ALGORITHMS FOR HEALTH PLANNERS: VOL. 6, HYPERTENSION

PREPARED FOR THE HEALTH RESOURCES ADMINISTRATION, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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PREFACE

This series of reports presents a methodology in algorithm form to assist health planners in developing objectives and actions related to the occurrence of selected health status indicators that should be amenable to health care intervention. The algorithms and background material remain to be field-tested by the project Health System Agencies (HSAs) and State Health Planning and Development Agencies (SHPDAs). The usefulness of this approach for health planners should be formally evaluated prior to widespread adoption.

Emphasis has been placed on developing a simplified, approximate analysis that health planners will find both feasible and effective. No detailed mathematical analyses are called for. The data required are, in most instances, readily obtainable. The algorithm is a methodology by which HSAs can investigate determinants of health status, identify breakdowns in the health care system, and specify needed improvements in the system. Some of the algorithms' steps suggest needed improvements in public health services; others suggest needed improvements in the delivery of medical care. HSAs have only a limited mandate to affect both these areas, but through public education and cooperative relations with health authorities and practitioners alike, HSAs can function as the agent for stimulating necessary remedial action along a broad front. Some of these actions can be assisted through incorporation in the areawide Systems Health Plans (SHPs) and Annual Implementation Plans (AIPs).

The goal of these algorithms is to assist HSAs to obtain valid and sufficiently detailed data that will provide a basis for monitoring breakdowns in the health care system and to improve planning decisions aimed at preventing such breakdowns. This should, in turn, affect population health status in the planning area.

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The reports in this series are:

L. Jeff Harris, Emmett Keeler, Arnold Kisch, Marie Michnich, Susana de Sola, and David Drew, *Algorithms for Health Planners: Vol. 1, An Overview*, R-2215/1-HEW.

L. Jeff Harris, Emmett Keeler, and Marie Michnich, *Algorithms for Health Planners: Vol. 2, Infant Mortality*, R-2215/2-HEW.

Arnold I. Kisch and Emmett Keeler, *Algorithms for Health Planners: Vol. 3, Breast Cancer Mortality*, R-2215/3-HEW.

L. Jeff Harris, Emmett Keeler, Shan Cretin, and Marie Michnich, *Algorithms for Health Planners: Vol. 4, Heart Attack Mortality*, R-2215/4-HEW.

Arnold I. Kisch and Susana de Sola, *Algorithms for Health Planners: Vol. 5, Preventable Death and Disease*, R-2215/5-HEW.

David E. Drew and Emmett Keeler, *Algorithms for Health Planners: Vol. 6, Hypertension*, R-2215/6-HEW.

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Marie Michnich handled logistics and coordinated our interaction with the pilot HSAs, the advisory panel, etc. Dr. Lawrence Miller, a Rand-UCLA clinical scholar, and Susana de Sola, a research assistant, provided helpful background information about hypertension, its detection and treatment.

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Many health planners from the five project HSAs and SHPDAs and the project advisory group and elsewhere in the United States helped improve the pertinence and usefulness of this report: John Brown of Alabama HSA 4, and Robert Schiller of the Alabama Department of Health; Stephen Davie and Robert Thimmes of Ohio HSA 2 and Dr. Erwin Teuber of Ohio SHPDA; Marvin Hanson and Rex Haberman of Nebraska HSA 1 and Dr. Ken Diamond of Nebraska Department of Health; Betsy Morton and Peggy Kopf of Washington HSA 1 and Gene Sabotta of Washington Department of Social and Health Services; Robert Geide and Mark Smith of California HSA 9 and Eleanor Ray of California Department of Health; Jay Getson of Massachusetts State Health Planning office; Carol Getts of Iowa HSA; Joseph Hafey of Western Center for Health Planning; Robert T. Jones of Florida HSA 9; and Linda Wendt of Louisiana HSA 1. Dr. George Goldberg of Rand and Dr. Donald Shepard of the Massachusetts State Department of Public Health provided thorough technical reviews.

CONTENTS

I. INTRODUCTION

Health Systems Agencies (HSAs) and State Health Planning and Development Agencies (SHPDAs) are required by public law 93-641 to prepare Health Systems Plans (HSPs) and Annual Implementation Plans (AIPs) to reflect both the present and the proposed future health status of the HSA population. The agencies are encouraged to use secondary data whenever possible and have been given limited resources for all their activities, including data collection.

The Rand Corporation has prepared a series of reports instructing HSAs about the assessment of health status and its relationship to action decisions for several major health problems: infant mortality, breast cancer, heart attacks, and an index of preventable deaths. This document presents an algorithm for HSAs with respect to the problem of high blood pressure (HBP).

The term "high blood pressure" is used interchangeably with its synonym "hypertension." The latter term is found more frequently in the medical and public health literature. However, since "hypertension" frequently is misunderstood by lay people, HSAs may prefer to use "high blood pressure" in dealing with the public.

HBP was selected for several reasons:

- It is a major public health problem that contributes significantly to morbidity and mortality.
- It is extremely prevalent.
- It is fairly easy to control.
- For HSAs, decisionmaking about HBP is improved markedly by the acquisition of primary data. This report may be considered a prototype for examination of the issues, costs, and benefits of HSA collection of primary data.

Figure 1 shows the annual mortality rate as plotted against diastolic blood pressure for men 35-44. Figure 2 diagrams the process of managing high blood pressure.

Unfortunately, there is no neat one-to-one link between the specific problems uncovered in an analysis of the HBP health status of the community and a solution to those problems. Rather, several alternatives are available to solve each specific problem.

Each HSA that uses this report should coordinate its activities with both the American Heart Association (AHA) and the DHEW National High Blood Pressure Education Program (NHBPEP).[1] These organizations provide valuable information and other resources to health planners; for example, each has compiled useful

[1] NHBPEP,
7910 Woodmont Av
Bethesda, MD 20014
Information Center 1: (301) 652-7750
Community Development Service: (301) 652-1370
American Heart Association
Education and Community Programs
7320 Greenville Av
Dallas, Texas 75231
(214) 750-5354

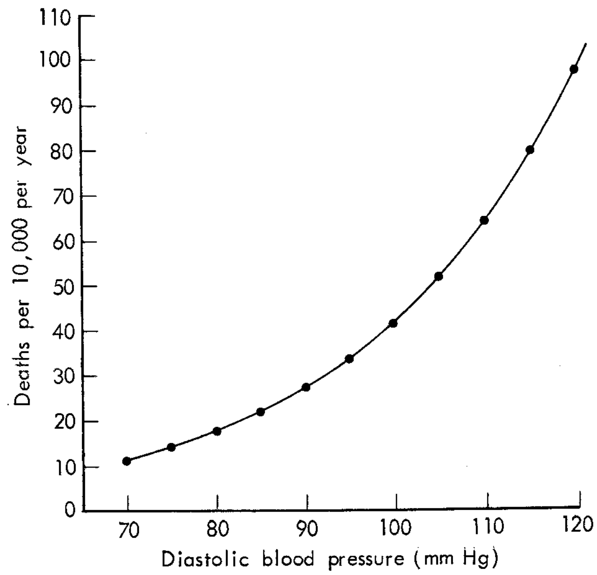


Fig. 1—Risk function for mortality (males 35-44)

SOURCE: Weinstein and Stason (1976)

bibliographies about HBP. We have incorporated below several of their summary forms. In addition, our bibliography includes references to materials prepared by DHEW and AHA that will be particularly valuable to planners. Two DHEW documents of direct relevance to this manual are *The Handbook for Improving High Blood Pressure Control in the Community* and the more inclusive *Program Director's Handbook.*

Control of HBP has a large potential payoff for the health status of the community. Perhaps as a result of the major national programs, research conducted by HEW through the Hypertension Detection and Follow-Up Program (HDFP) during the past few years revealed that awareness of HBP, treatment, and adequate control were reported to be substantially higher than during the 1960s and early 1970s. Figure 3 indicates the HBP health status of samples taken at three times.

Examination of these three pie charts indicates an apparent increase in awareness of HBP between 1971 and 1974. In addition, there appears to be an increase in the percentage of people aware of their condition who are receiving adequate therapy. Some caution should be used in interpreting these three charts since the first two are based on national samples, and the third is based on the sample of 14 communities used in the Hypertension Detection and Follow-up Program. Demographic and other differences between the 14 communities and the nation may explain some of the observed statistical differences.

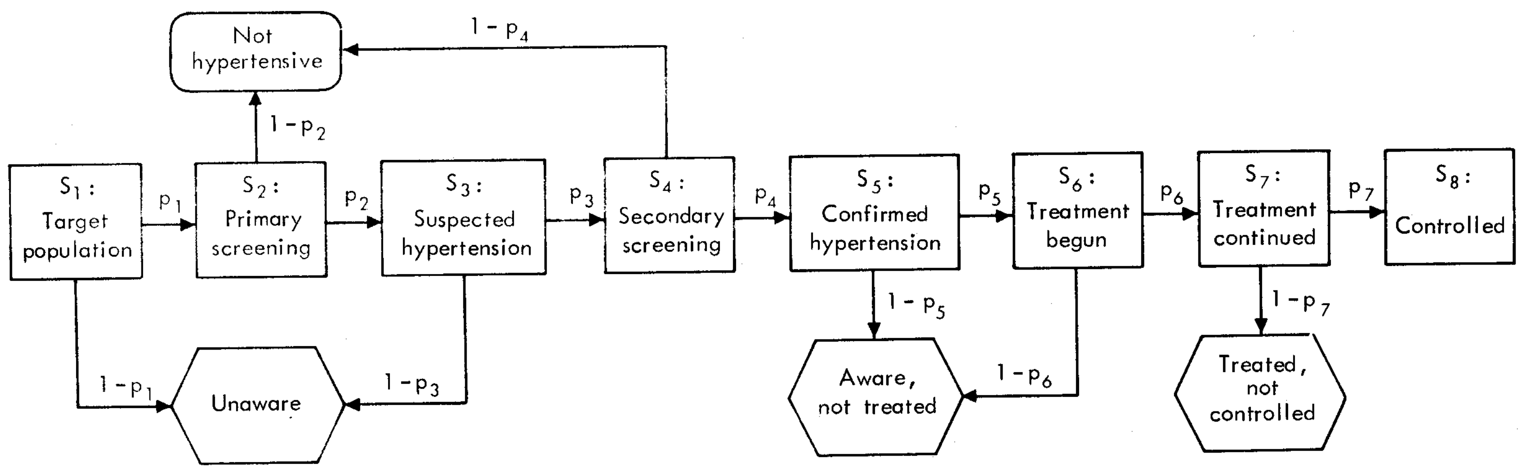
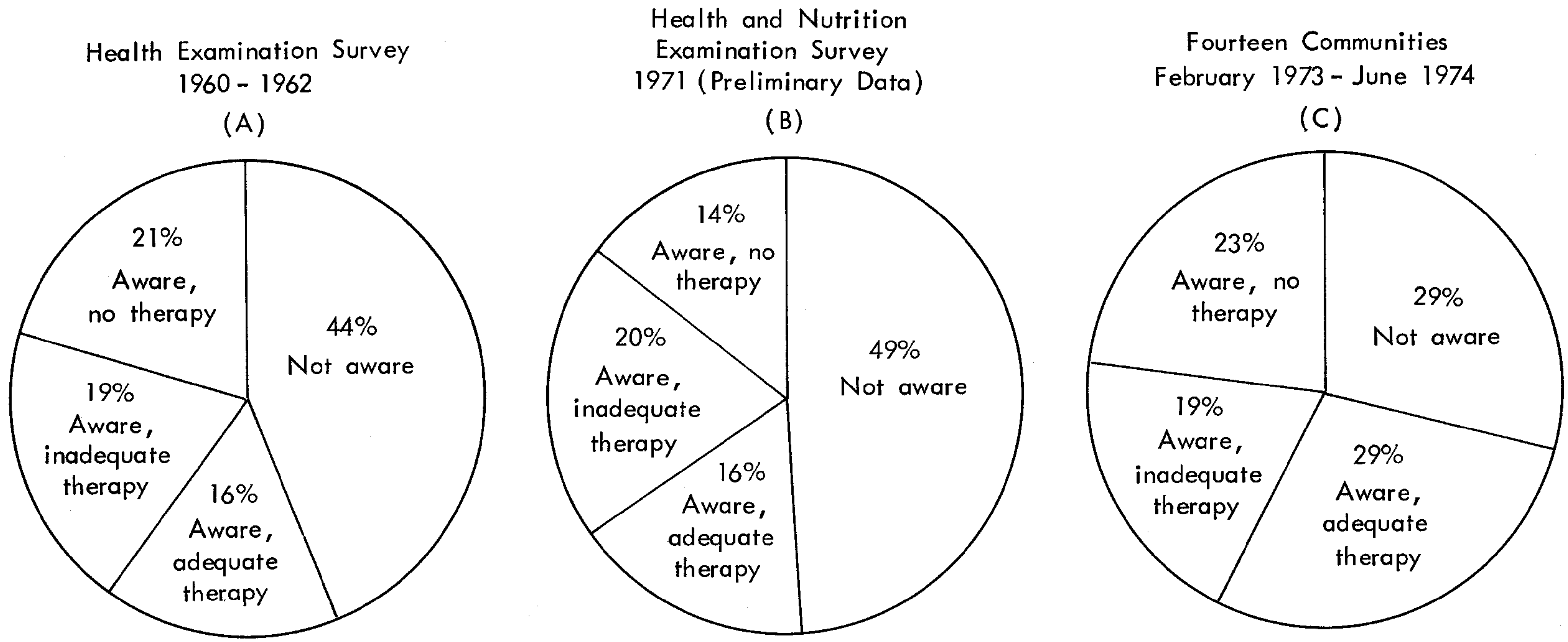


Fig. 2—A multistage model of the process of managing hypertension
SOURCE: Weinstein and Stason



Source: NHBPEP

(A) Computed from data published in Vital and Health Statistics, series 2, number 22, March 1967, National Center for Health Statistics.

(B) Computed from unpublished preliminary data furnished by The National Center for Health Statistics

(C) Hypertension Detection and Follow-up Study, National Heart and Lung Institute

Fig. 3—Percent of hypertensives aware, treated, and controlled

ISSUES

The following is a partial list of the issues HSAs might address:

- How do our area rates of HBP compare with national rates?
- Is our population more or less aware of HBP than others?
- How do treatment levels compare? Is treatment adequate?
- Do the community resources devoted to the treatment of HBP and its consequences meet our standards?
- How much will it cost to educate the public about this problem?
- How can health care professionals, especially physicians, be educated about this problem?
- How expensive is it to screen people?
- What are the limits on our ability as an HSA to cope with this problem?
- What is the efficacy, and efficiency, of various approaches to screening, referral to treatment, and compliance?
- What community resources can we draw upon to help in this battle?

THE DETERMINANTS OF HBP

The health status of an individual is an extremely complex constellation of factors including much more than blood pressure. Many experts would argue that the medical care system contributes only a fraction toward the total health status of an individual, serving merely as a repair mechanism when a part of the system breaks down. Other determinants of health status include heredity, environmental factors (such as pollution levels), the health habits of the individual (such as diet, exercise, smoking habits, driving habits), and socioeconomic status.

