Long-term Effects of a Blood Pressure Survey on Patient Treatment in a Community

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SUMMARY The influence of a systematic survey and follow-up of blood pressure in a population sample was assessed by a subsequent survey performed an average of 40 months later. A subsample of 764 men, originally ages 35–57 years, was randomly selected for telephone follow-up, while blood pressure was remeasured in 133 (17% of the subsample). These were drawn from 6779 men who had a diastolic blood pressure (DBP) ≥ 90 mm Hg, the average of the second two measurements of three at the initial survey. Ninety percent of the men in the telephone survey reported they had visited their physician or medical-care source. Of these visits, 70% were for consideration of blood pressure, and in 36% this visit was directly attributed to the screen. At follow-up, 52.8% were taking antihypertensive medication and in 61% of this group the medication was started after the initial screen. Follow-up revealed DBP reduced by 8.7% in the group not treated with antihypertensive agents either before or after the initial survey, by 13.4% in the group on treatment before the survey and by 17.7% in the group started on therapy after the survey. Although lack of a suitable comparison group is a limitation, these findings in a population-based cohort strongly suggest that systematic blood pressure screening, combined with effective immediate referral, may be associated with an important effect on blood pressure control in the community.

THE DETECTION and control of hypertension in the community appears to be improving. More people with hypertension are detected and a greater proportion are receiving adequate treatment. Mass blood pressure screening may be one of the reasons for this improvement. However, the effectiveness of screening programs has been questioned. Unsystematic, sporadic screening efforts appear to attract primarily a self-selected population of the elderly and health-conscious, or those previously detected and under care. Those not screened are at a higher risk and less likely to be detected by casual screening methods. Moreover, many screening programs have not provided adequate follow-up or liaison with medical facilities.

In the course of recruitment for a large primary prevention trial, approximately 31,000 middle-aged men were surveyed from a population base by a door-to-door method. High participation was achieved: 96.9% of households were contacted and 80.9% of age-eligible men were examined. This systematic process was combined with a standardized and prompt follow-up procedure for men found to have an average DBP ≥ 90 mm Hg. In the present study, the effect of the initial screening survey is evaluated by follow-up of a random sample of those with elevated blood pressure, 3–5 years after the initial contact. We sought to determine the influence of this survey, the equivalent of a systematic screening and referral effort on hypertension control.

Methods

Recruitment for the Multiple Risk Factor Intervention Trial (MRFIT), sponsored by the National Heart, Lung, and Blood Institute, formed the basis for this study. It involved all households in specified census tracts of Minneapolis-St. Paul. The recruitment was continuous from January 1974 to September 1975.

A letter was first mailed to individual homes in the selected census tracts informing the occupants of an upcoming home visit, as well as describing the nature...
TABLE 1. Blood Pressure Advice Received at Initial Survey

<table>
<thead>
<tr>
<th>Diastolic blood pressure (mm Hg)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 128</td>
<td>Immediate referral to physician, with results forwarded and physician contacted by telephone.</td>
</tr>
<tr>
<td>≥ 115–127</td>
<td>The blood pressure is high and will probably require treatment. Results are forwarded to physician by mail.</td>
</tr>
<tr>
<td>≥ 90–114</td>
<td>The blood pressure is above average. Results are forwarded to the individual. Diastolic blood pressure is designated abnormal.</td>
</tr>
</tbody>
</table>

of the project. A few days later, the interviewer visited the home and determined whether an age-eligible man (age 35–57 years) resided in the household. If so, demographic information was collected and a brief standard questionnaire on health opinions was administered. Age-eligible men were invited and given appointments to attend the screening clinic located at a convenient site in the community, usually a church or school. The clinic visit consisted of a health interview, measurements of blood pressure, serum cholesterol, and a questionnaire on cigarette smoking habits.

Blood pressure was measured by trained technicians certified in the procedure of Prineas and Rose. The three measurements were made with standard mercury sphygmomanometers, 2 minutes apart, after an initial 5-minute resting period. Measures were performed using the right arm with the subject seated. DBP was determined as fifth phase Korotkoff sounds. The average of the second and third readings was recorded.

