The Baseline Screening Electrocardiogram: Is It Worthwhile?

An Affirmative View

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To discuss appropriately the question of whether doing a baseline screening electrocardiogram (ECG) is worthwhile in adults requires a definition of some terms. A *baseline* (ECG) is generally considered to be an ECG taken for comparison with a later ECG. A *screening* ECG is one performed on a supposedly well person for the purpose of identifying risk of future cardiac disease or of detecting early, asymptomatic cardiac abnormalities. Screening ECGs are often repeated as a part of periodic general health checkups.[1] Thus a baseline screening ECG is herein considered to be the initial screening ECG.[2] The term *worthwhile* implies consideration both of benefits and costs. From the viewpoint of the patient, the reassurance of a true-negative ECG is generally regarded as an excellent investment, whereas early detection of a true-positive ECG may avert or postpone life-threatening cardiac events. On the other hand, the complexity and the lack of standardization of the ECG interpretation introduces the uncertainty of the benefits and the costs of false-positive and false-negative tests.

The interpretation of the ECG, a complex cardiac electrical signal, requires the analysis of a large number of measurements and patterns subject to a significant variability in interpretation by expert cardiologists of normal ranges and the diagnoses associated with ECG abnormalities.[3] Additionally, ECGs are sometimes insufficiently sensitive for detecting coronary artery disease, and such silent ECGs are considered to be false-negative tests. Furthermore, the sensitivity of the ECG in detecting early cardiac disease is dependent upon the method used, in that a single-lead screening ECG is less sensitive than a 6-lead ECG, which, in turn, is less sensitive than a 12-lead ECG, which, in turn, is less sensitive than a treadmill exercise ECG. The predictive value of an ECG will vary with the diagnosis of left ventricular hypertrophy, coronary artery disease, or an arrythmia.[3] Improved editing methods for computer-assisted ECG review, however, have recently been reported to have fewer than 1 percent total errors, false-positive or false-negative, for arrythmias.[4]

The identification of increased risk may in many cases add significant years to life by decreasing risk factors through improved lifestyle. Whereas ten years ago effective treatment for early ischemic heart disease was not yet available, and so routine screening ECGs were not recommended by some,[5] the early detection of ischemic heart disease may now add significant life–years by averting or postponing disease and death through early treatment, such as coronary angioplasty or bypass surgery. The benefits may be substantial to the patient as well as to the family and the employer for key employees. The cost savings to a health care insurer may be significant if expensive hospital care for late disease can be avoided by detection and treatment of early disease.

COST PER POSITIVE ELECTROCARDIOGRAM

As the ECG is a noninvasive test, without radiation exposure (in contrast to a chest roentgenogram), the costs of an ECG to a patient are limited to money, time, and anxiety. The provision of baseline screening ECGs as a prepaid benefit by health maintenance organizations minimizes the monetary cost to the patient and transfers the expense to the health care program.

The prevalence of clinically important ECG abnormalities is related to the age of the patient. The program costs for baseline screening ECGs can be usefully expressed by studying the cost per positive test. In a large, multiphasic

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TABLE 1. PERCENTAGE OF ABNORMAL SCREENING (6-LEAD) ECGs REPORTED IN 44,663 ADULTS

Age (years)	Percent with Abnormal ECGs*	Cost per Positive ECG** (in dollars)
<40	10.2	245
40–59	17.7	141
60+	31.5	79
All adults	17.3	145

** Clinically important abnormalities included atrial flutter or fibrillation; 1st-, 2nd-, or 3rd-degree atrioventricular block; ST-T variations; left or right intraventricular conduction delay; left or right ventricular hypertrophy; atrial abnormality; short PR interval; Wolff-Parkinson-White syndrome; probably recent or old myocardial infarct; or QT or QTA prolongation. Not included were reports of "borderline" or "nonspecific changes," sinus tachycardia or bradycardia, and supraventricular premature beats.*