These complexities have both a positive and a negative implication for HSA decisionmaking about HBP. On the positive side, HSAs can influence many factors that bear on health status and hypertension. That is, many of the multiple causes of health status are susceptible to some degree of influence by outside forces.

The ability of HSAs or any outside system to influence some of these factors is extremely limited. For example, no amount of medical expenditure is going to change biological inheritance. If a predisposition toward hypertension is inherited by, say, significantly more blacks than whites, there are numerous implications for actions by local agencies. But those actions will not change the biological inheritance or predisposition of the citizens.

THE RANGE OF POSSIBLE HSA ACTIONS

We have elaborated an approach to help HSAs assess and aid in the treatment of HBP with full awareness that the resources and power available to HSAs are limited. Consequently, we have taken care to indicate the costs and known efficacy of each option presented. The statutory goals and limits on HSAs are presented in detail in PL 93-641.

Health systems agencies are part of a complex network of local, state, and national organizations concerned about health, costs, and maintenance. These other organizations have resources that can be brought to bear on a given health problem; simultaneously, they represent political realities the HSAs must confront in carrying out their mandate. Figure 4 diagrams some of the determinants and implications of HSA action.

Optimally, HSAs should have access to detailed, reliable data on the health status of their communities, the health services available, and the efficacy of those services. In fact, poor information and limited resources for staff, equipment, and systems to gather and analyze data are a major handicap for Health Systems Agencies.

Historically, local planning agencies have been concerned with services and facilities. PL 93–641 mandated that HSAs focus on health status in drawing up their health systems plans. However, the data about health status that are available to HSAs, and the resources they will have to analyze those data, are poor.

Data on different aspects of health status are collected by different agencies in different locations. Birth certificates and death certificates *are* required and recorded in every state. However, numerous studies have indicated the weakness of death certificates as an indicator of the health status of populations. There are known errors in recording the cause of death, and those errors vary by region, state, and other factors. For example, it may be difficult to separate deaths from stroke and deaths from myocardial infarction when sudden death has occurred. In addition, the information on birth and death certificates covers only a portion of health status.

Other available secondary sources of data about health status are more limited. In some localities or states, hospital discharge data are collected and organized on a fairly systematic basis; elsewhere they are not. Some states have extensive tumor registries that provide detailed data about cancer; others do not. In addition, the quality of these data will vary from state to state.

In principle, HSAs should use computers and experts in information processing, statistical data analysis, and survey methods to process data. Unfortunately, the funding available to HSAs is extremely limited and the problem of poor data is compounded by the problem of insufficient staff expertise in data handling.

HSAs are mandated whenever possible to use existing data. However, existing data are relevant to only a portion of the decisions that local agencies will need to make. Consequently, it is important to understand the procedures and costs of attempting to acquire the additional (or primary) data necessary for other major decisions. One purpose for elaborating the procedures below is to trace fully what an HSA must do if it decides to acquire primary data about population blood pressure.

THE HBP ALGORITHM

In this manual, detailed guidelines are presented for HSA action to deal with HBP. The steps of the algorithm are summarized below.

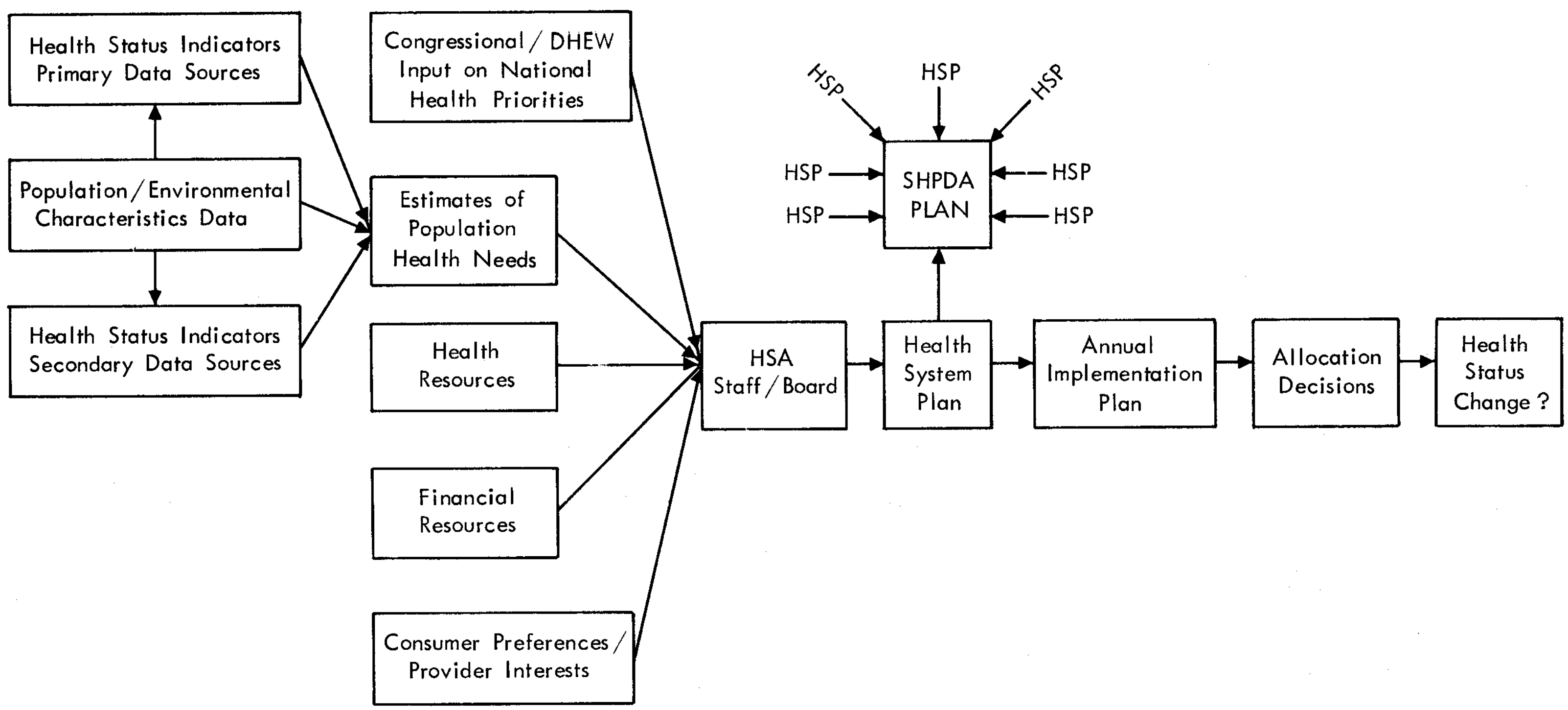


Fig. 4—Probable inputs and outputs of HSA planning process

Problem Recognition

The first step is to decide whether or not high blood pressure, or its treatment, constitutes a community problem. This includes value judgments by the HSA staff and board members as to the standards to use.

Problem Analysis

This includes the allocation of resources to develop a community profile of blood pressure status by age, sex, and race and to assess awareness and adequacy of treatment. A simple diagram of the steps required to control HBP is shown in Fig. 5. In problem analysis, the data are studied to determine where in this chain the problems lie.

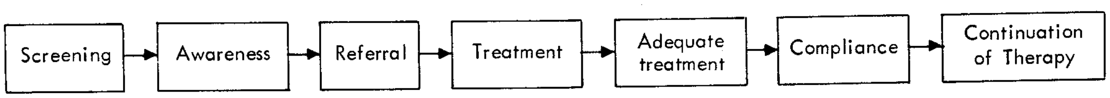


Fig. 5—Chain of hypertension control

Problem Solution

As the result of the problem analysis, it may be necessary to conduct HBP control programs for large sections of the community, to encourage case finding, treatment, and patient compliance. Detailed descriptions are given of the efficiency and efficacy of conducting these activities on a door-to-door basis, in doctor's offices, in clinics, through industry, and through media campaigns.

Problem Reassessment

Every community intervention, including those focused on HBP, requires evaluation after an appropriate period of time to determine its effectiveness. Guidelines are given for record keeping, data collection, and analysis techniques to trace the effectiveness of the HSA's anti-hypertension program.

II. HYPERTENSION

This section provides a review of the physiology, prevalence, and treatment of HBP. Full discussion of these subjects can be found in the articles and books cited in the bibliography.

We begin by discussing the physiology of blood pressure:

- What is blood pressure?
- What causes high blood pressure?
- Essential hypertension.
- Secondary hypertension.

We then review the epidemiology of hypertension and its relationship to morbidity and mortality:

- Prevalence of HBP.
- Demographic distribution of HBP, awareness and treatment.
- The relationship of HBP to morbidity and mortality.
- Effects of controlling HBP.

Finally, we describe the detection and treatment of HBP, including drug therapies. We close with a discussion of the public health challenges associated with HBP, especially the problem of patient compliance.

By any criterion, HBP is a major public health problem. Beyond those deaths in which HBP is explicitly labeled as the cause (estimated at 60,000 per year, Sheps and Kirkpatrick, 1975) it is a prime contributor to two of the leading three causes of death in this country: heart attacks and strokes. The physiological links between hypertension and these complications are discussed further below, but for an example of the benefits to be derived from a moderate reduction in the blood pressure of patients with HBP that is not considered to be of a severe form, note the figures in Table 1. Life expectancy of males age 20 would increase an average of 8.1 years and females 5.0 years with treatment to lower their diastolic blood pressure from 110 mm Hg to 90 mm Hg. With more severe forms of hypertension the increase in life expectancy from adequate lowering of the blood pressure would be even greater.

The calculations in Table 1 were based on a model that incorporates certain assumptions—i.e., that diastolic blood pressure is reduced from 110 to 90 mm Hg and that the patient life expectancy after treatment matches that of a person whose diastolic blood pressure always was 90 mm Hg (full benefit).

Table 2, based on data from the landmark Build and Blood Pressure Study of the Society of Actuaries, concluded in 1959, indicates mortality ratios for men and women associated with different systolic and diastolic blood pressures. These data were based on information provided by life insurance companies on about 4 million policy holders, of whom 200,000 had blood pressures exceeding 140/90 mm Hg. The data from this study are viewed from a different perspective in Table 3, which indicates the percent of applicants for life insurance with various initial blood pressure readings who survived 20 years. Note that this percentage steadily decreases as the blood pressure readings increase.

Table 1

INCREASE IN LIFE EXPENTANCY DUE TO ANTIHYPERTENSIVE TREATMENT, BY AGE AND SEX

Age	Life Expectancy (years)	Increase in Life Expectancy (years) with Treatment
Males		
20	46.5	8.1
30	38.2	5.8
40	29.7	3.9
50	21.7	2.5
60	14.8	1.4
Females		
20	53.2	5.0
30	43.9	4.4
40	34.8	3.7
50	26.4	2.8
60	18.5	2.3

SOURCE: Weinstein and Stason (1976)

Table 2

MORTALITY BY BLOOD PRESSURE LEVELS
(Mortality among standard risks = 100 percent)

Pressures	Mortality Ratio (%)	
(mm Hg)	Men	Women
Systolic Pressures		
88-97	78	—
98-127	88	90
128-137	118	105
138-147	155	122
148-157	194	140
158-167	244	230
Diastolic Pressures		
48-67	83	93
68-82	97	95
83-87	129	108
88-92	150	122
93-97	188	168
98-102	234	218

SOURCE: Society of Actuaries (1959).

Table 3

SURVIVORSHIP OF APPLICANTS FOR LIFE INSURANCE WHO SHOWED ELEVATED BLOOD PRESSURE READINGS AT THE TIME OF MEDICAL EXAMINATION FOR INSURANCE

Blood Pressure Reading	Percent Surviving at the End of 20 Years	
	Initially Age 35 (standard risk 89.0)	Initially Age 45 (standard risk 77.5)
132/85	85.9	73.7
132/90	82.0	70.9
142/85	82.0	68.2
142/90	78.2	64.7
142/95	74.6	60.7
152/85	78.2	61.5
152/90	74.6	58.3
152/95	70.3	54.7
162/90	—	52.5
162/100	—	46.1

SOURCE: Society of Actuaries (1959).

Clearly, reduction or elimination of hypertension-related heart attacks, congestive heart failure, strokes, and renal failure would represent a tremendous saving in human lives and a saving in medical expenditures to the community. But these latter savings in medical expenditures would be counterbalanced, if not exceeded, by the expense to the community (particularly to the patients for drugs) of anti-hypertension detection and treatment.

BLOOD PRESSURE

Blood pressure—the pressure exerted by blood against the blood vessel walls—depends on several factors: blood volume and viscosity cardiac output, and the resistance and elasticity of the vessel walls (Shank and Ludewig, 1974). These factors, in turn, are regulated by several physiological systems (circulatory, nervous, endocrine, and excretory) and are subject to disturbance when any of those systems is impaired. Although this report focuses on essential hypertension, for which the causes are unknown, some less frequent HBP results from malfunctioning in the regulatory systems.

Physicians traditionally have measured both systolic pressure and diastolic pressure and recorded both indexes. The former is the pressure recorded at the moment when the heart is most contracted, the latter when the heart is in a resting state.

There is no neat, distinct cutoff between "normal" and "hypertensive." When the blood pressure readings of a population are plotted, a continuous curve results. More important, a large body of research has shown that the probability of subsequent morbid events and mortality increases steadily as blood pressure increases. However, categories can be useful, and typically patients with diastolic blood pres-

sure readings exceeding 95 mm Hg have been defined as hypertensives, those with levels between 90 and 94 as borderline.

Since blood pressure rises with age, some suggest age-specific criteria. For example, note this recommendation from the National High Blood Pressure Education Program (1976 a, p. 4):

> All adults with diastolic blood pressures of 120 mm Hg or above should be referred promptly to a source of medical care. All persons with blood pressures of 160/95 mm Hg or above should have the blood pressure elevation confirmed within one month. All persons *under the age of 50* with blood pressues between 140/90 mm Hg and 160/95 mm Hg should be checked every 2 to 3 months. All persons over 50 years of age with a blood pressure between 140/90 mm Hg and 160/95 should be checked every 6 to 9 months. All adults with *diastolic* blood pressures below 90 mm Hg should be advised to have their blood pressure checked yearly.

There is a medical consensus about the value of treating severe hypertension but some debate about the cost effectiveness and value of treating mild and moderate hypertension.

"Labile hypertension" is a term given to a condition in which blood pressure readings are not consistently high. A patient may exhibit normal readings most of the time but have intermittent high readings. This condition is somewhat difficult to define since there is considerable variability (or low test-retest reliability) in any blood pressure measurement. In fact, it is possible that labile hypertension simply indicates a patient with a borderline reading. The importance of repeating the initial screening, or secondary screening, is discussed further below. Also, those with labile hypertension are likely to develop "fixed" HBP subsequently.

One must be careful to distinguish "secondary hypertension" (in which high blood pressure results from some other identifiable organic malfunction) from "essential hypertension" (in which there is no known organic problem other than high blood pressure). The vast majority of people with high blood pressure, roughly 85-95 percent, exhibit essential hypertension.

Although the causes of essential hypertension are unknown, they are assumed to be complex. Current theories center around the renin-angiotensin-aldosterone hormonal (RAA) system. The key element in this system is renin, an enzyme produced by the kidney. A disturbance resulting in excessive production of renin activates elements called angiotensins, resulting in higher blood pressure because of increased blood volume and increased resistance to blood flow.

