Comparisons of Referral Criteria for Public Screening of Blood Cholesterol Levels

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This research was supported by the National Heart, Lung, and Blood Institute, National Institutes of Health, under grant HL 37892. The research was presented to the American Federation for Clinical Research, Washington DC, May 1988.

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Synopsis

Total and high-density lipoprotein (HDL) cholesterol levels of 2,387 adults were screened at a worksite and a bloodbank. Hypothetical referral decisions were made according to three sets of guidelines: the 1984 National Institutes of Health Consensus Conference guidelines (NIHCC), a single referral cutpoint of 5.2 millimoles per liter (mmol per L), and the current National Cholesterol Education Program (NCEP) guidelines for screening in physicians' office.

Under the NIHCC guidelines, 31 percent of the participants would have been referred to their physicians, 32 percent under the NCEP guidelines, and 56 percent would have been referred had the 5.2 mmol per L cutpoint been used. Twenty-four percent of the participants would have been referred under both the NIHCC and NCEP guidelines; 7 percent would have been referred under the NIHCC guidelines, but not the NCEP's.

Eight percent would have been referred under the NCEP guidelines, but not the NIHCC's. Those who would have been referred were older, and more likely to be male and to have low levels of HDL cholesterol than the 7 percent who would have been referred under NIHCC guidelines only. All of the 8 percent had coronary heart disease, or two or more other coronary risk factors, whereas none of the 7 percent did.

If low HDL had been used as a risk factor under NCEP guidelines, the number of persons referred would have increased slightly (to 34 percent) and low HDL levels would have become one of the most prevalent risk factors. The researchers concluded that public cholesterol screening programs should use the NCEP guidelines (with or without HDL), rather than the NIHCC guidelines, or a single 5.2 mmol per L cutpoint.

NEW GUIDELINES for physicians for cholesterol screening, diagnosis, and treatment were released by the National Cholesterol Education Program (NCEP) in October 1987 and published in January 1988 (*1*). The guidelines replaced those of the National Institutes of Health Consensus Conference on Lowering Blood Cholesterol to Prevent Heart Disease (NIHCC), which were published in 1985 (*2*).

Both sets of guidelines recommend that adults be screened for high cholesterol levels in physicians' offices during the course of routine care. Neither set specifically details referral guidelines for public screening at sites other than physicians' offices, although supplemental materials mailed to physicians by the NCEP in February 1988 suggested that "In public screening programs, all patients with a cholesterol level above 200 mg per dl should be referred to their physician for remeasurement and evaluation" (*3*).

Recently, participants in a workshop on public cholesterol screening convened by the National Heart, Lung, and Blood Institute (NHLBI) recommended that public programs use the NCEP screening guidelines intended for use in physicians' offices rather than the single 5.2 millimole per liter (mmol per L), or 200 milligrams per deciliter (200 mg per dl), cutpoint (*4*). The results of using the NIHCC guidelines to determine referrals in public cholesterol screening programs have been documented (*5,6*). The results of using the more recent referral recommendations in public screenings are not known.

The NCEP guidelines for cholesterol screening

differ from those of the NIHCC in two fundamental changes. First, the NCEP guidelines establish two absolute and age-independent levels of cholesterol, 5.2 mmol per L (200 mg per dl) and 6.2 mmol per L (240 mg per dl) as decision points for labeling a patient's cholesterol level as desirable, borderline high, or high, and to indicate who should receive further diagnostic testing (*1*). The NIHCC guidelines have three age-specific levels, 5.2 mmol per L for those 20 to 29 years old, 5.7 mmol per L for those 30 to 39 years old, and 6.2 mmol per L for those 40 years and older (*2*). Because of this change, fewer young persons will be labeled as having high cholesterol levels and fewer will be referred. More older people will be labeled as having borderline high levels and may be referred.