*** An estimate of the current program's cost of an ECG, including cardiologist's interpretation, is $25*

Note: This table has been modified from Collen et al[6]

screening program of presumably well patients, it was found that adults younger than 40 years had clinically important ECG abnormalities 10 percent of the time, persons aged 40 to 59 years had almost twice this frequency (about 18 percent), and those aged 60 years and older had ECG abnormalities three times as prevalent (about 31 percent) (Table 1).[6] Accordingly, whatever the cost of screening ECGs to the program, the cost to detect a positive ECG on a patient older than 60 years would be one third that of an adult aged under 40 years. It is obviously more cost effective for a program to do screening ECGs in older adults. For example, if the cost to the program (not the fee charged to the patient) was $25 for an ECG, including cardiologist interpretation, then the cost to the program for every positive ECG found in an adult aged less than 40 years would be $245 (Table 1); however, the cost to the program for adults aged 60 years or older would be only $79 for every positive ECG.

COMMENT

The clinical interpretation of electrical signals from the heart obtained by an ECG is in some ways similar to the interpretation of auditory signals a physician obtains by auscultation with a stethoscope during the routine physical examination of the heart. As most cardiac examination findings have great interobserver variability and are prone to provide false-positive and false-negative signs, should the physician conclude that routine physical examination of the heart is not worthwhile?

Physical examination of the heart by the physician cannot replace the diagnostic sensitivity of the ECG for many cardiac abnormalities. The usual expectations of older adults who come for a health checkup generally include blood tests, urinalysis, and a screening ECG. If health checkups are not covered by insurance, the physician often includes some "routine" tests as "case finding" for the patients with medical complaints.[1] If a cost-effective justification for ECG analysis of the heart should be required, should cost-effectiveness justification of ausculatory analysis of the heart be then required, as the cost per positive auscultation (including the physician's time) is probably comparable to the cost per positive ECG?

It is recommended that all adults receive an initial baseline screening ECG during a general health checkup. Although the optimal interval for periodic screening ECGs has not been scientifically established, it is recommended that ECGs should be a routine part of the periodic health checkup every 4 to 5 years for adults aged under 40 years, every 2 to 3 years for those aged 40 to 59 years, and every 1 to 2 years for adults aged 60 years and over.

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An Opposing View

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Sackett[1] has identified five motivations for carrying out screening maneuvers:

1. Prevention of disability and untimely death by identifying an unknown disease process for which a favorable treatment can be instituted
2. Acquisition of clinical baseline information for later use when the patient might become ill
3. Protection of an economic wager (ie, a life insurance examination conducted because the company wishes to ensure that it wins more bets than it loses)
4. As an alternative to interview and examination by a clinician in separating the sick from the well
5. Protection of other citizens (ie, detection of an infectious disease in child care personnel).

The use of the electrocardiogram (ECG) as a screening maneuver involves the first two, of which the first is the most important. A simple, nontraumatic, relatively inexpensive test that can be applied to apparently healthy, asymptomatic individuals during the course of a routine periodic health examination and that, if positive, leads to early, effective treatment of the detected disease process makes both logical and financial sense. At first glance, the ECG might seem to fill the bill. Closer examination leads to another conclusion.

There is no question that the ECG is one of the more useful tests for evaluation of the patient with cardiovascular disease or with complaints, such as chest pain, that may indicate such disease. The screening application to which this discussion is directed is that in which the test is given routinely to all individuals at a certain time, such as 40 years of age, even though those individuals are asymptomatic and free from identifiable risk factors.

The following questions must be addressed in deciding to use a screening test: What disease can be detected, and can it be helped, if detected? In the case of the ECG, coronary artery disease, rhythm abnormalities, and conduction abnormalities are the conditions that might be detected. With rare exceptions these conditions would be treated only if they were causing significant symptoms.