The operation of thse systems is not fully understood. A sizable group of hypertensive patients exhibit normal renin activity. People with HBP can exhibit a variety of renin activity levels, but some believe that high renin activity may be correlated with heart attacks, strokes, and kidney failure (Marx, 1976). Laragh has hypothesized that hypertensives with high renin activity have increased vasoconstriction or resistance to blood flow, and those with low renin activity have high fluid volume (Marx, 1976).

Pathologies in each of the systems that regulate blood pressure can produce secondary HBP. These pathologies include endocrine disorders, tumors, renal disease, and so forth. Table 4 presents a list of the causes of secondary hypertension. Although the detection and treatment of secondary hypertension is important for the individual patient, it is less relevant to public policy decisions by HSAs for three reasons: (1) the low incidence (5-15 percent) of secondary hypertension relative to

Table 4

CLASSIFICATION OF HYPERTENSION

- Primary (essential): Accounts for 85%-95% of all cases
- Secondary
  - Hormonal
    - Adrenal
      - Pheochromocytoma
      - Aldosteronism
      - Cushing's disease
    - Thyroid
    - Pituitary (Cushing's disease)
    - Hyperparathyroidism
  - Renal
    - Parenchymal
      - Glomerulonephritis (acute and chronic)
      - Pyelonephritis (bilateral and unilateral)
      - Kimmelstiel-Wilson syndrome
      - Amyloidosis
      - Polycystic disease
      - Collagen disease
      - Tuberculosis
      - Miscellaneous (gout, tumor, radiation, trauma)
  - Vascular
    - Renal artery stenosis
    - Nephrosclerosis
    - Arteriovenous fistula
    - Embolism
  - Obstructive

SOURCE: Kaufman (1971)

essential hypertension, (2) the high cost of workups (i.e., examinations and laboratory tests) to determine if a patient has secondary hypertension, and (3) many patients with secondary hypertension can be treated with the same drugs that regulate essential hypertention.

Until recently, essential and secondary hypertension were referred to by the terms "benign" and "malignant." These labels had an unfortunate effect on medical practice in that essential hypertension, which has devastating consequences, was often perceived by physicians as "benign" and not worthy of serious attention. Presumably the physician education programs of recent years about the dangers of essential hypertension have corrected most instances of this problem.

Freis (1973c) has commented that physicians in large teaching centers are likely to overestimate the prevalence of secondary hypertension because the clients they see are not representative of the population. He estimates the true prevalence of secondary hypertension is below 5 percent.

In short, hypertension can be seen as a pathological development that can result from disturbances in one or more of several regulatory systems. The variety of possible causes of essential hypertension is matched by the variety of drugs available to combat it. Although essential hypertension can be controlled, it cannot be cured. However, many patients with secondary hypertension can be cured through surgery.

PATHOLOGICAL COMPLICATIONS OF HYPERTENSION

The pathological effects of untreated hypertension can take one of two basic forms. First, the stress placed on vessels in the brain by the increased blood pressure can cause a stroke from cerebrovascular hemorrhage. Second, for reasons not fully understood, hypertension accelerates the atherosclerotic process. This is a process in which the sides of the blood vessels become increasingly encrusted over time with plaques composed of cholesterol, clotted blood, and other substances. Even the vessels of young, healthy people may be characterized by "fatty streaks," and the buildup of plaques as a result of the atherosclerotic process gradually reduces the space for blood flow to the point where it becomes life-threatening. This process is presented pictorially in Fig. 6. When blood vessels in the heart or brain become closed, the functioning of the surrounding tissue is impaired, and the tissue dies. In the heart this is a myocardial infarction (or heart attack); a similar infarction in the brain is a stroke. The third target organ is the kidney whose function may be markedly reduced by a process called nephrosclerosis, a replacement of the individual kidney units (glomeruli) with a glassy material called hyaline.

Frequently HBP occurs in an individual who also has other risk factors associated with cardiovascular complications. These other risk factors include obesity, lack of exercise, smoking, and high serum cholesterol levels. The effect of a combination of these factors can be seen in Table 5, which is based on data from the "Pooling Project" (NHLI Task Force on Arteriosclerosis, 1971). In that study, data from several sources on middle-aged men with no evidence of heart disease were aggregated. Table 5 clearly indicates the increased mortality rate (both from all causes and from cardiovascular causes) associated with combinations of these risk factors. Note that each of these factors is susceptible to some form of community intervention such as education.

PREVALENCE

Hypertension is extremely prevalent in this country. It has been called the **"chief twentieth century epidemic" (Sheps and Kirkpatrick, 1975). Roughly 23,000,000 Americans have HBP. Of those, only one in eight was receiving adequate treatment in 1971. The others were major medical risks.**

The likelihood of developing HBP increases with age. A greater percentage of men than women exhibit HBP before age 50; after that, the trend reverses. In addition, there are racial differences. Blacks are particularly susceptible to HBP. In addition, they have a higher mortality rate associated with HBP than whites, above and beyond what one would expect because of the higher incidence of HBP among blacks. That is, about twice as many blacks have HBP as whites per 100,000 people but four times as many blacks die from hypertension as whites. According to Freis (1973c, p. 2), "It has been said that for every black patient that dies of sickle cell disease, at least 100 die from hypertension."

Table 6, from a report of the National Center for Health Statistics (Roberts and Maurer, 1976), reports the percentages of white and black adults with blood pressures of at least 160 systolic or 95 diastolic by sex and age in the early 1970s. These statistics were based on actual blood pressure measurements. Table 6 also indicates the proportion of those with definite hypertension who had not previously been

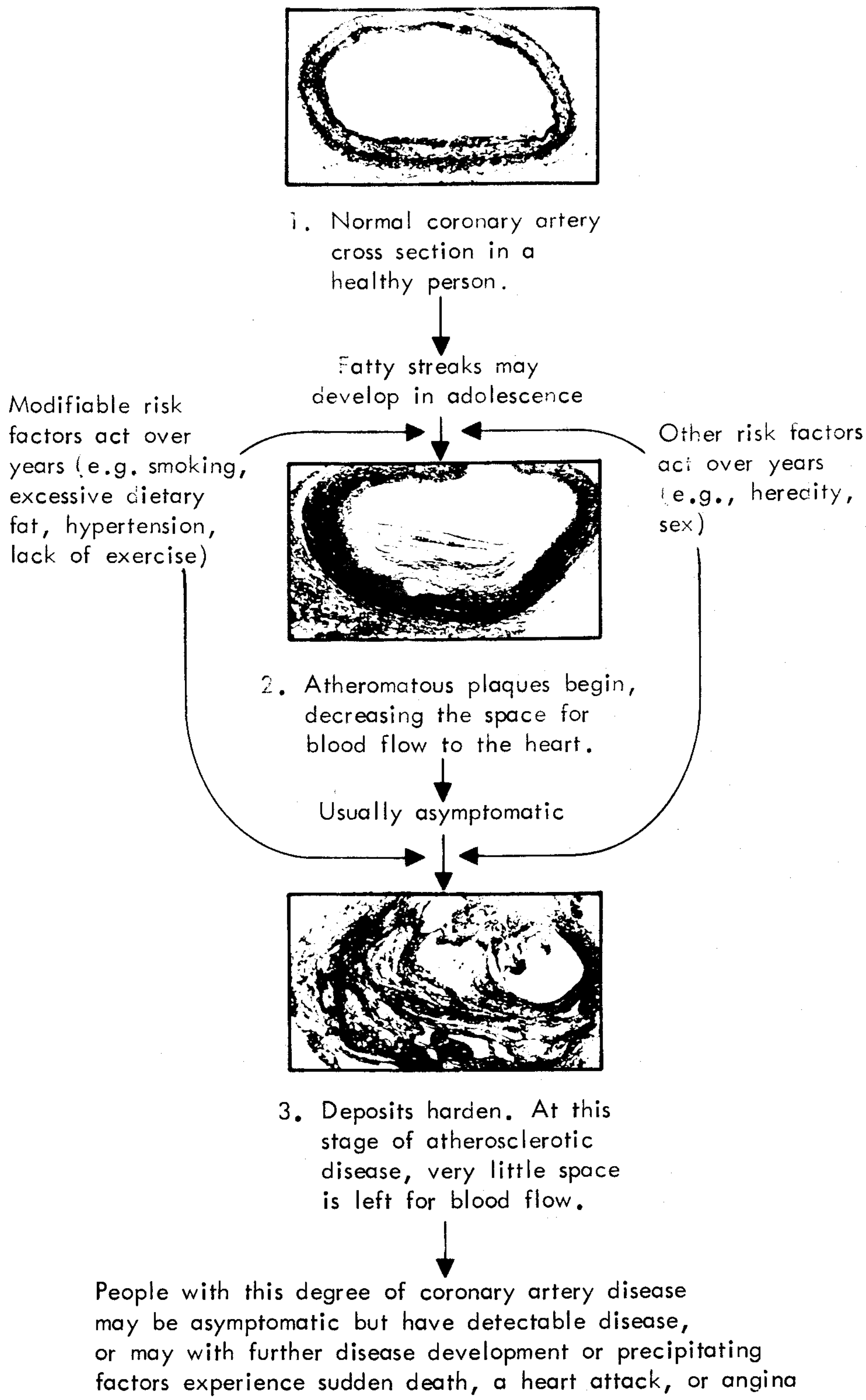


Fig. 6—Development of coronary artery disease

SOURCE: Johnson (1977)

Table 5

Rates of First Coronary Event According to Number of Risk Factors

Risk Factors	Population	Events	Rate/1,000
None	1.249	28	20
One	3,320	171	48
Two	2,178	198	90
Three	595	82	171

SOURCE: NHLI Task Force on Arteriosclerosis, 1971.

Table 6

Prevalence Rates of Definite Hypertension among White and Negro Persons 18-74 Years by Age and Sex, with Standard Errors and Proportion with this Condition not Previously Diagnosed: United States, 1971-74

Condition and age	White						Negro					
	Both sexes		Men		Women		Both sexes		Men		Women	
	Rate per 100 population	Standard error of rate	Rate per 100 population	Standard error of rate	Rate per 100 population	Standard error of rate	Rate per 100 population	Standard error of rate	Rate per 100 population	Standard error of rate	Rate per 100 population	Standard error of rate
DEFINITE HYPERTENSION, TOTAL[1]	17.0	0.57	18.5	0.84	15.7	0.72	28.2	1.75	27.8	2.33	28.6	2.28
18-24 years	3.1	0.65	4.9	1.29	1.4	0.30	3.7	1.06	4.6	1.77	2.9	1.06
25-34 years	5.8	0.65	8.2	1.28	3.7	0.57	13.7	2.86	17.7	5.98	10.2	1.95
35-44 years	13.6	1.09	17.3	1.97	10.1	0.94	32.0	3.85	38.2	6.55	28.3	4.71
45-54 years	22.2	1.59	25.8	2.06	18.9	1.86	44.0	6.31	36.8	7.95	50.9	7.69
55-64 years	31.4	1.59	31.1	2.14	31.7	2.02	52.6	5.24	49.9	7.86	54.5	7.11
65-74 years	39.3	1.72	35.3	1.85	42.3	2.26	55.1	3.87	50.1	4.28	58.8	4.73
DEFINITE HYPERTENSION NOT PREVIOUSLY DIAGNOSED, TOTAL[2]	56.6	1.51	64.5	2.00	48.2	1.86	47.2	3.87	54.9	5.13	41.2	4.66
18-24 years	66.9	10.86	67.0	13.68	66.4	12.00	78.1	8.91	90.4	16.94	62.6	18.33
25-34 years	69.1	6.02	71.1	8.84	65.0	6.67	54.0	11.52	52.0	18.35	57.0	12.55
35-44 years	63.3	4.02	66.8	6.48	57.5	4.57	39.6	4.94	38.2	8.82	40.8	6.79
45-54 years	61.9	3.22	64.3	3.74	58.9	4.71	55.6	8.45	71.8	10.26	44.3	10.03
55-64 years	50.4	3.18	62.1	4.34	39.9	4.71	39.2	7.35	48.9	12.99	33.0	8.36
65-74 years	49.2	1.95	61.9	2.32	41.2	2.56	43.7	4.67	51.0	4.70	39.1	5.58

[1] Systolic blood pressure of at least 160 mm. Hg or diastolic blood pressure of at least 95 mm. Hg.

[2] Proportion of persons with definite hypertension, as defined in footnote 1, who have never been told by their doctors that they had high blood pressure; standard error of proportions and population estimates.

NOTE: There are an estimated 19.4 million white persons at ages 18-74 years out of 113.6 million and 3.7 million Negro persons at ages 18-74 years out of 13.0 million that have definite hypertension as defined in footnote 1.

Source: Roberts and Maurer, 1976.

diagnosed. Table 7 provides further information about awareness and the use of medicine for HBP among the U.S. adult population.

Until recently, public health studies repeatedly showed that roughly half of all hypertensives were aware of their condition. Of these, only half were receiving treatment. Of those receiving treatment, only half had their blood pressure adequately controlled. This meant that only one out of every eight hypertensives in the United States was receiving effective treatment. The implications for public health planning of such ratios include screening, ensuring medical care for those identified as having HBP, and encouraging compliance to prescribed treatment regimens.

A major factor reducing patient compliance is that HBP usually has no demonstrable symptoms and that the devastating implications of high blood pressure do not become evident until many years have passed. Add to this the cost of drugs and the side effects of some of the anti-hypertension drugs and the problem of compliance becomes significant.

Table 7

RESPONSES TO SELECTED MEDICAL HISTORY ITEMS BY HYPERTENSIVE STATUS FOR PERSONS 18-74 YEARS; POPULATION IN THOUSANDS AND PERCENT: UNITED STATES, 1971-74

Medical history items	Definite hypertension		Borderline hypertension		Normotension		At least 105 mm. Hg diastolic	
	Population in thousands	Percent	Population in thousands	Percent	Population in thousands	Percent	Population in thousands	Percent
Total 18-74 years	23,171	100.0	23,413	100.0	81,353	100.0	6,172	100.0
Has a Doctor Ever Told You That You Have High Blood Pressure?								
Yes, still have it	7,701	33.2	3,421	14.6	2,997	3.7	2,731	44.2
Yes, not now	1,846	8.0	1,598	6.8	2,371	2.9	444	7.2
Yes, don't know now	904	3.9	562	2.4	596	0.7	277	4.5
No	12,712	54.9	17,810	76.1	75,282	92.5	2,716	44.0
Unknown	7	0.0	21	0.1	107	0.1	4	0.1
If Yes, How Many Years Ago Did You First Have It?								
Less than 1 year	177	0.8	65	0.3	54	0.1	97	1.6
1-5 years	5,343	23.0	3,241	13.8	3,616	4.4	1,550	25.1
6-70 years	4,874	21.0	2,241	9.6	2,259	2.8	1,793	29.0
Not applicable, unknown	12,777	55.1	17,866	76.3	75,424	92.7	2,732	44.3
During the Past 6 Months, Have You Ever Used Any Medicine, Pills, or Drugs for High Blood Pressure?								
Regularly	4,893	21.1	2,084	8.9	1,670	2.0	1,471	23.8
Occasionally	831	3.6	309	1.3	233	0.3	307	5.0
No	17,421	75.2	20,992	89.7	79,338	97.5	4,390	71.1
Unknown	27	0.1	28	0.1	112	0.1	4	0.1

Source: Roberts and Maurer, 1976.