The second fundamental change is that the NCEP guidelines recommend that cardiovascular risk factor information other than cholesterol levels be used in deciding whether further testing or treatment is needed for patients with borderline high total cholesterol levels. Persons with borderline high values should receive further testing and treatment if they have coronary heart disease or if they have two or more other risk factors (one of which is being male). Further diagnostic tests and physician-directed therapy are not recommended for those with borderline-high values who do not have coronary disease and who have fewer than two other risk factors. How this second change in screening strategy would affect public screenings is unclear.

Neither set of guidelines recommends using high-density lipoprotein cholesterol (HDL) levels for screening. Yet, the role of HDL has received increased attention recently, although the utility of using HDL levels in public screening is unknown.

The principal purpose of this study was to determine what referral decisions would be made if the NCEP guidelines were used in blood cholesterol public screening programs and to compare the guidelines to the referral decisions that would have been made had the NIHCC guidelines, or the 5.2 mmol per L referral cutpoint, been used. The second purpose was to assess how screening for HDL, in addition to total cholesterol, would affect referral decisions according to NCEP guidelines.

Patients and Methods

We screened 2,387 adult volunteers for total cholesterol and HDL cholesterol, 1,627 at an industrial worksite and 760 at a blood bank. Most subjects were not fasting when screened. The total group included 1,719 men (72 percent) and 668 women (28 percent). The average ages were 42.7 years for men and 38.8 years for women. The overall average age was 41.6 years, ranging from 18 through 70. Ninety-four percent of the subjects were white, 4 percent were black, and 2 percent were other races. All subjects provided informed consent to participate in the study and the protocol was approved by the University of Cincinnati Institutional Review Board.

Blood was collected in anticoagulated tubes (ethylene diaminotetra acetate, 1 milligram per milliliter) from subjects in the sitting position from venipuncture of the antecubital vein. Samples were centrifuged immediately for 10 minutes and the plasma was separated from the red cells. Plasma samples were refrigerated at 4 degrees C for transportation and analyzed for total and HDL cholesterol later in the day or the next morning.

Plasma total cholesterol and HDL cholesterol were measured with a Hitachi 705 Analyser (*A*) with enzymatic procedures standardized by the Centers for Disease Control (CDC) Lipid Standardization Laboratory, according to the Lipid Research Clinics (LRC) methods manual (*7*). High density lipoprotein was isolated using the heparin-manganese chloride procedure to precipitate very low density lipoprotein and low density lipoprotein (*8*). Our laboratory maintains phase III standardization as defined by the CDC. Because samples were obtained from nonfasting subjects, it was inappropriate to calculate LDL cholesterol values. More direct measurement of LDL cholesterol using preparative ultracentrifugation was not undertaken.

All subjects completed a written questionnaire at the time of screening. In addition to demographic information, the questionnaire requested information on other cardiovascular risk factors. Specifically, subjects were asked if they had hypertension, diabetes, a personal history of chest pain or heart attack, a family history of a parent or sibling who died of heart disease before age 55, and whether they smoked cigarettes (more than two a day). Because the questionnaire was designed before the release of the NCEP guidelines, three of the items differed slightly from those characteristics considered risk factors by the NCEP (*1*). Smoking was defined as more than two cigarettes per day (the NCEP uses more than 10 per day), no question on weight was included, and only premature coronary deaths were included in the family history (the NCEP uses coronary death or definite myocardial infarction).

All data were computerized and analyzed in two ways. First, subjects were classified according to the NIHCC guidelines (*2*). Hypothetical decisions to refer were made if the total cholesterol value was greater than or equal to the 75th percentile for the age group (5.2 mmol per L for persons 18 to 29 years of age, 5.7 mmol per L for persons 30 to 39 years of age, and 6.2 mmol per L for persons 40 years of age or older).