Referral

All men were given standard verbal messages in the clinic according to the measured level of DBP. In addition, results were forwarded by letter to the subject, again according to the level of DBP (table 1). Results were also mailed to physicians if the DBP was between 115 and 127 mm Hg. In men with DBP of 128 mm Hg or greater, the physician was contacted by telephone the same day and the participant was immediately referred. Letters were sent to participants and physicians within 2 weeks of the examination and “abnormal values” were designated by asterisks.

Follow-up

Two to 4 years (average 40 months) after the initial screen a follow-up survey was carried out on a sample of the men who at the initial screen had a DBP of ≥ 90 mm Hg. The randomly selected sample (n = 764) was stratified by initial level of DBP. Every man in the total population with a screen DBP of ≥ 115 mm Hg was contacted. A standard telephone questionnaire was administered involving blood pressure treatment status, medical visits and physician advice given subsequent to the first contact.

A randomly selected subgroup of 162 men, 20% of the telephone sample, was invited back to have blood pressure remeasured by methods identical to the original screen using trained technicians. The men were also asked to bring in their antihypertensive medications and were given a series of questions on health habits.

The study design is shown in figure 1. Excluded from the follow-up were men randomized into MRFIT, those taking oral medication for diabetes mellitus, those previously hospitalized for 2 weeks or more for a myocardial infarction, and those with ventricular ectopy on a 20-second, one-lead ECG. Fewer than 3% of the group initially screened were excluded by these criteria.

Results

Initial Screen

Over the survey period of 20 months, 123,259 household visits were attempted and 119,425 completed (96.9%). Of age-eligible men in 37,674 households, home interviews were completed on 32,703 (86.8%). Survey clinic visits were completed in 30,483, 80.9% of the age-eligible population.

Follow-up Survey

The follow-up survey was conducted an average of 40 months after the initial screen. From 6779 hypertensive men (DBP ≥ 90 mm Hg), 764 men were randomly selected for telephone interviews. Contact was successful in 97.4% of the sample; 15 men had died (2%), and five were lost to follow-up (0.6%).

The blood pressure treatment status is given in table 2. Of the total, 393 men (52.8%) were taking antihypertensive medication. Of those, 240 reported that medication was started subsequent to the initial screen that had detected the elevated pressure. Figure 2 dis-
TABLE 2. Treatment Status at an Average 4-year Follow-up (n = 764)

<table>
<thead>
<tr>
<th>Status</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently taking antihypertensive medication</td>
<td>393</td>
<td>52.8</td>
</tr>
<tr>
<td>Medication started before initial screen</td>
<td>139</td>
<td>35.4</td>
</tr>
<tr>
<td>Medication started after initial screen</td>
<td>240</td>
<td>61.1</td>
</tr>
<tr>
<td>Time medication started not known</td>
<td>14</td>
<td>3.5</td>
</tr>
<tr>
<td>Visited source of medical care after the initial screen</td>
<td>674</td>
<td>90.6</td>
</tr>
<tr>
<td>Reported no visit to source of medical care</td>
<td>68</td>
<td>9.1</td>
</tr>
<tr>
<td>Uncertain about medical visit</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Medical visit made for reasons of blood pressure</td>
<td>476</td>
<td>70.6</td>
</tr>
<tr>
<td>Medical visit made for other reasons</td>
<td>198</td>
<td>29.4</td>
</tr>
<tr>
<td>Medical visit directly attributed to participation in the initial survey</td>
<td>171</td>
<td>35.9</td>
</tr>
</tbody>
</table>

plays the treatment status by initial blood pressure classification. Overall, 90.6% of men reported one or more subsequent visits to their source of medical care. This percentage was similar regardless of the initial level of DBP. However, the majority of these visits were for reasons concerning blood pressure; 171 (35.9%) related this visit to a medical care source as directly due to participation in the initial screen. This attribution generally increased according to the initial level of DBP (fig. 3).