HBP AND MORBIDITY AND MORTALITY

Recognition of HBP as a public health problem and decisions about its treatment are based on a growing body of scientific research. As noted earlier, major analyses, carried out in the late 1950s by the Society of Actuaries (1959), established that life expectancy in both sexes at all ages varied inversely with arterial blood pressure.

Additional evidence has been provided by longitudinal studies of several communities. Perhaps the best known and most authoritative longitudinal community study has been the research conducted in Framingham, Massachusetts (Kannel, 1970; Dawber et al., 1951). This work frequently is cited as the authoritative demonstration of the relationship between high blood pressure and morbid events. Other studies of large populations were conducted at Albany, Tecumseh (Epstein et al., 1965), Los Angeles, Chicago, Evans County (Georgia) (Wilber and Barrow, 1972), and Minneapolis. (A number of these studies are described in Paul, 1975.)

THE EFFECTS OF LOWERING BLOOD PRESSURE

The above research established a link between high blood pressure and heart attacks, strokes, and kidney failure, but it took several studies conducted for the Veterans Administration (1967, 1970, 1972) by Freis and associates to establish that *reduction* of blood pressure reduces the risks of these morbid events. According to Deming (1975, p. 288), however, "the VA study has not established that the incidence of myocardial infarction is affected and of course it has established nothing about women." In the Veterans Administration Cooperative Study Group on Hypertensive Agents research, patients with a range of diastolic blood pressures were assigned to either active drug groups or placebos. There was a significant drop in the blood pressure of the actively treated group while the placebo group revealed no such change.

The analyses indicated that the risk of developing a major cardiovascular complication was three times greater for the control groups than in the treated group (55 percent vs 18 percent). Further analysis showed that debilitating strokes were reduced by a factor of 12 to 1, and strokes in general were decreased by a ratio of 4 to 1 by treatment. Renal failure, dissecting aneurysm, and congestive heart failure occurred only in the control group.

The effectiveness of treatment was considerably greater in the patients with initial diastolic levels of 105 to 114 mm Hg (moderate hypertension) than in those with a blood pressure below 104 mm Hg. Since the complications of mild HBP require a long time before they develop, this five year study may not have been long enough to track the effects of drugs on mild HBP.

Other studies on lowering blood pressure were conducted by Hamilton (1966) and by Wolff and Lindenman (1966). Hamilton assigned 61 patients to either active drugs or placebos. The untreated patients had three times as many complications, mainly strokes, than the treated group. Wolff and Lindenman followed 87 patients; 12 percent defaulted, and "over a two year period the incidents of morbid events in the treated patients was one-third of that observed in the placebo group."

The National Heart, Lung and Blood Institute is now funding several major studies—e.g., the Hypertension Detection and Follow-Up Program—aimed at an-

swering questions unanswered by the earlier work by Freis and others. For example, would the same effects be seen among female patients? Would MI go down, as well as stroke?

DETECTION OF HBP

The determination that a patient has HBP is a straightforward procedure involving the use of a sphygmomanometer (a blood pressure cuff) and a stethoscope. The entire process takes only a few minutes. Guidelines for blood pressure determination are discussed further below (AHA, 1972). The major considerations in BP measurement include:

- More than one measurement should be made. (However, many blood pressure experts believe that for screening purposes, though not for definitive diagnosis, a single measurement is sufficient.)
- The cuff should fit comfortably on the arm, neither too loose nor too tight.
- In the case of obese patients, the physician may substitute a thigh cuff for the standard arm cuff.
- The bladder portion of the cuff should be at least two-thirds the circumference of the arm.
- Some authorities recommend recording diastolic pressure when the sound is no longer audible. Most recommend recording it when the sound muffles (Shank and Ludewig, 1974).

More recently, some automated devices for measuring high blood pressure have been developed. One such machine, manufactured by the American Optical Company, proved valid and reliable in studies at the Peter Bent Brigham Hospital in Boston. The machine automatically senses the appearance and disappearance of sounds or pressure waves. It may be more reliable than a paraprofessional.

The physician's examination and treatment of the patient who has HBP must take into account its multiple causes: heredity, high salt intake, possible secondary causes, stress levels, obesity, smoking, and so forth. In taking the history the physician explores whether female patients are on birth control pills (cessation of pill taking often restores blood pressure to normal levels in a few months) as well as the family history of HBP. Special attention is given to patients whose parents died of hypertension-related diseases at young ages.

The history and physical examination may reveal symptoms that may indicate the secondary causes of hypertension. For example, headaches, sweating, and palpitations may indicate adrenal pathology; renal problems may be indicated by family history, hematuria, polyura, cystitis, flank pain, and other clues; a heart murmur is highly related to coarctation, and so forth. During the physical examination the physician also can explore the possibility of target-organ damage associated with HBP.

Given the low incidence rate for secondary hypertension and the high cost associated with a full workup, the tests described below should be carried out only if there is good reason to believe on the basis of the physical examination and history that the patient had secondary hypertension.

Table 8 lists some indications of the need for a special test for secondary hypertension. Among the laboratory tests that might be conducted in a full workup are measurement of blood urea nitrogen (test of kidney functioning), serum glucose (a test for Cushing's syndrome, pheochromocytoma, and diabetes), hematocrit level and white blood cell count (associated with renal failure, useful for general assessment), serum uric acid, urinalysis (tests for renal disease), urinary catecholamines (a test for pheochromocytoma), electrocardiogram, chest roentgenogram. Additional special laboratory tests that can be conducted include the rapid sequence intravenous pyelogram, renal arteriography, aldosterone determinations, and the assessment of plasma renin.

Table 8

INDICATIONS FOR SPECIAL TESTS IN HYPERTENSION

Excretory Urography
Hypertension of very recent onset
Age at onset less than 40 years or more than 60 years
History of flank pain, renal calculi, significant urinary tract infection, abdominal trauma, or impaired renal function
Abnormal urinalysis
Presence of abdominal bruit suggesting renal artery disease or of palpable renal mass
Severe hypertension (high BP levels and retinopathy)
Recent acceleration of previously chronic, quiescent course
Urinary Test (Catecholamines, VMA, or Metanephrines) for Pheochromocytoma
Paroxysmal headache
Palpitations
Unusual perspiration
Pallor
Tachyarrhythmias
Tremulousness
Great lability in blood pressure or pressor response to anti-pressor agents or during anesthesia
Evidence of hypermetabolic state (for example, weight loss, diabetes)
Severe hypertension (high BP levels and retinopathy)
Suprarenal mass (roentgenogram)

SOURCE: Sheps and Kirkpatrick, 1975.

Complete workups for secondary hypertension are expensive. For data about these costs, see Ferguson (1925) and McNeil et al. (1975); each report indicates that the average cost of finding one case of secondary hypertension was about $2000. Ferguson also reported that he was able to detect 21 out of 26 cases of secondary hypertension through history, physical examination, and urinalysis only.

If a secondary cause of hypertension is discovered through these examinations, surgery will frequently be indicated and will prove to be sufficient to reduce the HBP. Operative procedures also can correct HBP caused by adrenal tumors and Cushing's disease.

THERAPY FOR ESSENTIAL HYPERTENSION

For female patients on oral contraceptives, the physician may begin by recommending that the patient substitute another form of contraception. It has been estimated that between 7 and 15 percent of women taking oral contraceptives develop HBP (Ayers et al., 1973). The likelihood of developing HBP increases further if the woman is a smoker. For most women, discontinuing oral contraceptives reduces blood pressure to normal levels.

Once secondary hypertension and the effects of oral contraceptives are ruled out, physicians can recommend a stepped program beginning with mild forms of drug therapy. Also, they might suggest weight loss, an exercise program, tranquilizers or behavior modification (e.g., transcendental meditation, biofeedback) (Shapiro et al., 1977) in light of the influence of stress on HBP, and a salt-free diet. However, on this last item, Freis (1973c) has commented that to control HBP effectively the diet must be extremely low in sodium (under 200 mg per day). Experience has shown that less restrictive diets do not accomplish the goal.

Drug therapy should attempt to determine the minimum strength of drugs that will control the patient's blood pressure. The objective is normal blood pressure with minimal side effects and costs to the patient. A recent report by the Georgia Hypertension Detection Follow-Up Program unit found that the vast majority of patients could be managed with mild diuretics.

Typically, the first drug to be explored by a physician in the stepped-care program for a patient with HBP would be a thiazide or similar diuretic. These drugs dramatically increase the salt and water loss by the kidneys. It has been estimated that 50-75 percent of hypertensives with diastolic blood pressures less than 120 mm Hg can be controlled through the use of a thiazide diuretic. Other advantages include the fact that there are infrequent side effects, and that the diuretics operate in an additive fashion with other drugs. Side effects, when they occur, might include skin rash, hyperglycemia (high blood sugar), hyperuricemia (high blood uric acid), and hypokalemia (excess potassium loss).

"Loop" diuretics, furosemide and ethacrynic acid, are more potent and expensive drugs that are also used in cases of severe HBP or renal failure.

Should diuretics alone fail to control the blood pressure, the next step taken by the physician depends upon the severity of the hypertension, the type of hypertension, and the nature and extent of the processes secondary to HBP. Many physicians will add reserpine in combination with one of the mild diuretics. Reserpine, however, frequently produces one or more of the following side effects: a tranquilizing effect that for some patients is a positive development; mental depression for occasional patients; nasal stuffiness; weight gain; and decreased sex drive. Clearly, if some of those side effects develop, reserpine should be removed from the drug therapy.

The next drug the physician may prescribe **is** alpha methyldopa, which is prescribed in combination with a thiazide diuretic. Frequently it is effective, and it exhibits severe side effects much less frequently than reserpine. The rare severe side effects include hemolytic anemia (2 percent or less of patients), nasal congestion, and decreased sex drive. More frequent, milder side effects are sleepiness, dry mouth, fever, and mild depression. Some patients, roughly 10-20 percent, will develop persistent drowsiness, and for them another drug will be required.

Alpha methyldopa is particularly effective for hypertensive patients with renal

impairment. However, it is expensive, doses have to be adjusted to the individual patient, and it typically has to be taken three or four times per day, which tends to reduce patient compliance.

A major class of drugs available to the physician is best represented by hydralazine. Unlike the previous drugs, it acts directly to dilate the arterioles. Frequently it will be prescribed in conjunction with a thiazide diuretic or as part of a three drug combination including the diuretic and either reserpine, methyldopa, or propranolol. The severe side effects of hydralazine are well documented, but they tend to occur only with large does. To avoid the side effects—hot flashes, pounding of the heart, drug-induced lupus syndrome, congestive heart failure—large does of hydralazine should be avoided. The side effects accompanying smaller doses include headaches (for a short period of time), nausea, and peripheral neuritis (numbness of the extremities).

A class of anti-hypertensive agents has begun to be widely used. These so-called "beta blockers" (the prototype drug is propranolol) block certain effects (called beta effects) of the body's adrenagic hormones (e.g., adrenalin or epinephrine). They reduce the rate and contractility of the heart and therefore diminish the output of blood into the vascular system. These agents are particularly useful in cases where patients have significant atherosclerotic disease of their coronary arteries.

Another potent drug available for coping with cases of severe hypertension is guanethidine. This usually is prescribed in conjunction with a thiazide or loop diuretic. Individual doses and tolerance vary widely, and great care needs to be taken in determining the dosage for a given patient. Once that level is found one pill per day will suffice. It is associated with several severe side effects that may require withdrawal of the drug. These are increased bowel mobility (which can readily be controlled) and orthostatic hypotension.

A host of anti-hypertensive agents have recently been licensed by the FDA; some have attributes that are invaluable in certain selective situations. In addition, the drug diazoxide was licensed for use in hypertensive emergencies and together with sodium nitroprusside provides the mainstay for dealing with hypertensive crises. Table 9 summarizes the physiological effects of various therapeutic agents.

This brief review of drug therapies was intended as informational background for HSA planners. It is not possible in such an outline, nor was it our goal, to indicate all of the factors that must be considered by a physician in choosing among drugs. Each available drug has associated with it a variety of effects, side effects, limitations, and constraints with which an experienced physician is familiar. In addition, the physician will consider the effects of combining two or more of these drugs and the implications of combining these drugs with other medication the patient may be taking.

The drugs available to combat HBP have a positive effect, but each carries with it some side effects. The stepped-care approach has been designed to locate the most effective combination of drugs for a given patient with the minimum side effects (Frohlich, 1977). Since compliance with the drug regimen is essential to the control of the patient's blood pressure, the problem of side effects should be handled with great care. Every effort should be made to elicit information from the patient about any side effects he may be experiencing without concentrating on that aspect of the treatment. Possible side effects of the more potent drugs should be spelled out in advance.

Table 9

PHYSIOLOGIC EFFECTS OF VARIOUS THERAPEUTIC AGENTS

Agent or class	Heart rate	Cardiac output	Peripheral resistance	Plasma volume	Plasma renin activity	Renal plasma flow	Mechanism or site of action
Oral diuretics							
Short-term	U, I[a]	D	I	D	I	D[b]	Arterial smooth muscle; renal tubules
Long-term	U	U	D	D	I	D[b]	
Sympathetic inhibitors							
Reserpine	U, D	D	D	I	D	U	Catecholamine depletion, central and postganglionic
Methyldopa	U, D	U	D	I	D	U, I	Catecholamine depletion, postganglionic
Clonidine	D	D	U, D	I	D	U	Central postganglionic, sympathetic block
Guanethidine	D	D	U	I	D	D	Postganglionic, sympathetic block
Pentolinium, mecamylamine	U, I	D	U	I	D	D	Postganglionic, parasympathetic block
Trimethaphan	I	D	U	I	D	D	Postganglionic, parasympathetic block
Propranolol	D	D	I	U, I	D	U	β-Adrenergic block
Vasodilators							
Hydralazine	U, I	I	D	I	I	U, I	Arterial smooth muscle
Minoxidil		I	D	I	I	U, I	Arterial smooth muscle and central effect
Diazoxide	I	I	D	I	I	U, I	Arterial smooth muscle
Sodium nitroprusside	I	D	D	U	I	U, I	Arterial smooth muscle

SOURCE: Sheps and Kirkpatrick, 1975.

[a]I = increased; D = decreased; U = unchanged

[b]Unchanged in loop diuretics (for example, furosemide).

TREATMENT OF MILD HYPERTENSION

The costs and side effects incurred in treating patients exhibiting moderate or severe hypertension are justified by the demonstrated savings in terms of morbidity and mortality (see, for example, Freis, 1973c). But there is still debate about the value of treating those with mild hypertension. Those who argue against treating mild HBP cite the expense, side effects of anti-hypertensive drugs, and lack of absolute clinical evidence that reduction of mild hypertension reduces future morbidity and mortality.

Each HSA will have to face this decision in setting blood pressure and treatment standards (see Sec. III). This decision about the level at which to recommend treatment will depend upon HSA value judgments, current medical knowledge, and the resources available to both the community and the patients.

HBP AS A PUBLIC HEALTH PROBLEM

The problem of HBP remains more a public health and a public education problem than a medical problem.