Second, subjects were classified according to the NCEP guidelines, ignoring the HDL cholesterol level, and hypothetical decisions to refer were made as follows. If the total cholesterol level was less than 5.2 mmol per L (200 mg per dl), the level was labeled desirable and the subject was not referred. If the total cholesterol level was greater than or equal to 6.2 mmol per L (240 mg per dl), it was labeled high and the subject was referred. If the total cholesterol level was between 5.2 mmol per L and 6.2 mmol per L inclusive, the level was labeled borderline-high and risk factor information was evaluated before making a referral decision. Any borderline-high subject who reported a personal history of coronary heart disease was referred. If a borderline-high subject was male and gave a history of smoking, hypertension, diabetes, or a family history of premature coronary heart disease as described, he was referred to a physician for further care. If a borderline-high subject was female and had any two of the other risk factors, she was referred. Borderline-high subjects not meeting these criteria were not referred.

HDL cholesterol levels were not considered in the first analysis of risk factors for this purpose because most mass screening programs do not screen for HDL cholesterol levels. A second analysis, which included low HDL levels as an NCEP risk factor (less than 0.9 mmol per L [35 mg per dl] is considered low by these criteria), was performed to determine what impact would result from considering HDL levels in the decision to refer.

The NCEP guidelines are based on serum values for cholesterol which average 3 percent higher than plasma values (*9*). The NCEP suggests that plasma results be converted to equivalent serum values by multiplying by 1.03 (*1*). We converted our plasma results to serum equivalent values in this way for the purposes of this report. The NIHCC guidelines do not specify which values are to be used, although these guidelines were derived from the LRC prevalence study, which utilized plasma values. We used our serum-equivalent values in applying the NIHCC guidelines because we were interested in evaluating the impact on referrals of the important changes contained in the NCEP recommendations. The changes were the use of age-independent and absolute cutpoints, and the consideration of other risk factors in addition to cholesterol levels in making treatment decisions. Using plasma values in applying the NIHCC guidelines, while using serum values in applying the NCEP guidelines, would have illustrated the impact of a 3 percent bias in values, while masking the impact of these more essential differences.

'. . . use of the NCEP guidelines for mass cholesterol screening (excluding HDL) produces referrals with greater cardiac risk, without significantly increasing their total numbers.'

Once referral decisions had been made using both sets of guidelines, those decisions were compared. The demographic and risk factor characteristics of persons referred by one set of guidelines, but not the other, were evaluated specifically. The two groups in which discordant decisions occurred were compared statistically using a two-sample *t*-test for age and two-by-two chi-square analysis with Yates correction for sex, risk factor status, proportion of subjects with high-risk HDL levels, proportion of subjects previously unaware of their high cholesterol levels, and proportion of subjects erroneously referred because of high HDL levels. A high HDL referral error was defined as referral of a participant with a non-HDL cholesterol (total cholesterol minus HDL cholesterol) of less than 3.75 mmol per L (145 mg per dl). Since high HDL referral errors are more likely in women because of their typically higher HDL levels (*10*), and since the median very low density lipoprotein (VLDL) cholesterol for the adult female population is approximately 0.4 mmol per L (*10*), a non-HDL cholesterol level of less than 3.75 mmol per L almost always implies a LDL cholesterol level less than 3.35 mmol per L (130 mg per dl), which is considered desirable and not in need of specific therapy under the current NCEP standards.

Results

Results of cholesterol screening of the 2,387 subjects are shown in tables 1 and 2. Use of the NIHCC guidelines would have resulted in referral

Table 1. Results of screening using National Institutes of Health Consensus Conference guidelines

Label	Criteria: Age in years, mmol per L	Number	Percent
High risk[1]	40 and older, > 6.7	211	8.8
	30–39, > 6.2	123	5.2
	18–29, > 5.7	66	2.8
Moderate risk[1] .	40 and older, 6.2–6.7	174	7.3
	30–39, 5.7–6.2	94	3.9
	18–29, 5.2–5.7	67	2.8
Usual risk	40 and older, < 6.2	885	37.1
	30–39, < 5.7	474	19.8
	18–29, < 5.2	293	12.3
Total		2,387	100

[1] Referred for further diagnosis and treatment.

