A New Approach to Coronary Heart Disease

**Additional Indexing Words:**
- Radioactive tracers
- Preventive medicine
- Acute myocardial infarction
- Angina pectoris
- Potassium-43
- Ejection fraction
- Technetium-99m
- Ventricular volume

**From the Department of Radiological Science, The School of Hygiene and Public Health, The Johns Hopkins Medical Institutions, Baltimore, Maryland.**

Address for reprints: Henry N. Wagner, Jr., M.D., Acting Chairman, Department of Radiological Science, The Johns Hopkins Medical Institutions, School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, Maryland 21205.

GEORGE Bernard Shaw has said, "The reasonable man adapts himself to the world; the unreasonable man persists in trying to adapt the world to himself. Therefore, all progress depends on the unreasonable man." Cardiologists must be "unreasonable men" if they are to find a way to slow the rapidly increasing incidence of coronary heart disease. We must find some approach that takes into consideration Americans' penchant for eating too much, smoking too much, and exercising too little, often in a stressful environment. That we probably cannot change. But if we could identify high risk patients early and persuade them to make major alterations in their life style, we could substantially reduce the likelihood that they will suffer a myocardial infarction.

Diagnostic tests for the detection of coronary heart disease are designed for four distinct groups: 1) the general adult population during periodic health examinations; 2) patients with symptoms suggesting coronary artery disease such as chest pain; 3) patients with objective evidence of coronary artery disease such as abnormal electrocardiograms; and 4) patients being considered for coronary artery surgery. The 6,016 cardiologists in the US who restrict their practice to the care of patients with heart disease are not enough to serve as the major diagnostic link.

Coronary arteriography, essential in selecting patients for coronary artery surgery, cannot be a primary means of identifying persons with occult coronary artery disease. Coronary arteriography is done in a relatively small fraction of persons who suffer a myocardial infarction each year and is most often done after the initial attack. Only a little over a third of this country's hospitals have angiographic laboratories. Furthermore, coronary arteriography is far from an innocuous procedure, having a mortality rate of 0.6% and requiring hospitalization for its performance.

What are needed are safe, simple, broad scale methods that will enable family physicians, internists, and other health professionals who provide most of the primary patient care in the United States to identify the patient with coronary heart disease.

There is an additional important need for simple tests that will permit objective evaluation of drug or surgical therapy of coronary heart disease. These are perhaps the most important of all when we consider that approximately 25,000 saphenous vein bypass procedures were performed in 1971-1972 in the United States, compared to only 9,000 open-heart operations per year for congenital heart disease and 17,000 other open-heart operations for other types of acquired heart disease. Strict efficacy studies are now required by the Food and Drug Administration prior to the approval of widespread use of new drugs. Can we afford to be less stringent in our requirements for documentation of the safety and efficacy of surgical procedures?

We need better noninvasive procedures that can be applied on a wide scale. Radioactive tracer studies are prime candidates, chiefly because such procedures fill the gap between the clinical examination of the patient and more complicated, albeit more definitive procedures such as arteriography and cardiac catheterization.

The use of radioactive tracers to study the circulation is not new. Almost 50 years ago, Herman Blumgart and Soma Weiss in Boston first injected solutions of radium salts into the antecubital vein of a patient and used a cloud chamber to measure the velocity of the circulation between the point of injection and the detector. When we look at tracers such as technetium-99m, albumin, and the modern scintillation camera, we see that enormous technical advances have been made. Many new techniques based on the use of radioactive tracers to study the circulation are still at the stage...
between development and widespread application, but evidence is accumulating that they will eventually achieve a place of considerable importance.

Which techniques are the most promising? One is the delineation of zones of myocardial infarction by means of monovalent cations, such as potassium-43 and cesium-129. Unfortunately, the cost of these tracers is high and their availability is limited. The search continues for a better myocardial scanning agent. The goal of such studies is to be able to delineate and quantify the location, size, and severity of myocardial infarction. Because of its excellent physical characteristics, the nuclide, technetium-99m is a most attractive candidate as a radioactive label, but the ideal chemical form of the radiopharmaceutical remains to be found.