> More refined ... drugs ... are being developed, and more and more people are learning about hypertension. But unprescribed drugs or disregarded prescriptions do not control hypertension, and people forget what they learn—so the key to controlling hypertension may be the interest and motivation of the physician himself. Without his vital concern and thoughtful flexibility in individualizing treatment, no therapeutic regimen or public education program can remain effective.
>
> The challenge of the 1950s was to discover better drug therapy for hypertension. In the 1960's, the task became one of uncovering all cases of hypertension with secondary causes, and in this decade, the challenge is to detect every hypertensive patient and initiate treatment. But the challenge of the 1980's may be to cultivate and maintain the interest and concern of the primary care physician so that hypertension commands the degree of attention and urgency now ascribed to cancer and myocardial infarction. (Sheps and Kirkpatrick, 1975, p. 719.)

The importance of public education in regard to the potential benefits of controlling the hypertensive state are suggested by the following: The Louis Harris (1973) polling organization conducted face-to-face interviews with 1679 adult Americans. They were questioned concerning the future shape of medical research. The one point on which the public agreed most strongly was that the most desirable medical advance in the next 20 years is the prevention and treatment of cancer. Nonsurgical prevention and treatment of heart disease was runner-up, followed by treatment of mental illness. There was no mention whatsoever of HBP.

PATIENT COMPLIANCE

A major problem in the detection and treatment of HBP as a public health threat is that of patient compliance. This is ironic, given the devastating implication of HBP and the fact that it can be detected and controlled. It derives largely from the asymptomatic nature of the disease and the costs and side effects of drugs.

After observing that physician judgment is a poor measure of patient compliance (because patients may lie to their physicians), Freis (1973c) presents several reasons for noncompliance as revealed by research:

- The patient failed to understand directions.
- The regimen was overly complicated.
- The patient did not understand the nature of his illness and the need for continued treatment.
- The patient was seen by too many different therapists (often the case in outpatient clinics).
- The patient was made to feel like a second class citizen, because of prolonged waiting to be seen, prolonged waiting to receive his medications at the pharmacy, and by the busy, impersonal atmosphere of overcrowded clinics.

He goes on to list remedies for these problems, including minimizing waiting times at clinics and at the pharmacist's and establishing rapport between patient and doctor. Also encouraged are educational materials for the patient about his condition, discussion with other hypertensive patients, and instruction in how to take blood pressure readings at home. Patients should understand that if a given drug has threatening side effects, other drugs are possible.

Sheps and Kirkpatrick (1975, p. 718) add:

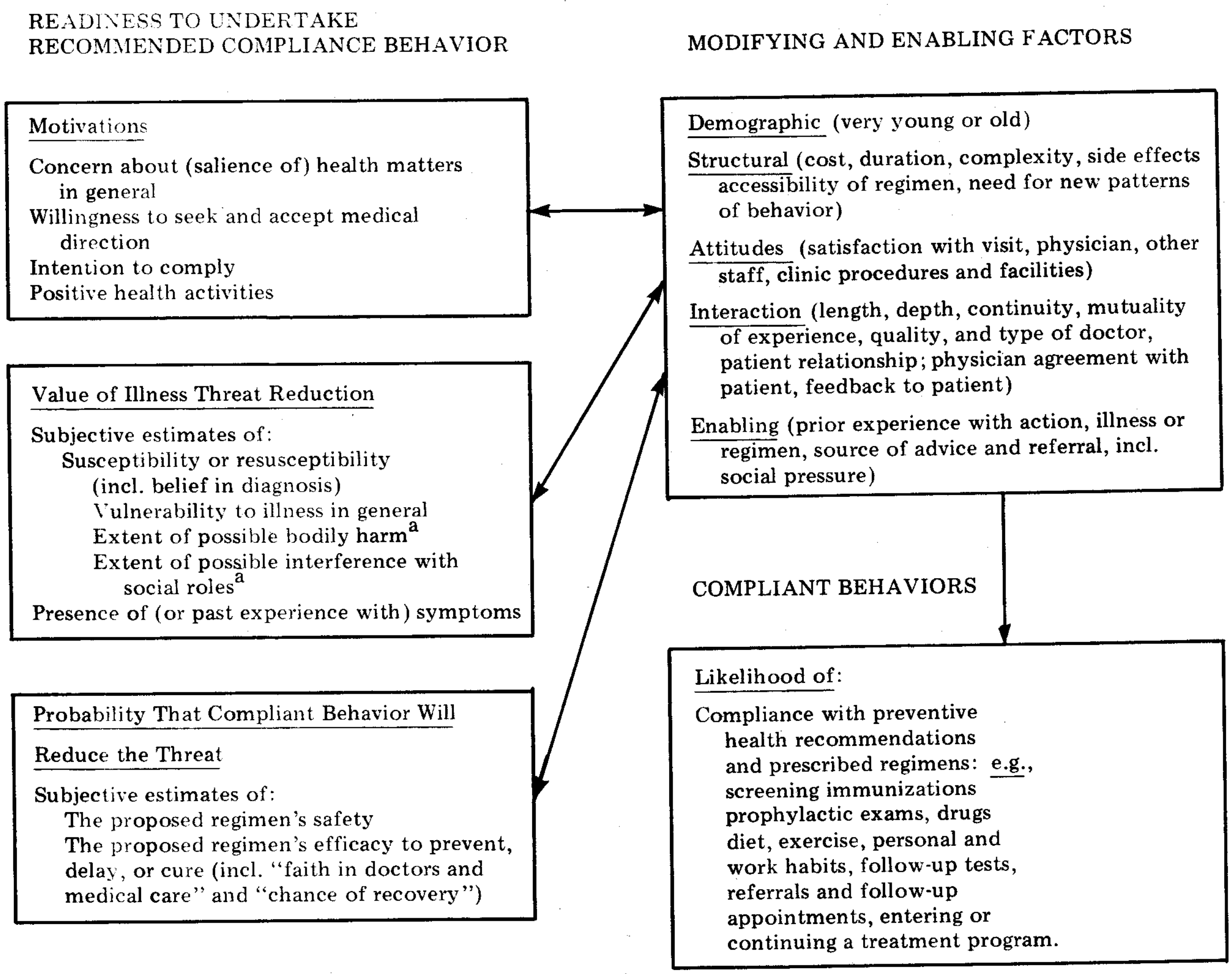
> The drug schedule must be constructed so that it is appropriate to the patient's lifestyle and daily routine, with which the primary care physician should become familiar. For example, some patients work shifts that change often. Moreover, taking medicines "with meals" may mean two, three or four doses to different patients. It may indicate the medicines should be taken just before, just after, or during meals. To clarify instructions, Mazzullo and Lasagna have suggested drawing a clock on labels and circling times at which pills are to be taken.

It should be noted that all of Freis's reasons explicitly or implicitly place the blame on the provider of care rather than on the patient. However, other noncompliance factors lie primarily with the patient. Becker and Maiman (1975) theorize that beliefs about health, incorporated in a "health belief model," constitute the major determinants of compliance. Moreover, compliance is a special problem in poor clinic populations. They argue (p. 11) that "it seems fair to assert, after an extensive survey of the literature, that patient noncompliance has become the best documented, but least understood, health related behavior." As a result of their own research, and a review of the literature, Becker and Maiman emphasize the following as important in improving patient compliance: patient-practitioner relationship, physician continuity, social influence, and some demographic and personality variables. Figure 7 presents their model of compliance behavior.

Some research indicates that information transfer alone is insufficient, but behaviorally oriented strategies are effective in improving compliance. Both behavioral reenforcement and monetary incentives have been proposed as ways of increasing patient adherence to drug therapy. Those approaches are now being tested with randomized clinical trials. For discussion of various approaches to improving compliance, see Weinstein and Stason (1976) and *Medical World News* (1977).

Since there have been no allocations to HSAs for resource development so far,

plans should give greatest weight to problems that can be corrected without major resources. The compliance problem may fit this description; Inui (1976) has suggested that physician education is crucial here and requires mainly the interest of the hospital preceptor. In fact, throughout this algorithm, we try to underscore our belief that physician education is an inexpensive and potentially effective way to reduce HBP in a **target area.**



[a]At motivating, but not inhibiting, levels.

Fig. 7—Hypothesized model for predicting and explaining compilance behavior

[a]At motivating, but not inhibiting, levels.

III. THE HYPERTENSION ALGORITHM: PROBLEM RECOGNITION

The basic philosophy behind the development of these guidelines should be made explicit. Simply stated, there is no single answer to the question: What is the best way to detect and treat HBP? We are not making a brief for the exclusive use of clinics, industrial firms, or door-to-door screening. We are offering information about the costs, procedures, and demonstrated effectiveness of each of these approaches. However, it is our judgment that each HSA will find itself faced with different needs, goals, community structure, and resources; therefore, the guidelines must provide information about multiple options to permit a solution that fits those attributes. We expect that most HSAs that tackle the problem of hypertension will use a variety of approaches depending on their needs and resources.

An HSA may decide to mount a campaign against HBP simply because, in the judgment of the staff and board, it represents a prevalent public health problem that can be reduced by community action. If such a normative decision has been reached, the problem recognition phase may be skipped. The purpose of Sec. III is simply to determine if there is an HBP problem worthy of attention. However, note that even minimum prevalence levels of HBP are high. Also, an estimate of the potential benefit to the community can be derived from Table 1.[1] For example, a 40 year old male whose HBP is controlled as the result of an HSA program will have his life expectancy increased by 3.9 years, on the average. Associated benefits include the reduced future need for services to the stroke victim, etc.

If there is doubt about whether to move against HBP, this problem recognition phase can help the HSA determine the prevalence of HBP in the target area. In fact, HSAs that have decided to focus on HBP still might gain valuable information about HBP levels in their community by carrying out the problem recognition phase.

PROBLEM RECOGNITION OUTLINE

1. Select appropriate planning areas for evaluation (state, HSA, sub-HSA area).
2. Establish standards, preferably age, sex and race-specific standards, for defining HBP and community goals.
3. Calculate the rates for each planning area.
4. If hypertension rates differ from the community-set standards at a statistically significant level, proceed to the Problem Analysis. Otherwise stop. (For a discussion of appropriate methods of testing statistical significance see App. A.)

[1] As noted earlier, Table 1 is based on a model that incorporates certain assumptions—e.g., that the patient's blood pressure is reduced from 110 to 90 mm Hg. The initial pressure, 110 Hg, is higher than that of the typical hypertensive.

PROBLEM RECOGNITION GUIDELINES

Selection of Area to be Analyzed

The following considerations are useful in selecting the different planning areas:

- Political and geographic boundaries;
- Population size, density, and subgroups;
- The particular health care services being planned;
- The minimum sample size needed to detect a statistically significant difference in the health status indicator when it occurs; this depends on the probability of the health status outcome, the size of the difference looked for, and the amount of error tolerated as discussed in the section on sample size (App. A).

Selection of the appropriate area or subarea to be analyzed will be based on a number of organizational, health, and political considerations. These reasons may include an expectation that hypertension is a particularly severe problem in certain sections of the HSA—for example, in certain counties, or in an inner-city area. The initial expectation may be based on knowledge of the inadequacy or poor quality of medical care services in some sections of the HSA. It may be based on the socioeconomic status of the area. The problem recognition phase will test the hypothesis that certain areas within the HSA are prone to high blood pressure. Planners may decide to focus on the entire HSA, or a portion of it, as the result of a combination of factors: organizational goals, estimates of the prevalence of hypertension, expectations about the quality of medical care in the area, social goals, and so forth.

Setting Standards

Standards for health status measures will be used in two ways. In the problem recognition phase, the standard is used as a community screening device to discover problem areas that would benefit from further analysis. In the analysis phase, standards for related health status or health service criteria are used to determine what the causes of substandard health status measures might be. The tests used to determine whether a measure is significantly substandard may vary in these two uses, for reasons explained below.

Standards may be derived from theory about the best that is possible or from hoped-for goals; we will call these *ideal* standards. Alternatively, they may come from current experience for groups like the one being considered; we will call these *normative* standards, or *norms.* For example, ideal standards for population proportions of people with high blood pressure who are unaware, untreated, or uncontrolled might be zero for all three. As norms, we might take the national rates reported above in Table 6 and Fig. 3.

Planners must decide which standards they want to use. This decision is political and there is no scientifically correct answer. However, we [illegible] predict the consequences of that decision. Choosing [illegible] the same as deciding that problem analysis should be done. Every HSA in the country will have population rates of high blood pressure greater than zero. However, using

norms for screens and the usual test for significance, less than half of the HSAs will have rates higher than the national rate for that period. Because the standard used for screening determines how many population groups require further analysis, the standard chosen will depend on how useful analysis is expected to be and how limited the resources for analysis are.

In problem analysis, the use of ideals as standards will often lead to the conclusion that the area is deficient in all forms of health services. The use of norms pinpoints those populations and aspects of health care provision that are significantly below average. Concentrating on the worst areas is fair, and may be most efficient if problems in these areas are more controllable (e.g., if there are diminishing returns to health care resources). However, using norms ignores problems that are national in scope, and planners may feel current uncontrolled HBP rates are unacceptably high. In any event, the standards set should be consistent with the power and resources available for change in the area, and with the tractability of the problem.

Deciding whether to consider white and black populations separately is a particularly sensitive issue. Using standards based on total cardiovascular mortality is the same as using percent black as the screening device, since the differences between white and black mortality are generally larger than the differences between areas within these groups. This can be seen in Fig. 8, a scatter plot of the total cardiovascular mortality rate and the percent nonwhite in people aged 60-64 in 1970 in a sample of states. The states above the mortality cutoff of 1/100 are the same as those to the right of the percent nonwhite cutoff of 10 percent, with the exception of New York. Even New York is close to the cutoff for both. We recommend that *rates* be calculated for both black and white subgroups. Blacks are more likely to be hypertensive than whites, because of economic differences, poorer access to care and observed racial differences.

Overall standards can mask problems in both white and black subgroups. An area with a small number of blacks will look acceptable, even if there are general problems in health care delivery in the area (see Kleinman, Feldman, and Mugge, 1976, for an example). However, adjusting total mortality and using separate and higher mortality standards for blacks may miss problems that are nationally endemic to them (such as poorer access to care or quality of care).

Although cardiovascular mortality differences between blacks and whites, which reflect such factors as heredity, life-style, and past health care, are difficult for HSAs to control, current status measures are controllable. For this reason, there is much less justification for separate and weaker standards for black levels of awareness and untreated high blood pressure. We recommend that the standards for all groups reflect only accessibility differences.

We have not been able to get much information on groups other than black or white. Some of the reported national data are based on white-black categories, and some on white-other. Most areas can include local data on "others" with blacks or not, depending on how the national data used for comparison are reported, but HSAs with substantial "others," e.g., Native Americans, must analyze data on them separately.