Table 2. Results of screening using National Cholesterol Education Program guidelines

Label	Criteria	Number	Percent
High[1]	> 6.2 mmol per L	534	22.4
Borderline high with NCEP risk factors[1]	5.2–6.2 mmol per L with coronary heart disease or 2 or more risk factors	230	9.6
Borderline high without NCEP risk factors	5.2–6.2 mmol per L No coronary disease and less than 2 risk factors	586	24.5
Desirable	< 5.2 mmol per L	1,037	43.5
Total		2,387	100.0

[1] Referred for further diagnosis and treatment.

of 735 persons (31 percent). Use of the NCEP guidelines and risk factor information, excluding HDL, would have resulted in referral of 764 subjects (32 percent). However, only 578 people (24 percent) would have been referred by both the NIHCC and NCEP guidelines. A total of 157 people (7 percent) would have been referred by NIHCC guidelines, but not by NCEP guidelines, while the opposite was true for 186 persons (8 percent).

The characteristics of the two subpopulations of subjects with discordant referral decisions differed significantly, as shown in table 3. The 186 persons referred by NCEP guidelines, but not by NIHCC guidelines, were older, more likely to be male, and more likely to have low HDL cholesterol levels. As could be predicted by comparing the guidelines, all 186 of the subjects had total cholesterol levels between 5.2 and 6.2 mmol per L and either coronary heart disease, or at least two other risk factors (not counting low HDL). All 157 persons referred only by NIHCC guidelines had total cholesterol values between 5.2 and 6.2 mmol per L, but none of them had coronary heart disease or two or more other risk factors. Those referred by NCEP guidelines were more likely to have been screened previously, although they were no more likely to have known already that they had high cholesterol levels.

As noted in table 2, 230 of the 764 persons referred by the NCEP guidelines had borderline-high total cholesterol levels (5.2 mmol per L to 6.2 mmol per L), and either a personal history of coronary heart disease (40 persons, or 17 percent), or two or more NCEP risk factors (190 persons, or 83 percent). Most (161 persons, or 85 percent) of the 190 persons with borderline total cholesterol levels who were referred because of other risk factors had exactly two such risk factors. Only 26 persons (11 percent) had three risk factors and only 3 persons (2 percent) had four. The cardiac risk factors prevalent in the 190 persons referred because of other risk factors are shown in table 4. Male sex was the predominant risk factor, but smoking, hypertension, and family history were common.

The hypothetical decisions to refer according to the NCEP guidelines were made without using HDL information, since most public screening programs do not measure HDL levels. Had HDL cholesterol levels less than 0.9 mmol per L been included as an NCEP risk factor, an additional 48 men and 4 women would have been referred for further care by the NCEP guidelines, for a total of 816 referrals (34 percent of the screened population). Table 4 lists the risk factors responsible for referral when low HDL is included as a risk factor. In this situation, low HDL becomes the second most prevalent risk factor, other than maleness.

A difficult policy decision regarding referral criteria would have been necessary had these other coronary risk factors not been taken into account in using the NCEP guidelines. As noted, if all subjects with total cholesterol values above 5.2 mmol per L had been referred, as suggested previously by the NCEP (*3*), 1,350 persons (56 percent of the screened population) would have been referred. Alternatively, if a more strict cutpoint of 6.2 mmol per L had been used, 534 persons (22 percent) would have been referred; 186 persons with borderline levels and other risk factors who merited further investigation and treatment would

Table 3. Comparison of subgroups with discordant referral decisions

Characteristic	Referred by NIHCCR but not NCEP		Referred by NCEP but not NIHCC		Referred by NIHCC and NCEP		Total screened population	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Mean age in years	[1]30	...	[1]49	...	45	...	42	
Male	[1]101	64	[1]173	93	464	80	1,719	72
HDL < 0.9 mmol per L	[2]12	8	[2]32	17	67	12	264	11
High HDL errors[3]	15	10	13	7	3	0.5	NA	...
Never screened	[1]116	74	[1]85	46	264	46	1,357	57
Known to be high	19	12	31	17	176	30	323	14
At risk by NCEP	0	0	186	100	211	36	578	24
Total	157	...	186	...	578	...	2,387	...