Consider the consequences for the patient who is found to have an abnormality. Previously "normal," he or she is now labeled as "abnormal." This abnormal ECG finding thus creates an adverse psychological state, perhaps without benefit. In the case of a conduction defect, such as Wolff-Parkinson-White syndrome, nothing should be done unless paroxysmal tachycardia intervenes. In the case of abnormal rhythms, significant disorders can be detected by other means, such as the clinical examination, and would not be treated in the absence of symptoms.

Coronary artery disease is certainly an important condition, causing a significant burden of death and early disability. Would it not be useful to detect this early, before symptoms develop?

The ECG, like all other tests, is not perfect. There are always false-negative and false-positive results. Everyone is aware of the occasional patient who dies suddenly of a massive heart attack shortly after a normal ECG. Of more concern in the screening application, in which the test is applied to normal subjects, is the problem of false-positive results.

Ober[2] has recently underscored this problem by pointing out that the application of a test to a population in which there is a small likelihood of the presence of the disease produces large numbers of false-positive results. Each of these must be investigated by expensive and potentially harmful tests such as coronary angiograms. The application of a safe and inexpensive test such as the ECG can therefore lead to a cascade effect,[3] in which costly and risky interventions become unavoidable for a subset of normal individuals.

Even if detected and confirmed, will coronary artery disease diagnosed earlier produce a beneficial effect for the patient? Most would agree that balloon dilatation of coronary vessels and bypass procedures should be reserved for those with significant symptoms. What about lifestyle modifications? Would the knowledge of the disease lead to a greater level of compliance with advice about smoking, dietary changes, weight loss, and exercise? Unfortunately, experience teaches us otherwise. Counseling maneuvers have been generally ineffective in causing changes in patient behavior. In addition, the behaviors that should be encouraged are those that should be urged on all patients regardless of whether they have coronary artery disease. Trading fear and psychologic stress for compliance seems to be an illogical and cruel strategy.

There are no published systematic studies of the cost and benefit from routine screening of a normal population with ECGs. There are a few tangential studies that should

be examined. Moorman and colleagues[4] evaluated the usefulness of the admission ECG in 1,410 patients admitted to a general medical service in a teaching hospital. Six hundred thirty-five of these patients had cardiac disease as indicated by history or physical examination. Seven hundred seventy-five patients had no evidence of cardiac disease. Among the latter group, the screening admission electrocardiogram added information in eight cases (1 percent). Three ECGs established a diagnosis, two of which affected management. Five ECGs suggested a diagnosis, three of which proved correct and important. Only two patients appeared to have received benefit from the screening ECG. An attempt was made to calculate the cost per year of life saved. This calculation yielded an estimate of $24,000 per year of life saved, based largely on one case.

The relevance of this information to a discussion of the usefulness of a screening ECG in an ambulatory setting is that the yield in this highly selected, older (mean 55 years), sick population was only 1 percent, with only 0.25 percent receiving a benefit from the information. The yield in a younger, ambulatory, healthy population would be expected to be far less.

Rubenstein and Greenfield[5] examined the usefulness of a baseline ECG in evaluation of chest pain at a later point in time. This study is thus directly applicable to the second motivation for using ECG screening as cited above. Of the 236 patients, 195 had clinical or acute ECG changes sufficiently diagnostic that the baseline ECG could not have affected the decision to hospitalize or discharge. In 11 patients with equivocal clinical and ECG findings, a baseline ECG might have been useful in avoiding an unnecessary hospitalization. In no patient would the baseline ECG have avoided an inappropriate discharge. The authors concluded that the routine ECG has little value as a baseline for future comparison when patients develop acute cardiac symptoms.

In summary, based on currently available evidence, there seems to be no reason to abandon two apocryphal clinical rules that have stood the test of time:

1. Never rush to make a clinical diagnosis for which you can do nothing.
2. In ordering a test, think of what you would do if it were positive, and what you would do if it were negative. If these are the same, do not order it!

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