At present, to visualize the normal myocardium and delineate zones of infarction, the patient is injected with an intravenous dose of ionic potassium-43, and shortly thereafter the distribution of the radioactive tracer is delineated with a scintillation camera or rectilinear scanner. Because of the high potassium influx in all muscle, including heart muscle, the tracer is rapidly taken up by normal muscle, leaving areas of ischemia or infarction as “cold” defects in the normal pattern. This technique has been successful in delineating abnormal regions in nearly all patients with acute infarction. In patients with angina pectoris, without infarction, the region of myocardium which is poorly perfused can be delineated by imaging the distribution of tracer during anginal stress. The ischemic zone of the myocardium is then depicted as a “cold” area. If the patient is reevaluated, by scanning after injection of tracer at rest, the scan appears normal. The use of a stress test with myocardial scans may permit us to differentiate infarction from ischemia. At this time, we do not have sufficient data on patients with less severe coronary heart disease.

The value of myocardial scanning with potassium-43 is enhanced by combining it with a second procedure in nuclear medicine, visualization of ventricular volumes and movements during selected parts of the cardiac cycle. In these studies, the patient is injected with a radioactive agent that distributes itself throughout the vascular compartment. The scintillation camera is used to monitor changes in radioactivity content within the various cardiac chambers as the heart beats. Ventricular volumes and ejection fraction can be calculated, either by analysis of biplane contours of the ventricles during systole and diastole or by quantification of the radioactivity within specific chambers identified by electronic or computer-assisted flagging of areas of interest selected by the physician or technologist as he views the display system.

Studies of this diagnostic method have found abnormally low ejection fractions in all patients with acute myocardial infarction. Over 90% had regions of akinesis or hypokinesis of the left ventricle, as determined by comparison of the ventricular contours during systole and diastole. Most had elevated left ventricular end-diastolic volumes. The correlation between the size of the akinetic zones and the size of the decreased potassium-43 uptake was good, a result that encourages more widespread use of the technique.

Of course, all of these findings were in patients with a clearcut myocardial infarction. We must await the results in a large series of patients with less serious disease. It is conceivable that such noninvasive techniques may permit early identification of patients with severe coronary atherosclerosis. In 1971 it was reported that 45% of the combat casualties in Vietnam had some evidence of coronary atherosclerosis at autopsy, and 5% had evidence of severe atherosclerosis. To be able to identify these abnormalities in early development would be a great step toward lowering the death rate from myocardial infarction in this country.

Tracer studies are innocuous, can be performed quickly on out-patients, at a cost of at most one tenth that of cardiac catheterization and coronary angiography, and can safely be repeated over the course of illness, even in the sickest patient. The most immediate use of tracer studies, after validation, should be documentation of the effectiveness of saphenous vein bypass surgery and coronary vasodilator drugs.

Other nuclear procedures of promise include measurement of the distribution of blood flow to regions such as the brain, kidneys, and extremities; arteriovenous shunting; study of the metabolism of the heart in vivo; radioimmunoassay of digoxin and other important cardiac drugs; and measurement of humoral substances such as renin in patients with hypertensive cardiovascular disease. It seems likely that measurement of the spatial and temporal distribution of important cellular elements and chemical substances within the body—the essence of nuclear medicine—will join other noninvasive
modalities such as phonocardiography, electrocardiography, vectorcardiography, and echocardiography in filling the gap between the man in the street with undiagnosed coronary heart disease and the very ill patient admitted to the cardiac catheterization laboratory.

HENRY N. WAGNER, JR.
H. WILLIAM STRAUSS

References
2. Personal communication from M. Robbins, Regional Medical Program, Preliminary tabulation of data from a survey of U.S. Hospitals in September, 1972, by the Joint Commission on Accreditation of Hospitals. Regional Medical Program Service 1972
A New Approach to Coronary Heart Disease
HENRY N. WAGNER, JR. and H. WILLIAM STRAUSS

Circulation. 1973;48:229-231
doi: 10.1161/01.CIR.48.2.229
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1973 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/48/2/229.citation