[1] Difference is significant at $P < 0.001$.
[2] Difference is significant at $P = 0.01$.
[3] High HDL error equals referral of a patient with total cholesterol minus HDL cholesterol of less than 3.75 mmol per L.

NOTE: NA = not applicable. NIHCC = National Institutes of Health Consensus Conference recommendations. NCEP = National Cholesterol Education Program recommendations.

not have been referred, and would have been falsely reassured. The policy options, as well as the options in which risk factor information is collected and used, are illustrated in table 5.

Discussion

Recently published NCEP guidelines for cholesterol screening differ from the 1984 NIHCC guidelines by using absolute cholesterol level cutpoints for decision-making rather than age-related percentiles, and by using risk factors other than cholesterol in the decision to pursue further evaluation and treatment. Use of the NCEP guidelines (excluding HDL) in mass screening programs has little impact on the total number of persons referred for further testing, compared to use of the NIHCC's. However, those referred using the NCEP guidelines include a significant number who had significant risk for coronary heart disease who would not have been referred previously. Similarly, a subgroup of persons with lesser cardiac risk, who would have been referred under the old system, are not referred under the new. Thus, use of the NCEP guidelines for mass cholesterol screening (excluding HDL) produces referrals with greater cardiac risk, without significantly increasing their total numbers.

In order to apply the NCEP guidelines, however, mass screening programs must collect and use risk factor information other than cholesterol levels in making referral recommendations. If a screening program does not collect and use such information, it faces choosing between a 5.2 mmol per L referral criterion, and thereby referring more than half of those screened, or using a higher cutoff (6.2 mmol per L, for example) and failing to refer some who merit further care. Choosing the former option

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may lessen the cost effectiveness and other potential advantages of mass screening. If the majority of subjects in public screening programs are referred to physicians for followup, thus incurring office visits and additional testing costs, it may be more cost effective to educate the population about the importance of cholesterol levels and to rely on traditional physician visits for detection. Moreover, referring more than half of screened persons may overload the local health care system. Such a policy may result in the referral of many who ultimately will not merit therapy under NCEP guidelines, thereby threatening physician and patient confidence in public screening programs. Choosing the latter option (option 2 in table 5) leads to false reassurances of a significant number of persons with important coronary risk who merit therapy.

One concern in using risk factor information in determining referrals is that the questionnaires and staff needed to determine who is at risk will add excessive complexity and cost to public screening programs. We found that it takes about a minute for the person being screened to answer risk factor questions and less than a minute for a trained staff person to determine risk status using the NCEP guidelines. The screening result and recommendations can be written on the questionnaire in order

Table 4. Prevalence of National Cholesterol Education Program risk factors in referred subjects with borderline total cholesterol and no personal history of angina or heart attack

Risk factor	HDL ignored [1]		HDL considered [2]	
	Number	Percent	Number	Percent
Male	184	97	232	96
Smoking	87	46	88	36
Hypertension	79	42	81	33
Family history	51	27	52	21
History of stroke	8	4	8	3
Diabetes	2	1	2	1
HDL < 0.9 mmol per L	32	17	84	35

[1] 190 referred subjects with 2 or more NCEP risk factors, HDL not considered.
[2] 242 referred subjects with 2 or more NCEP risk factors, HDL < 0.9 mmol per L used as a risk factor.

to reduce paperwork and enhance education. Thus, this approach should not produce excessive costs or complexity. Moreover, there may be significant added public health benefits from improved patient education concerning coronary disease risk. For example, all smokers identified during this process could be given a stop smoking message, educational materials, and a referral to a smoking cessation program.

