful screening test.

As we have previously noted (4), Guidera and Steinberg are not the first investigators to fall into this trap when seeking a screening test for paroxysmal atrial fibrillation that utilizes signal-averaging. It is unfortunate that such errors find their way into peer-reviewed journals, as reliance on the published (but incorrect) predictive value of such studies may increase testing costs and subject patients with positive tests to unnecessary, or even potentially harmful, further investigation or therapy.

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