Table 3 is a summary of the medical advice that the individual recalled. The most common responses were confirmation of elevated blood pressure and starting treatment. There were frequent responses to suggest that blood pressure values were lower at the medical visit than at the initial screen (reported as findings of "BP normal," "borderline," and "don't worry"). Few recalled specific advice about weight loss or reduced salt intake. None reported that antihypertensive medication had been discontinued. One man reported that his referral diagnosis of hypertension had been attributed to a specific disease.

Blood pressure control according to treatment status is shown in figure 4 for 133 of the 162 men (82%) invited to a repeat clinic measurement in this laboratory. Of those not treated with antihypertensive medications either before or after the initial screen, a DBP reduction of 8.7 ± 7.8 mm Hg was observed. Of those on medication before the initial screen and who continued on treatment, a 14.1 ± 10.3 mm Hg fall was found. The group newly started on antihypertensive medication after the initial screen showed an 18.1 ± 10.7 mm Hg fall in DBP. This is a decrease of 8.7%, 13.4%, and 17.7% for the three groups. Each group difference was statistically significant compared to untreated individuals (p < 0.01 level in two-tailed analysis of variance).

Eighty-nine percent of men on antihypertensive medication brought their medications to the follow-up visit. Agreement between the medications brought and the information acquired by telephone was 97%. Where disagreement existed, there was underreporting of medications, or confusion as to which medications were antihypertensive.

Tables 4 and 5 give the frequency of the medication

FIGURE 2. Treatment status by initial blood pressure classification.

FIGURE 3. Percentage of patients in each blood pressure range who visited a physician as a result of the blood pressure screening.

TABLE 3. Recollection of Physician Advice (n = 674)

<table>
<thead>
<tr>
<th>Advice</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Blood pressure high&quot;</td>
<td>134</td>
<td>20</td>
</tr>
<tr>
<td>Treatment started</td>
<td>132</td>
<td>20</td>
</tr>
<tr>
<td>&quot;Blood pressure normal&quot;</td>
<td>123</td>
<td>18</td>
</tr>
<tr>
<td>Continue medication advised</td>
<td>88</td>
<td>13</td>
</tr>
<tr>
<td>&quot;BP borderline&quot;</td>
<td>85</td>
<td>13</td>
</tr>
<tr>
<td>&quot;Don't worry&quot;</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Weight loss advised</td>
<td>82</td>
<td>12</td>
</tr>
<tr>
<td>Reduced salt intake advised</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Increased exercise advised</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Return visit advised</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Discontinue medication advised</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Close observation observed</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>Secondary hypertension suggested</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Don't remember</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>674</td>
<td></td>
</tr>
</tbody>
</table>
prescribed according to generic and brand names. Thiazide diuretics are the most frequently prescribed antihypertensive drugs in the area; propranolol was the next most frequently used. Triamterene 50 mg, hydrocholorothiazide 25 mg (Dyazide: Smith, Kline & French) was the most common antihypertensive agent prescribed by brand name. Sixty-one percent of the were taking one antihypertensive medication, 32% two medications, 6% three, 1% four, and one man, five.

**Discussion**

This systematic study of long-term results of a screened cohort from a population-based survey of blood pressure suggests a high level of improvement in hypertension detection and control in the population. Although experience in an unscreened comparison group was not feasible, the fact that 36% of men attributed the subsequent medical care visit directly to the initial screen, and the relationship of this visit to their DBP, suggests that screening and systematic referral and follow-up can play an important role in hypertensive care.

Despite the “regression to the mean” phenomenon, which “guarantees” that pressure in the reference group will be lower on subsequent medical visits, a substantial proportion of those referred in the 90–105-mm Hg DBP range was subsequently treated. This suggests that a change has occurred in the attitude of Minneapolis-St. Paul physicians toward treating mild DBP elevation. This trend may be enhanced by the publication of results of the NIH-sponsored Hypertension Detection and Follow-up Study. That study convincingly demonstrated a significant decrease in mortality as well as morbidity in a population of mild hypertensives treated with an aggressive, stepped-care pharmacologic regimen compared to referred medical care.\(^ \text{13} \)\(^ \text{14} \)

In our study not only were a large proportion of referred hypertensives subsequently treated, but treatment was highly effective in lowering blood pressure, both among those started on treatment after screening and among those already on treatment.