The decision to measure HDL cholesterol in a public screening program and to use that information to guide referrals is significant. Use of the NCEP guidelines without HDL data (option 3 in table 5) produces appropriate referrals, but results in a few high HDL errors and in reassuring a larger number of people (mostly men) with borderline total cholesterols and low HDL levels who, in fact, are at risk because of low HDL levels. Such persons may be at risk from high LDL levels as well, which can be in the high risk range, despite borderline total cholesterol levels, which are borderline only because their HDL levels are low (total cholesterol equals LDL cholesterol, plus HDL cholesterol, plus triglycerides divided by 5, when triglycerides are less than 400 mg per dl). Choosing to measure HDL produces more and probably better referrals, but creates greater expense. Venous blood is required for accurate measurement at present, and standardization of HDL measurements in clinical laboratories remains a major problem (*11*). Widespread screening for HDL cannot be recommended until more reliable results can be assured, since small laboratory biases in HDL measurement can make the results functionally meaningless (*12*). Thus, designers of public screening programs will have to weigh the benefits and costs of measuring HDL, depending on individual circumstances and access to an accurate laboratory.

While the NCEP guidelines produce higher risk referrals, not all would agree that this is the ultimate goal in public screening programs. The most important function of mass screening is identifying persons with risk factors that have not or will not be identified because the person has not or will not see a physician for screening. Our results demonstrate that subjects at higher cardiac risk referred according to NCEP guidelines are more likely to have been screened before, although they are not significantly more likely to know they have elevated cholesterol. It may be argued that referring older but not younger patients is not an advantage, since prevention is most appropriate in the young who do not yet have atherosclerosis. In summary, use of the NCEP guidelines produces referrals with more cardiac risk, but may not produce referrals that meet the goals of every public prevention program.

There are a number of minor qualifications to these conclusions. First, we studied volunteer subjects, rather than a group selected as representative of the population. It is possible that a randomly selected sample from the population, or a sample derived from other sites for public screening, would yield different results. However, the percentage of subjects in this study referred by the NIHCC guidelines (31 percent when using serum values, 25 percent when using plasma values) was about what would be expected had these criteria been applied to a representative group. All public screening programs screen volunteers; none has or is likely to study a perfectly representative sample. Thus, our findings are more generalizable to public screening programs than results from a representative sample would be. Of course, a public screening program which attracted a significantly different population might find different results.

Second, the findings of this study are based on a single cholesterol determination for each subject. The NCEP guidelines specifically call for a repeat measurement of all borderline-high and high values 1 to 8 weeks after the initial test, before making labeling and treatment decisions. Thus, it is possible that some of our subjects were classified in error and that subsequent evaluation would show them to be at higher or lower risk. This was minimized by using a well-standardized reference lipid laboratory that provided reliable cholesterol measurements. However, biological variation and other factors, such as regression to the mean, concomitant medications, and seasonal variation, could account for misclassification. However, few public screening programs have the ability to bring

Table 5. Effects of using risk factor data on mass screening referral decisions

Characteristic	Risk factor information not used		Risk factor information used	
	Option 1	Option 2	Option 3	Option 4
Total cholesterol referral cutpoint	5.2 mmol per L (200 mg/dl)	6.2 mmol per L (240 mg/dl)	6.2 mmol per L, or 5.2 mmol per L, if coronary heart disease or 2 or more risk factors	6.2 mmol per L, or 5.2 mmol per L, if coronary heart disease or 2 or more risk factors
Low HDL used as risk factor?	No	No	No	Yes
Percent referred in this study	56 percent	22 percent	32 percent	34 percent
Potential consequences of using this option	Referral of many who may not need therapy Overload system? Cost effectiveness?	False reassurance of at least 10 percent who merit therapy	All patients merit treatment by NCEP guidelines Refer in error a few with high HDL Won't refer many with low HDL	More expensive Venous blood needed Can avoid high HDL errors Picks up more of those at risk because of low HDL

people back for a second cholesterol determination days or weeks after the original screening. Patients want to know results and what to do about them at the time of screening. Therefore, our protocol closely approximated actual practice and is relevant despite this deviation from NCEP guidelines.