Calculation of Rates

There are many ways to profile an HSA population's HBP incidence and man-

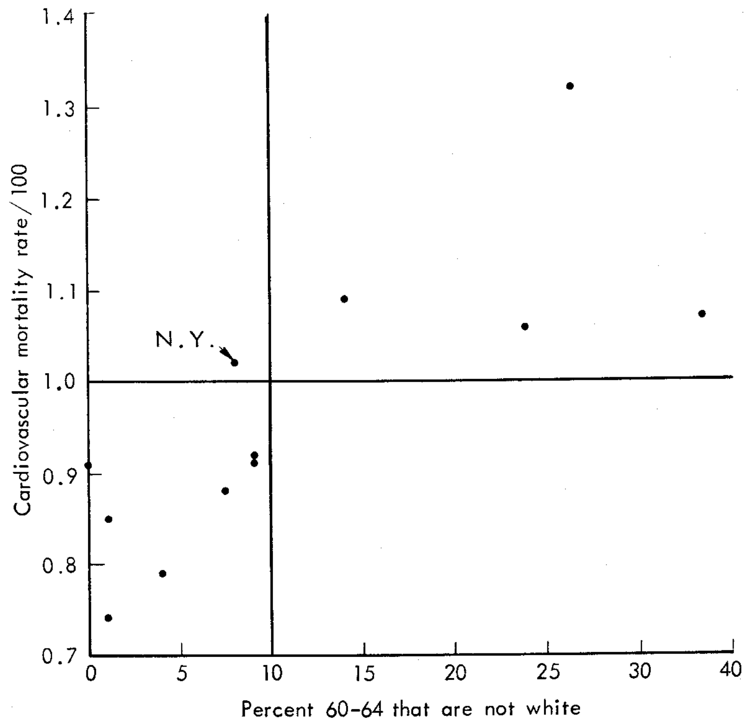


Fig. 8—Cardiovascular mortality and percent nonwhite 60-64 year olds in 1970 in random sample of states

agement. Each method has associated costs, assets, and liabilities. For some HSAs the primary goal may simply be to determine the HBP level in the community as part of the development of a health systems plan. That is, the goal of the HSA may be to assess population health status with respect to blood pressure and not to move on to treatment, education, and other action. If so, the next section will be the most pertinent.

Since primary data collection is expensive, and since HSAs have not been allocated funds for resource development, HSAs may wish to base their decisions on existing secondary data. Three methods of estimating the HBP health status of the population are discussed below:

1. Analysis of cardiovascular mortality data.
2. Analysis of demographic data.
3. Analysis of existing blood pressure data.

Cardiovascular Mortality Rates

Since high blood pressure has more of an effect on mortality at younger ages (especially for males) and the cause of death may not be as reliable on the death certificates of older persons, we recommend cardiovascular mortality of 55-64 years old as the criterion. Even though such deaths are over 40 percent of all deaths at that age, they are still quite rare, and a large amount of data must be collected to see valid population differences in mortality rates (see App. A). We recognize that, in general, HSAs want to assess the health status of and plan for small populations

(< 50,000 people) so that local needs and situations can be acknowledged. The procedures recommended here may require either aggregating data over a number of years with the danger of obscuring real changes that occurred over time, or enlarging planning areas with the danger of obliterating local differences, or some combination of the two.

In deciding on the size of the area, or the numbers of years of data to include (reasonable choices based on the standards in Table 10 would be in 1975 alone, or the three years, 1974, 1975, 1976), an HSA would make preliminary calculations of the necessary sample size as shown in App. A. For example, to detect a 20 percent

Table 10

UNITED STATES CARDIOVASCULAR MORTALITY RATES PER 1000

		1972	1973	1974	1975
55-64	Whites	7.42	7.25	6.85	6.53
	Others	11.70	11.37	10.60	9.79
65-74	Whites	19.35	18.61	17.82	16.73
	Others	24.97	24.98	23.45	21.30

SOURCE: (Unpublished data from Div. Vital Stat, NCHS). Cardiovascular mortality consists of 8th revision ICDA categories 390-448.

increase over the norm in cardiovascular mortality (c = .2 in Formula 2, App. A) 80 percent of the time it occurs, using a 5 percent significance level, the minimal number of expected deaths is

$$E = \frac{1.1(6.2)}{.2^2} = 172 \text{ deaths.}$$

Assuming white national mortality is taken as the norm for the area and one year of data is used, this requires $172 \times 1000/6.53 = 26{,}340$ 55-64 year olds or about $26{,}340/.093 = 283{,}000$ total population. If three years of data are used, the area could have a population as small as $283{,}000/3 = 94{,}000$.

The discussion on standards setting is pertinent to the next step. National norms for cardiovascular mortality are given in Table 10. We think cause of death will be more accurately reported in people aged 55-64, but if small populations are to be tested for significantly raised rates, it will be necessary to use 65-74 year old cardiovascular mortality or several years of data.

Next, population statistics and deaths from cardiovascular diseases (ICDA codes 390-448) broken down by age and race should be obtained from state or local sources (Paul, 1975). Enter the total number of cardiovascular deaths in each race-age category in the appropriate box in Form 1. Also enter the population in each race-age category under consideration in Form 1. Finally enter the standards for each race-age category in the appropriate box in Form 1. Multiply the population by the standard to get the expected number of deaths in each cell, and add the

Sample Form 1

Population and Cardiovascular Mortality

Area = All of HSA

Year(s) = 1975

		Age Groups 55-64
1. White	Cardiovascular Deaths	200
2. White	Population	30,000
3. White	Standard	6.51/1000
4. Expected	Deaths (2 x 3)	195.3
5. Other	Cardiovascular Deaths	170
6. Other	Population	15,000
7. Other	Standard	9.91/1000
8. Expected	Deaths (6 x7)	148.7

Total 55-64 Observed = 170 + 200 = 370

Total 55-64 Expected = 195.3 + 148.7 = 344.0

$$u = \frac{\text{Observed} - \text{Expected}}{\sqrt{\text{Expected}}} = \frac{26}{\sqrt{344}} = 1.40$$

total observed and expected number of cells. The illustrative calculations shown in the sample Form 1 are based on a large area, so that only 1975 data on 55-64 year olds are used. (The chosen standards are assumed to be the actual race-specific 1975 standards.)

Appendix A has the statistical calculations necessary to test whether the mortality rates are significantly higher than the standard. The sample Form 1 shows the calculation for this step. Here observed mortality is higher than standard, but u = 1.4, which is less than 1.65, the 5 percent significance level. So mortality is not quite significantly higher. The HSA might stop, or because the result is close, perform the computation for 65-74 year olds or racial subgroups, and proceed if differences in those groups were significant.

Demographic Analysis

Much can be learned about populations at risk through calculation of the expected number of hypertensives in the target area on the basis of the demographic characteristics of the population. These estimates can provide a reasonably accurate estimate of the HBP threat in a community.

For example, suppose the distribution of the population in various demographic categories for the HSA is as follows:

	Young Whites	Young Blacks	Old Whites	Old Blacks
Males	200,000	50,000	175,000	35,000
Females	225,000	50,000	225,000	40,000

(In this example we have simplified matters somewhat by reducing the age categories to a dichotomy, young versus old, for illustrative purposes.)

The national rates of HBP as reflected in Table 6 then could be combined with the information in this population demographic table to yield an estimate of the hypertension level in the community. For example, if the rate for young white males was 6.0 percent and that for young females was 3.0 percent, then calculation of the rates in Cells 1 and 2 of the above table would be:

Cell 1 = 6.0 × 200,000 = 12,000
Cell 2 = 3.0 × 225,000 = 6,750
Total number of young white hypertensives = 18,750
Rates for young whites = 18,750/425,000 = 4.4%

Let us suppose that the information available from Table 6 yielded the following rates for the eight cells.

	Young Whites	Young Blacks	Old Whites	Old Blacks
Males	6.0	13.0	26.0	50.0
Females	3.0	12.0	35.0	56.0

Then with the procedures outlined in the above equations, the rate of hypertension for the entire community would be 17.7 percent.

Estimates of the hypertension rate for any subarea within the HSA, or in the HSA in its entirety, can be calculated given knowledge of the demographic characteristics of the area and the information in Table 6. Information about the demographic characteristics, of course, will be available to the HSA from public census information.

This technique—estimating local conditions on the basis of national rates and local demographics—is called synthetic estimation (see Kleinman et al., 1976). It assumes that the local area follows national trends and that the demographic characteristics are the key factors in predicting the HBP rate. A weakness of this method is that those using it may miss something *unusual* (and perhaps important) that is occurring in their area.

Analysis of Existing Blood Pressure Data

The above procedures for demographic analysis provide a fairly accurate estimate of HBP rate for the HSA or subarea if, and only if, the trends there follow national trends. However, planners at the local level probably will want more specific local information. HSA planners should thoroughly canvass the community to discover the degree to which blood pressure data have already been gathered.

Surveys should be done of any person, group, or organization likely to have acquired a significant body of blood pressure data in a form available to the HSA to be analyzed. The possibilities include hospitals, clinics, and industrial firms with blood pressure screening programs.

Canvassing these groups may yield one or more samples of the population in which blood pressure has been recorded. If these "secondary data" do exist, certain

information must be elicited about the sampling procedures and the screening techniques used if generalizations about the HSA or a subarea are to be derived from the data.

The major issue will be how much the sample of participants in a screening program represented the area. Statistical sampling is a highly complex field. Numerous texts describe the techniques involved (Snedacor and Cochrane, 1967, Slonim, 1960). In fact, the HSA staff may wish to call on statisticians from a local university or from the Public Health Service central staff. Some of the basic principles of sampling are discussed here as they apply to the problem of blood pressure determination.

The goal is to find a sample representative of the population. A key quesrion is whether there is any reason to believe that the sample was randomly drawn from the community. Did every citizen of the community have a roughly equal chance of being included in the screening program? Rarely is this the case. For example, a screening program conducted by a clinic will tend to favor those who live in proximity to the clinic. (Further, if the sample unit is clinic visits, rather than patients enrolled in the clinic, then the sample will overrepresent patients who visit the clinic more frequently. These patients are likely to be sicker and more concerned about their health. (Shepard and Neutra, 1977). A screening program conducted by an industrial firm certainly will overrepresent the kinds of people who are employed there and their families. Some door-to-door screening yields a statistically representative profile of the community, as in the Hypertension Detection and Follow-Up Program (Borhani et al., 1976).

Samples where the refusal rate was high are more likely to be unrepresentative of the target population.

The above review of the methods used to obtain the sample will give some clue about representativeness. A more rigorous test can be provided by comparing the demographic characteristics of the sample with the known demographic characteristics of the population. For example, assume a population distribution as shown **on p.32.** Suppose that the Acme Plumbing Company, which employs 5,000 workers, has screened these workers and their families, producing blood pressure data on 20,000 people, and that the demographic characteristics of these people are as follows.

	Young Whites	Young Blacks	Old Whites	Old Blacks
Males	3,500	1,250	3,000	1,250
Females	4,000	1,250	4,500	1,250

Sample *size* is crucial (although size alone does not mean a sample is representative). In any given category, if the sample is large,[2] the data yielded may be extremely valuable. That is, even if the sample is not representative of the entire population it may indicate the HBP level of a given category of people. Appendix A gives some guidelines as to the degree of error associated with various sample sizes. After this inspection the observer may conclude that the sample provides an adequate estimate of blood pressure levels for men only, or for blacks only, or for old people only. Similarly the source of the sample may mean that generalizations

[2] Regardless of the proportion the sample is of the population.

are limited to particular social groups—the employed, the non-institutional population, the more stable residents. The information then can be interpreted as a meaningful sample of the community with respect to those groups only and the search continued for other estimates of blood pressure for the groups that were not covered.

The simple statistical tests presented in App. A indicate the degree to which a sample matches the population. At a less rigorous level, inspection of the table above will reveal whether the ratio of males to females is different for the sample than for the population. Similarly, inspection will reveal the representativeness of the white/black mix, the age mixture, and of various combinations.

It is possible to adjust the data from large samples to more accurately reflect the population. For example, if the population of young white men is 200,000 and of young white women is 225,000, but 500 of each were measured, yielding blood pressure estimates of 15 percent and 10 percent, the following equation allows one to estimate the number of hypertensives among young whites in the community:

$$.15 \times 200{,}000 + .10 \times 225{,}000 = 52{,}500 \text{ or } 12.4\%.$$

In epidemiological terms this weighting procedure is called standardizing to the HSA population by age, sex and race, using the direct method.

To summarize the procedures to be used when a canvass of community organizations has yielded one or more samples in which blood pressures were recorded: First assess the degree to which the procedures involved were likely to yield a biased sample—e.g., only of working people or only of young people. Second, determine whether the sample size is large enough to give reasonably valid estimates of blood pressure. Third, compare the demographic distribution of the sample with that for the population of the area or subarea as determined from census data. If the sample size in a category is large enough, the data can be used to estimate blood pressure for that category within the population. If the entire sample demographics match those of the population reasonably closely, the entire sample can be used as an estimate of the hypertension level in the population. If the sample is large, but the demographics do not match those of the population, the weighting procedure described above can be used to estimate the level of hypertension in the population.

The next step in working with an existing sample is to assess the methods actually used to record the blood pressures. How many readings were done? How well trained were the personnel? What devices were used? A full description of the recommended procedures for blood pressure screening is given by the American Heart Association (1974). Even when the sample size and demographic characteristics are adequate, blood pressure samples should be viewed with caution, or rejected, if improper techniques were used by those doing the screening.

IV. HYPERTENSION ALGORITHM: PROBLEM ANALYSIS OUTLINE

When completed, the problem recognition phase of this HBP algorithm answers the question, "Are area HBP levels significantly above the standard set by the HSA?" In this section we outline the steps to gather primary data that will enable planners to trace and identify the components of the HBP problem. (This data gathering also will assess whether there is an HBP problem for those HSAs that were unable to complete the problem recognition phase—e.g., if no blood pressure samples existed in the community.)

For HBP there is not a tidy connection between specific problems and specific solutions. Section V will present a menu of solutions that can be applied to *each* problem. (These include educational programs, door-to-door screening, neighborhood clinics, and clinics in industrial firms.) However, when a solution appears more feasible or effective for a given problem, we have indicated this below.

A. PROBLEM ANALYSIS OUTLINE

1. Establish standards for uncontrolled HBP, awareness, and effectiveness of treatment.

2. Decide whether data about these factors are adequate; if not, design and conduct a new survey.

3. Calculate rates for each planning area and summarize these on Form 3. Note that Form 3 includes rates of normotensives (people with normal blood pressure) and hypertensives, percentages that are aware of their condition, and percentages receiving adequate treatment.

4. If HBP rates (or the other indexes, awareness and treatment) differ from the community-set standards at a statistically significant level, proceed as follows.

5. Hypertension levels significantly higher than standard:

   a. Is there evidence that the hypertension is concentrated in one or more sections of the area under consideration?

      If yes, note especially Sec. V "clinics" and continue. If no, continue.

   b. Is the hypertension concentrated in certain demographic groups?

      If yes, note Sec. V "clinics," "educational programs," and continue. If no, continue.

   c. Is the area characterized by one or more large businesses or industries.

If yes, note especially Sec. V "industrial clinics" and continue. If no, continue.

d. Is the level of awareness about hypertension significantly lower than the HSA-established standard?

If yes, continue. If no, proceed to 7.

6. Awareness

a. Have there been extensive educational programs in the community?

If yes, evaluate to see where improvement is possible. If no, see Sec. V "educational programs" and continue.

b. Is there evidence that physicians in the community do not consider hypertension a major threat?

If yes, see Sec. V "private screening," "educational programs," and continue. If no, continue.

c. Is there evidence that physicians in the community, while considering HPB a major threat, have outdated ideas concerning what levels of HBP deserve or require antihypertensive therapy?

If yes, see Sec. V "private screening," educational programs," and continue. If no, continue.

7. Treatment

a. Does the proportion of hypertensives under a doctor's care fall significantly below the standard?