In conclusion, the 4-year results of a cohort exposed to screening in the middle 1970s provide evidence that a systematic approach to the community in the detection, referral and follow-up for people with hypertension can have an important and sustained influence on blood pressure control in itself. Improvement in hypertension detection and control in the medical setting must also play a role. Education across the community, at all age levels, as well as in programs in industrial settings, would likely enhance even these results, leaving the major issue the primary prevention of elevated blood pressure.

**References**

Release of Atherosclerotic Debris After Transluminal Angioplasty

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SUMMARY
To determine if there is release of endothelial cells or plaque contents after percutaneous transluminal angioplasty, effluent from atherosclerotic segments of the aorta and iliac arteries of rabbits were collected before and after angioplasty. No endothelial cells or cholesterol plates were identified in the pre-angioplasty effluents. Only a few single endothelial cells and cholesterol crystals were found in effluents after angioplasty. We conclude that embolization of endothelial fragments and cholesterol plates occurs during angioplasty, but only to a minor degree, and is probably not clinically important.

PERCUTANEOUS coronary transluminal angioplasty (PTCA) is useful in treating angina pectoris in selected patients with coronary atherosclerotic lesions. Improvement in the angiographic appearance of an atherosclerotic vessel after PTCA and improved thallium exercise scintigraphy have documented the clinical efficacy of this technique. Pathologic studies in an animal model have demonstrated that PTCA produces endothelial desquamation or splitting of the fibrous cap of the atherosclerotic plaque. These animal studies are corroborated by postmortem studies of human coronary and peripheral vessels that have undergone transluminal angioplasty.

The demonstration of endothelial desquamation and intimal splitting implies that there is peripheral embolization of fragments of endothelial cells or endothelial patches, and that the contents of the atherosclerotic plaque may be released at the time of PTCA. This study was done to determine whether there is release of cells and debris into the circulation during transluminal angioplasty using an animal model.

Methods and Materials
An animal model of atherosclerosis was produced. Aortic atherosclerosis was initiated in five male New Zealand white rabbits by feeding them a 2% cholesterol diet (ICN Co.). After 1 week on this diet, the aortic and iliac endothelium were injured using a procedure described previously. The rabbits were maintained on a 2% cholesterol diet following aortic debridement.

Six to 12 weeks later, the rabbits were reanesthetized with i.v. 2% pentobarbital. A laparotomy was performed and the abdominal aorta distal to the renal arteries and the right and left iliac arteries were mobilized. After ligation of the aorta just distal to the renal arteries and ligation of the left iliac artery, the right iliac artery was transected approximately 1.5-2 cm from the aortic bifurcation. A “bird’s eye” (Goodale-Lubin) catheter was introduced into the aorta distal to the tie below the renal arteries and passed antegrade approximately 1 cm. Through a separate incision in the aorta distal to the tie, a Grünzig transluminal angioplasty catheter (balloon 3.0 mm in diameter, 2.0 cm long) (Schneider Co.) was introduced and advanced past the tip of the angiographic catheter. A Renografin (meglumine diatrizoate) cineangiogram of the isolated aortic/iliac segments was performed to find an area of atherosclerotic stenosis suitable for dilation. The Renografin was removed by flushing with 10 ml of normal saline. Another 10 ml of normal saline was then injected through the angiographic catheter and the effluent from the transected right iliac artery was collected. The transluminal angioplasty catheter (balloon 3.0 mm in diameter) was then

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Supported in part by NHLBI grants HL-262-15 and HL-18714.

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Received February 2, 1981; revision accepted August 12, 1981.

Long-term effects of a blood pressure survey on patient treatment in a community.
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Circulation. 1982;65:946-950
doi: 10.1161/01.CIR.65.5.946
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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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:
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