Third, determination of other risk factors was accomplished by a self-administered questionnaire and the definitions of some of the risk factors in this study (smoking, obesity, and family history) were slightly different from NCEP recommendations. Physicians and paramedical personnel in medical offices can determine the status of some risk factors more directly than a self-administered questionnaire, thereby increasing accuracy. Yet, the three most prevalent risk factors in this study other than maleness were cigarette smoking, hypertension, and family history, and two of them rely on self-reporting in any setting. The differences in risk factor definition between this study and the NCEP guidelines could have had a variable impact on the results. Our definition of smoking (two or more cigarettes per day) probably resulted in more subjects being referred, while our failure to include obesity as a risk factor and our decision to consider only coronary deaths as a positive family history probably resulted in fewer referrals.

In general, screening programs should define risk factors in accordance with NCEP guidelines (though many would advocate a more inclusive smoking definition), but the decision to include obesity (greater than 130 percent of ideal weight) as a risk factor is more difficult, since a measurement of height and weight, a standard weight table, and a calculation are necessary in order to do so.

Most subjects were not fasting at the time of screening. Previous research has documented that neither total cholesterol nor HDL cholesterol is significantly altered by fasting (*9*). Both fasting and nonfasting HDL cholesterol levels have been found to be equally predictive of subsequent cardiac events in an epidemiologic study (*13*). Thus, the use of nonfasting values in this study is valid, and applicable to the public screening in which most patients will have eaten within 12 hours of testing.

Most of this discussion has related to public screening outside of physicians' offices. However, our conclusions could apply to the physician's office setting, where individuals will be screened and physicians must decide whether or not to pursue further diagnostic or therapeutic efforts. Physicians who use the NCEP guidelines instead of the older NIHCC ones are likely to identify higher risk patients without significantly increasing the total number of patients who need aggressive care.

While laboratory accuracy and the NCEP recommendation to convert plasma values to serum were not subjects of this report, it is instructive to appreciate the impact that small biases in cholesterol measurement can have on the numbers of referrals from public screening programs. Had we used plasma rather than serum values (plasma results are about 3 percent lower on average), 25 percent of the subjects would have been referred using NIHCC guidelines, while 27 percent would have been referred using NCEP guidelines. In other words, a bias in cholesterol level determinations of only 3 percent would result in a 5 to 6 percent

change in the total numbers of referrals. Currently, the NCEP Laboratory Standardization Panel recommends that laboratory bias should be less than 5 percent at most and ideally should be less than 3 percent (*14*). The importance of this recommendation cannot be overstated.

In summary, the new NCEP guidelines for cholesterol screening function well as referral criteria in the mass screening setting. Persons referred for further testing, using the NCEP guidelines, are at significantly higher coronary heart disease risk than those who would have been referred using previous guidelines. In order for the NCEP guidelines to function well in this way, however, it is essential for public screening programs to collect and use risk factor information, in addition to cholesterol levels in making referral decisions. Collecting information on other risk factors offers public health programs an opportunity to educate or to intervene on other important problems, such as cigarette smoking. When practical, and when accurate laboratory determinations are available, testing may include HDL cholesterol levels in order to avoid high-HDL referral errors and to identify persons at higher risk than their total cholesterol levels would indicate because of very low HDL levels.

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Equipment

A. Hitachi 705 random access blood chemistry analyzer, distributed by Boehringer Mannheim Diagnostics, 9115 Hague Rd., Indianapolis, IN 46250.