If yes, see Sec. V and continue. If no, continue.

b. Is there evidence that a significant number of patients take their medication but do not have reduced blood pressure?

If yes, review Sec. II, then continue. If no, continue.

c. Is there evidence that compliance with drug therapy is a major problem?

If yes, review Sec. II "compliance" see Sec. V, and continue. If no, continue to problem solution.

B. PROBLEM ANALYSIS GUIDELINES

Assessment of awareness, treatment, and compliance levels almost inevitably requires the gathering of primary data by the HSA. Rarely will there be data for a representative sample of the target area population that provide information not only on blood pressure levels but also on awareness, treatment, and compliance. Since acquisition of primary data can be expensive, decisions should be made with care. The first step should be the determination of the appropriate subarea for

which estimates are to be derived. Next, decisions should be made about the size of the sample and methods used to assure a representative sample (see App. A). Once again, population demographics based on census data can be used as a benchmark. Basically, four approaches can be used. In a given situation, an HSA may try a combination of these approaches.

1. **Door-to-door canvassing.** The cost, efficacy, and procedures for door-to-door canvassing as a screening, and as a treatment, device are discussed in Sec. V and in Borhani et al. (1976). Included there and in Selltiz et al. (1961) are presentations of sampling strategies—e.g., block sampling—and interview techniques that can be used in a door-to-door survey procedure.
2. **Clinics.** Presumably an HSA that encourages the development of clinics will see these sites as useful not only for screening but for treatment. The procedures, costs, and demonstrated efficacy of the clinic approach are discussed in Sec. V and in Finnerty (1972); Finnerty, Shaw and Himmelsbach (1973); and Paul (1975).
3. **Health fairs.** The HSA may want to participate in one or more health fairs in various sectors of the community to encourage people to have their blood pressure measured. Media publicity preceding the health fair will encourage participation and insure a better sample. One disadvantage of this approach is that the totally voluntary nature of participation often leads to a biased sample.
4. **Industrial firms.** Some of the community sampling can be done with the aid of major business firms that can launch programs to screen (and perhaps to treat) their workers and their families. For a discussion of the contribution that industrial firms can make to screening and treatment—the costs and efficacy—see Sec. V and Alderman and Schoenbaum (1975), Paul (1975), and Schoenberger et al. (1972).

Regardless of which of these approaches, or what combination of techniques, is used to derive new sample information about HBP, accurate blood pressure measurement is essential. For a description of the appropriate methods to be used see AHA (1974).

Every participant in the screening program should be asked whether a doctor has ever told him that he has high blood pressure. If so, as much data as possible should be gathered about the information given this person by his physician. What were the blood pressure levels? Was the person advised to change his habits and to undergo any form of therapy? What has been his attitude toward the therapy? Has he continued it? Form 2, which was prepared by the American Heart Association, will be useful in gathering this information.

Participants who acknowledge that they have been told by a doctor that they have high blood pressure will fall into two categories: those who continue to record high blood pressure and those with normal levels. The former group consists of patients who have received insufficient treatment and patients whose prescribed treatment may be adequate, but who have not been complying. Both groups should be of concern to public health officials. As discussed in Sec. II, those who do not comply constitute a special public health challenge. The data gathered by the HSA should be summarized in Form 3.

Form 2

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(NAME) HEART ASSOCIATION

BLOOD PRESSURE SCREENING PROGRAM

Medical History Form

Date__________

NAME:____

ADDRESS:____
Street or Route # City State Zip

TELEPHONE NUMBER__________________________________

AGE____SEX____MARITAL STATUS______NO. OF CHILDREN______

BLOOD PRESSURE READING______________HEIGHT________WEIGHT________CIGARETTES________NO. PER DAY________

NAME OF FAMILY PHYSICIAN OR OTHER SOURCE OF MEDICAL CARE:

____

____

Please answer the questions below:

1. Have you ever been told you have heart trouble? yes no

2. Have you ever had a heart attack? yes no

3. Have you ever been told you have kidney trouble? yes no

4. Have you ever been told you have high blood pressure? yes no
   If yes, Under treatment?_____How long?_____

5. Does any member of your family have high blood pressure? yes no
   If yes, Check who:
   - Mother
   - Father
   - Brother
   - Sister
   - Son
   - Daughter
   - Wife

   Are they under treatment? yes no

6. Have you ever been told you had a stroke? yes no

Form 2—continued

40

7. Have you ever had any of the following: (check)

	yes	no	do not recall
a) A sudden, temporary weakness or numbness of the face, arm, or leg?			
b) Temporary difficulty or loss of speech?			
c) Sudden, temporary dimness or loss of vision, particularly in one eye?			
d) An episode of double vision?			
e) Unexplained headaches or a change in the pattern of your headaches?			
f) Temporary dizziness or unsteadiness?			
g) A recent change in personality or mental ability?			

8. When were you last seen by a physician?____________________

ADDITIONAL COMMENTS________________________________

____

____

____

Form 3
Hypertension Health Status Summary Sheet

Age Groups	Male Whites						Female Whites	Male Blacks	Female Blacks
	Pop	Sample Size	Hyper.	No. Aware	No. Treated	No. Adeq. Treated			
___							[same categories as male white]		
___									
___									
___									

Area = State ___

HSA ___

Sub HSA Area ___

Date =

SECONDARY SCREENING

The importance of secondary screening—that is, of obtaining a second and third measurement of the patient's blood pressure—should be underscored regardless of the case finding methods used. Some patients exhibit labile hypertension (a high blood pressure may be recorded on one reading but normal blood pressures on other readings). In addition, even patients without labile hypertension require second and third measurements because blood pressure levels vary with the time of day, the state of relaxation of the patient, and other factors. Also, the measurement of blood pressure is imprecise, susceptible to both instrument and human error.[1] For these reasons, a patient identified as hypertensive on a first reading should be retested before it is assumed that he or she indeed requires therapy.[2] (Carey et al., 1976.)

Frequently a patient will have his initial reading at a clinic or firm and be referred to a physician for subsequent screening and treatment. Since several blood pressure readings are required to establish a profile, the patient should be given a card with his name, the date, and the blood pressure readings to carry with him to the physician's office. Alternatively, the card could be mailed to the physician since the patient may not show up at the doctor's office without prodding.

Gordon, Sorlie, and Kannel (1976) and Rosner (1977) have used statistical criteria to study the number of readings that should be made before defining a patient as hypertensive. The conclusions of Gordon and associates, who analyzed 18 year longitudinal data from the Framingham study, are that since a sizable proportion of those initially identified as hypertensive will subsequently exhibit normal readings, secondary screening is advised.

The importance of the fact that blood pressure and its consequence are continuous should be underscored here. There is no magical cutoff between "normal" and "sick." Viewed positively, this means that a judgment to treat, or not to treat, a borderline case cannot be grievously in error. If a blood pressure reading is within a point or two of the cutoff, either decision is equally valid.

Telling a patient that he has HBP can raise his anxiety level and alter his self-image, sometimes in dramatic fashion. Patients sometimes make major decisions about their lives to reduce stress when made aware of their state of HBP. These anxieties and decisions are unnecessary and destructive, if, indeed, the patient is found to be normal on secondary screening.

Work by Sackett at McMaster University indicated that absenteeism increased after hypertensives were made aware of their condition. Further analysis showed that this held only for those who did not enter treatment or did not control their blood pressure. Thus, screening may be counterproductive if not coupled with successful referrals and treatment.

Even a patient who is revealed to have HBP on the second and third readings will experience some anxiety about this condition (which ironically can rebound on

[1] The Framingham study data indicate that the standard deviation on a single blood pressure determination is 6 mm Hg. Then, the standard duration on the average of 2 readings is about 4 mm Hg. This means that the true reading will be within ± 8 mm Hg of the average of 2 readings in 95% of the cases.

[2] If only one reading is to be taken, it may be advisable to use a higher cutoff than if the average of three readings were used. This is because the single reading is more likely to yield a spurious diagnosis of hypertension.

the patient's blood pressure) and may make adjustments in life style. Consequently, the physician, nurse, volunteer, or paramedic who communicates this information should be trained to do so in the most supportive manner possible. In the case of mild hypertensives, some have argued that given the questionable efficacy of treatment and the anxiety-arousing effects of knowledge by a patient that he or she has HBP, such patients should not be informed of their condition. We do not endorse this viewpoint but do encourage a supportive communication of the patient's health status. The patient and physician then can make a rational decision about whether the benefit of treatment outweigh the costs.

Awareness

Assessing the awareness of the community citizens about their own blood pressure is important. The questions included in Form 2 may be particularly useful here. National statistics about the levels of awareness, as summarized in Table 6, provide useful benchmarks against which to compare the information derived from the target area or subarea.[3] If hypertension levels are not significantly above the standards set by the community, but awareness levels are low, major educational and treatment efforts may be required. Alternatively, the community may target increased awareness as an objective even if it is not significantly below the national average.

It may be useful to assess the degree to which physicians in the community perceive hypertension as a major threat. This could be done through a survey of physicians. If secondary data about community HBP levels, or primary data gathered by the HSA, reveal that many people have been informed by a physician that they have HBP but have not been encouraged to seek treatment, this could indicate outdated physician attitudes.

At Which Point to Intervene

Frequently an HSA will have to decide what emphasis to give to the awareness, treatment, or compliance link. Such decisions rest on multiple factors including the severity of the problem at each link, resources, and unique community characteristics. For example, if the awareness problem is concentrated in one black neighborhood, the HSA may target that area for action regardless of decisions about improving treatment and compliance elsewhere.

In general, a dollar spent at the end of the chain has more effect on the total number of controlled hypertensives than a dollar spent on detection. That is, if a dollar spent on detection vs. treatment yields the same percentage increase at that step, the final percentages will differ. To illustrate this maxim, it is necessary to consider the notion of cumulative probabilities. Table 11 shows that, given the $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$ formula (and assuming 80 percent of patients are given the appropriate therapy by their doctors) only 10 percent of all with HBP will be controlled. These illustrative examples do not fit the case in which a special effort is made to reach

[3] The national survey that yielded Table 7 revealed that one-fourth of those with definite HBP have been taking medication regularly or occasionally. The people in this group either are receiving inadequate treatment or are not complying adequately with their treatment.

Table 11

HIGH BLOOD PRESSURE CONTROL PROCESS
TYPICAL PROBABILITIES

	Each p_{Event}	$p_{Cumulative}$
Detection	.50	.50
Referral	.50	.25
Correct therapy	.80	.20
Maintain control (2 years)	.50	.10

SOURCE: Graham Ward, NHBPEP.

a group that has been missed by the health care system.) Table 12 indicates two hypothetical changes in the chain that would result in doubling the number of controlled hypertensives. Note that modest increases in therapy and compliance accomplish the same goal as increasing detection to 100 percent.

Table 12

HIGH BLOOD PRESSURE CONTROL PROCESS ALTERNATIVE
PROBABILITIES TO DOUBLE THE NUMBER OF
CONTROLLED HYPERTENSIVES

	Each p_{Event}	$p_{Cumulative}$	Each p_{Event}	$p_{Cumulative}$
Detection	.50	.50	1.00	1.00
Referral	.50	.25	.50	.50
Correct therapy	.90	.23	.80	.40
Maintain control	.85	.20	.50	.20

SOURCE: Graham Ward, NHBPEP.

Finally, the cumulative probability presentation can be used to assist communities in setting realistic goals. Note, in Table 13, that if each step in the process is assumed to have a reasonable maximum of 85 percent success, the resulting proportion of controlled hypertensives is 52 percent.

HSAs vary tremendously, reflecting the geographical, socioeconomic, and urban-rural differences of the areas. However, it is instructive to consider a "typical" HSA—one with demographic characteristics and health resources representative of the United States as a whole—and examine which strategies are most cost effective for it. (We assume that the staff capability of this hypothetical HSA is sufficient to relate health planning to health outcomes in a serious way.)

In general, the activity that will merit highest priority is improving the adherence to HBP control regimens by persons with known *moderate* HBP whose adherence is incomplete. Two points should be underscored. Cost effectiveness is maximized by focusing resources at the end of the chain of HBP control. Also, the benefit of treatment increases with the severity of the patient's hypertension. Thus, in an HSA with limited resources, intervention might focus on compliance and target it

Table 13

HIGH BLOOD PRESSURE CONTROL PROCESS
ALTERNATIVE PROBABILITIES ASSUMING
85% SUCCESS

	Each Event p	Cumulative p
Detection	.85	.85
Referral	.85	.72
Correct therapy	.85	.61
Maintain control (2 years)	.85	.52

SOURCE: Graham Ward, DHEW.

to those patients for whom the benefit of treatment is largest and most certain—perhaps patients with diastolic blood pressure of 105 mm Hg or above.

The general relationships between the problems isolated in this phase and the solutions presented in Sec. V could be stated as follows:

- If there is only a problem with compliance, both physican education and population education programs may be appropriate. The latter programs should be supplemented with behavioral approaches or incentives. In addition, the establishment of clinics, both neighborhood and industrial, should be considered.
- If the problem is inadequate control of hypertension despite compliance by the patient, it is largely a medical problem, which may be counteracted by physician education.
- If the problem is a low rate of successful referral to treatment, then the screening techniques should be examined with an eye toward shifting resources to mechanisms with demonstrated success at referring people to treatment—e.g., neighborhood clinics. Physician education should also be considered.
- If the problem is the most basic, significantly low awareness of hypertension, then screening (through clinics, industrial firms, door to door, or neighborhood health fairs) and both population and physician education programs are recommended.

V. HBP: PROBLEM SOLUTION

Many HSAs, SHPDAs, and communities will want to reduce HBP as a threat to the health of the citizens of that area, regardless of health status. Although the status measures discussed above can pinpoint specific problems, any HSA may want to consider HBP reduction programs. This section contains steps HSAs can take to combat HBP, lack of awareness, poor treatment, and attrition from treatment. Note that while HSAs will be the facilitators and perhaps the founders of such programs, they will not be providing services directly.

Most of the origins of an elevated HBP rate in the population are not subject to HSA influences. That is, if a group's HBP rate is high because of genetic factors or stress, it is unlikely that such factors could be substantially changed by HSAs (although their effect—HBP—can be controlled).

The information gained in the Problem Analysis Phase of this algorithm can provide guidelines as to the most effective action for an HSA to take against this community problem. For example, if the problem analysis phase has indicated that hypertension levels are particularly high in a predominantly black neighborhood, the HSA might encourage the establishment of a clinic to screen and treat people there.

The *Program Director's Handbook,* produced by Merck Sharp and Dohme in cooperation with the NHBPEP, contains numerous valuable suggestions including guidelines for enlisting the aid of other concerned groups and individuals in the HSA area. This can benefit HSA work on HBP by creating a combined community effort while identifying sources of volunteers as a cost-saving device. The handbook suggests that the following groups and individuals might be contacted:

1. Medical centers and large hospitals.
2. Clinics.
3. The local medical and dental societies.
4. Heart Association.
5. Red Cross.
6. Professional colleagues in positions of responsibility.
7. Various health planning agencies.
8. HMOs.
9. Universities/colleges/junior colleges.
10. Health councils.
11. State and local health departments.
12. Neighborhood centers.
13. Schools, unions, health programs, employees' groups.
14. Pharmaceutical representatives.
15. Service clubs.
16. Various organizations of any sort, such as religious groups.
17. Financial institutions.

