ANKLE/ARM BLOOD PRESSURE INDEX: AN INSURANCE PERSPECTIVE

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Abstract

Recent studies conclude that the ankle/arm blood pressure index (AAI) is a useful clinical tool for refining cardiovascular risk classification in the elderly. A reduction in the AAI to 0.9 or less is associated with increased risk for both coronary heart disease and total cardiovascular disease morbidity and mortality, as well as all-cause mortality. This relationship persists after adjusting for traditional risk factors and known cardiovascular disease.

AAI will appear more common in attending physician's statements, prompting a need to educate underwriters about this technology. AAI may be of particular interest to insurers dealing in the elderly market, to those with strong physician examiner systems, and in markets where blood or urine tests are not commonly used in underwriting.

Introduction

Two recent reports\(^1\) and an editorial\(^2\) in the *Journal of the American Medical Association* suggest that a relatively simple office procedure may be a useful clinical tool for refining cardiovascular risk classification in the elderly. This procedure is the ankle/arm blood pressure index (AAI).

AAI is defined as the ratio of the systolic blood pressure in the ankle compared with that in the arm. This is not a new test. Rather, it has been available for many years and has been endorsed for research purposes by the American Heart Association Council on Epidemiology.

In normal arteries, systolic pressure rises as the distance from the heart increases. Diminished ankle pressures relative to brachial artery pressures therefore reflect the overall occlusive process in the main proximal peripheral arteries. Occlusive disease in the iliac artery generally leads to the largest drop in blood pressure, followed by disease in the superficial femoral. Lesions distal to the division of the popliteal artery usually do not diminish ankle systolic pressure.

Measurement of AAI is relatively simple from a technical perspective. It can be performed in a physician's office or screening center using a hand-held Doppler flowmeter (current cost about $50). The ankle systolic blood pressure is determined from the tibial pulse. The arm systolic blood pressures measured with the Doppler flowmeter are typically 2 to 4 mm Hg higher than the pressures measured with a stethoscope, and thus it is important that both the ankle and arm pressures be measured with a Doppler instrument.

Clinic personnel who are already competent in the measurement of blood pressure require only 2 to 3 hours of training and practice to learn this technique and perform it accurately and reliably. The measurements take about 5 minutes to complete. Obesity and edema of the leg may hamper detection of the peripheral pulses.

Vogt, et al.

The study by Vogt, et al. evaluated the relationship of the AAI to short-term (four to five years) mortality in 1,492 women 65 years of age or older. The study was part of the Multicenter Study of Osteoporotic Fractures, a prospective study of risk factors for fractures in elderly women. Excluded from the study were black women (because they are at low risk for osteoporotic fractures), and women who were institutionalized, unable to walk without the help of another person, or who had a bilateral hip replacement. The average age was 71 years (range 65 to 93 years).

The systolic blood pressures in the right and left posterior tibial artery and the right brachial artery were measured twice after the subjects had been resting in the supine position for at least five minutes. The pulses were detected using a hand-held Doppler flowmeter, and blood pressure was measured using a standard mercury manometer.

The resting AAI was determined separately for each leg. For example, the AAI for the right leg was calculated as the average of the two measurements of the right posterior tibial pressure divided by the average of the two brachial pressure measurements. The lower of the right and left AAI values was used as a measure of the presence of disease. Usable data were obtained for 93.5% of women. The AAI could not be calculated in some cases, generally because the women refused to allow duplicate measurements of the tibial systolic pressures either
due to time constraints or to discomfort during the procedure. In about 10% of the unsuccessful cases, the tibial pulses could not be located due to obesity or leg edema.

Eighty-four women died during the follow-up period. In this population of elderly women, the presence of lower-extremity arterial disease, defined as an AAI of 0.9 or less, was strongly and independently associated with increased mortality in the entire group and among those free of cardiovascular disease at baseline. Slightly less than 5% of those with an AAI of greater than 0.9 died during the follow-up period, compared to 22% of those with an index of 0.9 or less. Survival rates were similar in the first year but diverged after two years.

The overall prevalence of an AAI of 0.9 or less was 5%. The majority of women with a low AAI appeared to have mild occlusive disease, as evidenced by the fact that the ankle/arm blood pressure index in 75% of women with a low AAI was between 0.90 and 0.71.

In subjects with an AAI less than or equal to 0.9, the relative risk of death was significantly elevated for all-cause mortality, mortality due to atherosclerotic heart disease (ASHD), all cardiovascular diseases (CVD) combined, cancer, and other causes (see Table). Exclusive of all women who reported a history of cardiovascular disease at baseline did not affect the overall pattern of mortality. Other independent predictors of mortality were age, and being a current or former smoker. Mortality was not related to total serum cholesterol level, systolic or diastolic blood pressure. A low AAI remained an important predictor of death after correcting for other risk factors.

Symptoms of claudication were reported by 7.4% of women in this population. The mortality rate among those with claudication was approximately half that of women who reported no such symptoms. The authors suggested that this discrepancy was probably due to the low sensitivity and specificity of leg pain as an indicator of peripheral artery disease. Based on data provided in this article, AAI was clearly more accurate than a history of peripheral artery disease. Based on data provided in this article, AAI was more accurate than a history of peripheral artery disease.*

Newman, et al.

The study by Newman, et al. was designed to measure the relationship of a low AAI to cardiovascular disease morbidity and mortality in older adults with systolic hypertension. During a one-year period (1989 to 1990), the AAI was measured in 1,537 older men and women (mean age: 75 years) who were participating in the Systolic Hypertension in the Elderly Program (SHEP). Follow-up averaged 16 months. The AAI was measured by trained observers using a Doppler stethoscope and a standard blood pressure cuff.

Participants with an AAI of 0.9 or less in either leg were considered to have peripheral artery disease. The prevalence of a low AAI in this population was 25.5%. Those with a low AAI were significantly older and more likely to smoke. Men and women were equally likely to have a low AAI.

The relative risk of death in subjects with an AAI of 0.9 or less was significantly higher than the risk in those with an AAI greater than 0.9. This relationship persisted after adjusting for age, sex, known cardiovascular disease at baseline, systolic and diastolic blood pressure, current smoking, diabetes, body mass index, HDL-cholesterol, and triglyceride level. A low AAI was a much stronger predictor of mortality in the study population than was total serum cholesterol.

Editorial Comment

The editorial was written by Dr. William Applegate, Department of Preventive Medicine, University of Tennessee. He states that the studies by Vogt and Newman provide compelling evidence that a reduction in the AAI of 0.9 or less is associated with increased risk for both CHD and total cardiovascular disease morbidity and mortality as well as all-cause mortality.

Additional studies are cited that confirm the correlation between a low AAI and angiographically documented peripheral artery disease. The degree of correlation varies with disease severity. For example, an earlier report demonstrated that AAI is low in all patients with complete arterial occlusion, but in only 50% of those with mild stenosis. Likewise, previous studies reported similar relative mortality risks in people with peripheral artery disease diagnosed with noninvasive tests. The consistency of the data reported by different investigators "add to the body of evidence that an AAI of 0.9 or less is highly predictive of future CHD and all-cause mortality." Technology assessment is addressed. A recent epidemiological study indicated that the variability of AAI attributable to observers, timing of measurement, and repeated measure is considerably less than that attributable to biologic variability. Nonetheless, AAI as a measure of peripheral artery disease is not a perfect test. In the article by Newman, et al., of those subjects

* The sensitivity, specificity, and positive predictive value of claudication compared to AAI were, respectively, .18 (15/82), .93 (1315/1410), and .14 (15/110).
with an AAI of 0.9 or less in the left leg, 73% were still abnormal after four years, but 27% had become normal.

In conclusion, Dr. Applegate states that a reduced AAI should be seen as a marker (not a diagnostic test) of peripheral artery disease, generalized atherosclerosis, and coronary heart disease. Studies to date warrant use of AAI by primary care physicians to stratify risk in elderly persons who have other cardiovascular risk factors. This recommendation cannot be extended to most middle-aged persons because of the lower baseline prevalence of atherosclerotic disease, except for those at intermediate or high risk based on traditional cardiovascular risk factors. He concludes with the following statement:

"Even though an abnormal AAI is not a classic risk factor, the correlations with future CHD as well as all-cause mortality make an abnormal AAI one of the strongest risk markers available for predicting subsequent cardiovascular events."

Underwriting Perspective

Technical considerations:

- This is not a perfect test. False positives and false negatives will occur.

- AAI is relatively simple to perform using a Doppler flowmeter. Clinical personnel (generally nurses) who are already competent in the measurement of blood pressure require only two to three hours of training and practice to learn this technique and perform it accurately and reliably. The measurements take about five minutes to complete.

Clinical significance:

- Elderly people with an AAI of 0.9 or less are at increased risk for both coronary heart disease and total cardiovascular disease morbidity and mortality, as well as all-cause mortality. This relationship persists after adjusting for traditional risk factors and known cardiovascular disease.

- The predictive value of this test relates to the fact that it is a marker of current rather than future disease.

- The prevalence of a low AAI (0.9 or less) depends on the population screened.

Underwriting implications:

- AAI will be determined more commonly by primary care physicians, principally in elderly patients. Middle-aged persons with multiple cardiovascular risk factors may also be screened.

- These measurements will appear in attending physician's statements, prompting a need to educate underwriters about this technology.

- In some cases, AAI may be superior to traditional risk factors as a predictor of excess morbidity and mortality.

- Determining the use of AAI in risk selection would be relatively straightforward. Underwriters already deal with an analogous situation, namely, peripheral artery disease diagnosed by the attending physician from a history of claudication or a non-invasive test of arterial circulation.

Special uses:

- AAI may prove useful to insurers dealing in the elderly market by providing an assessment of overall cardiovascular risk status. It may also be of interest in large cases where the insurer does not want to order an exercise stress test because of the applicant's advanced age.

- AAI may be particularly useful in markets where insurers maintain strong physician examiner systems. Elderly applicants could be selectively referred to examiners who already have a Doppler flowmeter.

- AAI may also be of interest in markets where risk selection tools such as blood or urine tests are not commonly used.

Cost:

- Cost estimates range from $25 when performed in a primary care physician's office, to $50 or more if done in a specialized vascular laboratory (personal communications).

- Nurse paramedical examiners would be able to perform this test with proper training. Audiovisual training materials are available from Doppler manufacturers.
### Table

**All-Cause and Cause-Specific Mortality per 1,000 Person-Years and Relative Risk of Mortality in Elderly Women**

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Mortality Rate for Cases with AAI &gt;0.9</th>
<th>Mortality Rate for Cases with AAI ≤0.9</th>
<th>Age-Adjusted Relative Risk</th>
<th>Multivariate-Adjusted Relative Risk*</th>
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<tr>
<td>All-Cause</td>
<td>10.9</td>
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<td>3.1</td>
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<td>15.1</td>
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<td>3.7</td>
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<td>CVD</td>
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<td>30.1</td>
<td>6.0</td>
<td>4.0</td>
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<tr>
<td>Cancer</td>
<td>4.8</td>
<td>18.1</td>
<td>4.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Other</td>
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<td>6.0</td>
<td>2.2</td>
<td>1.1</td>
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<th>Mortality Rate for Cases with AAI &gt;0.9</th>
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<td>Other</td>
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<td>4.9</td>
<td>2.2</td>
<td>—</td>
</tr>
</tbody>
</table>


* Adjusted for age, smoking status, waist/hip ratio, body mass index, cholesterol level, systolic blood pressure greater than 140 mm Hg, walking for exercise, history of angina, myocardial infarction, stroke, and rheumatic heart disease and other heart problems.

† Adjusted for age, smoking status, diabetes, waist/hip ratio, body mass index, cholesterol level, systolic blood pressure greater than 140 mm Hg, and walking for exercise.

### References