In the Problem Recognition and Problem Analysis phases, the HSA staff may have uncovered problems at one or more links in the chain from screening to awareness to referral to treatment to adequate treatment to compliance.

The size of the community effort to solve those problems depends on the points in the chain where the problem occurred. In dealing with *each* problem, a number of activities are possible and are discussed below. We propose no single solution to a given problem; rather, we have attempted to present alternatives (for *each* problem) so that the HSA can select one or more alternatives to tackle a given problem in light of its goals, resources, community activities already under way, and so forth.

This section contains discussions of the procedures, costs, benefits, and demonstrated efficacy of each of the following approaches to HBP detection, treatment, and compliance:

- Education programs.
- Private screening
- Door-to-door programs.
- Industrial firms.
- Clinics.

EDUCATIONAL PROGRAMS

The community can use educational programs to combat the problem at *each* link in the chain. That is, education of the population, through the mechanisms described below, can be done for the following purposes:

- To make the public aware of the threat of HBP.
- To encourage people to have their blood pressure measured.
- To encourage people to seek treatment if they have HBP.
- To teach people the benefits of exercise and a good diet.
- To teach people about various stress-reducing techniques.
- To teach people the importance of compliance with drug regimens.
- To teach physicians about the importance of HBP.

Physician education programs can be valuable by increasing the likelihood that physicians in various specialities will measure blood pressure, increasing their awareness of the importance of hypertension as a medical problem, increasing the number of patients for whom they encourage treatment, and teaching them the importance of appropriate follow-up to ensure compliance.

Table 14, taken from the Louis Harris poll, provides some summary information about hypertension. Note that 60 percent of the population and 50 percent of those with HBP incorrectly believe that if you have HBP you have symptoms. Occasionally, when HBP is very severe, it may cause headaches and other symptoms. Table 15 provides information about the knowledge and experience of those with hypertension. Note that 54 percent of those who had stopped taking medication indicated that their doctor said it was no longer needed. Even allowing for the fact that this figure is inflated by patients who did not want to admit that they stopped for other reasons, it does appear to indicate a need for greater physician education. (See also Inui, 1976.)

Educational programs at the local level can be a fairly low-cost item when contrasted with the establishment and maintenance of permanent clinics. Physician

Table 14

PUBLIC KNOWLEDGE OF HYPERTENSION

	Total population (%)	People with hypertension (%)
Know "hypertension" means high blood pressure	24	33
Feel worry and anxiety the major cause	40	39
Volunteer that hypertension is cause of:		
Heart trouble	13	18
Stroke	43	54
Kidney trouble	1	3
Know control of blood pressure helps prevent:		
Heart trouble	1	3
Stroke	15	21
Believe that, if hypertensive should have symptoms	60	50
Know medicines important in treatment	82	90
Know salt restriction important in treatment	62	72
Believe hypertension is usually cured by treatment	7	8
Believe hypertension usually requires continued treatment	83	87
Believe "X" to be very serious		
X = cancer	94	94
X = heart condition	83	89
X = stroke	89	91
X = kidney trouble	61	69
X = hypertension	63	72
Under 35 years old	48	51
Over 65 years old	75	77
Believe can tell, personally, if blood pressure up		69

SOURCE: Louis Harris (1973).

education programs, of course, are even less expensive since they involve an intensive program aimed at a well-defined, smaller audience. Mass education programs can take many forms:

- Community lectures.
- Distribution of brochures.
- Radio and television spots.
- Newspaper advertisements.

Evidence on the efficacy of community-based HBP control programs relying on education has been presented by Farquhar and associates (1976, 1977). They launched mass media compaigning about health in two northern California communities to study the effects on those communities as contrasted with a control community. According to Farquhar, the residents of those communities not only learned

Table 15

HYPERTENSIVE PATIENTS' KNOWLEDGE AND EXPERIENCE

Item	%	Item	%
Know medicine important	90	Side effects present	16
Given medicine	90	Cost:	
Had stopped medicine	23	$10 per month or more	21
Stopped:		$5 to $10 per month	31
Doctor said no longer		Less than $5 per month	46
needed	54	Medicine a good value	54
Doctor said stop, no		Medicine too expensive	39
reason given	10	Salt restriction important	72
Personal decision	21	Told to reduce salt intake	57
Side effects	3	Given low-salt diet	21
Medicine doses per day:		Frequency of adding salt	
One	47	when told not to:	
More than one	48	Often	28
Less often	8	Sometimes/occasionally	33
How often forgot:		Almost never	39
Often	4	Frequency of adding salt	
Sometimes/occasionally	26	when *not* told not to:	
Almost never	70	Often	49
		Sometimes/occasionally	31
		Almost never	20

SOURCE: Louis Harris (1973).

a great deal but also made major changes in their living habits. Farquhar et al. (1977) note, "The mass media materials were devised to teach specific behavioural skills, as well as offering information, in affecting attitudes and motivation." In addition to the above approaches the mass media campaign included television and radio programming, weekly newspaper columns, billboards and posters.

People in the two experimental communities had significantly lower heart attack "risk scores" after one year than did the control community, with an even greater difference after two years. The mean systolic blood pressure dropped 11 and 8 mm Hg in the two treatment communities; the drop was particularly notable among those who initially had higher pressure levels. In one of the communities, additional intensive face-to-face instruction was given to some high-risk individuals. Despite this, progress in the two communities was about the same after two years, although the community receiving intensive treatment had shown greater improvement after one year. Farquhar concludes (p. 2):

> Lessons from our two year data relevant to blood pressure control are primarily these: (1) multi-factor health education can achieve surprisingly large blood pressure changes in a community at relatively low cost and without education directed at health professionals, (2) increased compliance with blood pressure medication may occur as an unanticipated benefit of multi-factor education in the absence of specific effort devoted to compliance, (3) the greatest fall occurs in individuals at greatest risk, and (4) weight reduction and possibly salt restriction explain some of the blood pressure effect.

The Farquhar work on community education is still in the early stages. One unanswered question is the permanence of the effects. Will there be a hi[illegible] de[illegible]

of slipping back to old, poor health habits? How permanent will the lifestyle changes be?

Private Screening

Recent surveys have shown that between 67 and 84 percent of patients visit physicians annually; over 90 percent visit a physician every five years (National Center for Health Statistics, 1973a). Private screening potentially could reach a huge percentage of the population, particularly if other health professionals—dentists, optometrists, etc.—were encouraged to measure blood pressure. In light of these statistics, the NHBPEP has concentrated its educational programs primarily on health professionals and advocates special screening for hard-to-reach populations only. A key advantage of private screening is greater continuity of care, so referral for definitive diagnosis and treatment is more likely. Further evidence as to the potential role that private physicians can play in detecting and treating hypertension is provided by a study reported by Reid et al. (1977). They found "91 percent of all unaware hypertensives had regular physicians. Sixty percent had consulted a physician within 18 months, and 92 percent had consulted a physician within 60 months of the survey." They concluded, "routine measurement of blood pressure by physicians may be more efficient than door-to-door surveys in contracting the unaware hypertensive person."

The potential payoff to the HSA of educational programs for professionals should not be ignored. These programs would be less costly than mass education and might lead to effective screening of a large proportion of the population. Such programs, of course, would need to be combined with educational materials for physicians and other health professionals about the importance of both treatment and compliance to therapy.

The NHBPEP convened a Working Group on the Training and Evaluation of Physicians that elucidated goals for a physician education program (NIH, 1973). These are quoted below as a good summary of the behavior changes needed by doctors in their approach to HBP.

Goals for Developing Learning Objectives for High Blood Pressure Education

Uncontrolled high blood pressure must be of concern to every person who participates in patient care. Physicians particularly must assume responsibility to assure that their patients have their blood pressure recorded at appropriate intervals. Further, they must set in motion appropriate diagnostic and therapeutic programs for patients found to have high blood pressure.

The specific goals of the educational program described here are:

1. For all physicians:

   a. That they regularly record the blood pressure of all patients whom they see. When the actual measurement of blood pressure is delegated to another person, that they ensure the measurement is made accurately and recorded in a manner which will call abnormalities to their attention.

b. That they make an initial assessment of patients with high blood pressure and:

   (1) assume responsibility for diagnostic investigations and therapeutic planning; or
   (2) refer patients with high blood pressure to an appropriate resource for further study and care.
   (3) In either case, all physicians who detect high blood pressure in their patients must assume responsibility to see to it that these patients, who are usually asymptomatic, receive prompt, comprehensive and continuing care through some source.

2. For primary care physicians: In addition to the goals for all physicians, physicians assuming primary care responsibilities for patients must:

   a. Have knowledge and skills which allow them to take a well-directed history from patients with high blood pressure and record that history so that pertinent negative, as well as positive, information is clearly evident.

   b. Obtain information concerning the prior therapeutic programs of their patients with high blood pressure and record the therapeutic history so that the successes or failures of past treatment can be related to both the qualitative and quantitative aspects of prior regimens.

   c. Have knowledge and skills to assess through physical examination the anatomical and functional status of patients with high blood pressure, paying particular attention to the eyes, the cardiovascular system, the nervous system and the renal system. They must record these observations in the patient's record.

   d. Have knowledge of the pertinent examinations of body fluids relevant to the preliminary investigation of patients with high blood pressure and then be prepared to obtain these examinations and record them so that the information can be utilized for diagnostic and therapeutic assessment.

   e. Have knowledge of the principal special diagnostic examinations pertinent to identifying conditions which cause secondary high blood pressure and be able to make decisions or seek advice regarding the applicability of such measures to particular constellations of clinical findings in patients with high blood pressure.

   Have knowledge of antihypertensive drugs and be able to develop and carry forward a logical, stepped-care therapeutic program for patients requiring drug therapy and to maintain a record of that drug program so organized that drug responses can be related to diagnostic findings.

g. Achieve sufficient interpersonal skills to facilitate patient compliance with long-range continuing therapy, and the alleviation of psychosocial stress.

The major liability of an approach that relies on private screening is that it misses people who are isolated from traditional health care services. Such people may need outreach screening (Weinstein and Stason, 1976).

DOOR-TO-DOOR SCREENING

One alternative available to community agencies anxious to detect HBP is door-to-door screening. This can serve two purposes: acquisition of sampling data to estimate population rates and the detection within a high-risk area of hypertensive persons with the goal of referring them to treatment.

When used to estimate rates, the standard procedure is to select a number of city blocks through an appropriate sampling technique. At that juncture, field workers are instructed to record the blood pressures of each person, or each person above a certain age, on that block, going from house to house. The specific techniques to be used in this kind of sampling approach are described in Selltiz et al. (1961) and Snedacor and Cochrane (1967).

In addition, sociological texts on methods of interviewing and survey techniques should be consulted. Alternatively, experts in this field can instruct the field workers so that they receive maximum cooperation from the people they approach and get effective blood pressure readings.

The key advantage of this approach is that it can yield a statistically valid sample. For this reason, the door-to-door technique has been used in the national Hypertension Detection and Follow-Up Program. The disadvantages are that it is very expensive, and given the involuntary nature of participation by those whose blood pressure is assessed, extensive follow-up is required to see that those identified as hypertensive seek treatment. Add to this the problem of obtaining valid blood pressure readings when volunteers are used.

On cost, Taylor (1975) found that some door-to-door screens cost $10 or more.

Because of the expense involved in this kind of data collection, an HSA may wish to concentrate from the beginning on a particular segment of its target population. This could be a segment with a problem that is expected to be particularly acute, the minority community for example, or where an intervention is particularly easy. If during problem definition a target area already has been selected, such a survey can confirm the initial expectation that HBP is a problem in the target area.

INDUSTRIAL FIRMS

Business and industrial firms have a vested interest in the health of their employees (and of the employee's families). Aside from altruistic or paternalistic motives, organizations with healthy employees increase productivity and save money in the long run. Combine this realization with the fact that it is a fairly straightforward, inexpensive matter for a large organization to screen for blood

pressure and monitor drug regimens in a small clinic, and it is easy to understand why a number of firms have been launching such programs. For a small organization, all that is required is a nurse on duty who can take blood pressures with a consulting physician as backup.

In general, larger, well-established firms are potentially more receptive to the establishment of a HBP screening and treatment program than small or new businesses. The larger the organization, the more likely there are to be resources for this kind of activity. Also, established businesses are more likely to retain a given employee over a long period of time and, thus, have a greater investment in his or her health status.

A large number of business organizations have established hypertension clinics or have added extensive hypertension activities to existing clinics. The best documented example of this approach is the work of Stamler et al. (1967) in Chicago. They reported an extensive screening program involving 76 companies and over 22,000 participants. Over half, 58.9 percent, of those with HBP reviously had been unaware of this fact. Only 11.2 percent of those with HBP were successively being treated—i.e., their blood pressure was controlled.

More recently Schoenberger (1976) has reported on multiphasic screening at many different industrial sites in and around Chicago. Although 65 percent of the hypertensives they diagnosed had not previously been identified, the program "failed to achieve striking improvement in the control of hypertension." Among the problems they cite in an industrial program are increasing volunteer participation, effective referral to medical care, persuading management of the importance of HBP, and educating physicians to be more aggressive in their treatment of it.

Frequently in a rural area, industrial firms can help planners cope with the absence of a large medical center. Charman (1974) has reported the experiences of such a HBP screening and control project in Berlin, New Hampshire. Two large businesses cooperated with an intensive community campaign. All employees of each firm were notified in advance about the screenings; 63 percent responded after one follow-up call. Of those identified as exhibiting HBP (after three separate blood pressure checks) 86 percent were found to be receiving drug therapy in a one year follow-up. Charman underscores the importance of enlisting the community physician's participation early in the campaign, as opposed to viewing him or her as the passive recipient of screening referrals.

NEIGHBORHOOD CLINICS

Finnerty and associates have demonstrated the potential success of neighborhood clinics and hospital outpatient department in Washington, D.C. Finnerty (1972, 1976) argues persuasively that such clinics should employ indigenous volunteers and paramedics and will enjoy enormous success. The success is manifested in demonstrated high rates of compliance.

According to Finnerty, in the past, "Patients dropped out, not because they were uneducated, not because they didn't care about their health, and not because they could not afford the medication, but rather that they were treated like cattle, herded from one room to another, left waiting for hours, and examined by a different doctor on each visit." The clinics he has established are aimed at counteracting each of those problems.

Finnerty states that his use of paramedics from the neighborhood offers several advantages. First, it is inexpensive. Second, paramedics know the people, the neighborhood, and the problems that are likely to result. Third, they are not perceived as threatening by the patients. Specially trained nurses and paramedics have been active in several clinics—e.g., the Fort Belvoir Amos Project, a project at Boston's Beth Israel Hospital, and the Washington, D.C. HDFP center. In Washington, each patient was assigned to a particular nurse and paramedic. According to Finnerty, this procedure, combined with a sensible appointment schedule, reduced attrition from 42 percent to 4 percent over a two year period. He estimates the ratio of physician to paramedic costs at eight to one.

A 1975 NHBPEP report (Stokes and Carmichael, 1975), currently being updated, estimated the cost of primary screening in a clinic. They assume paid health personnel ($4/hour) with a 50 percent overhead rate. Given an estimated five minutes mean screening time, they then computed the cost per screen at 50¢.

Among the findings from Finnerty's work is that a patient is significantly more likely to show up for his first treatment appointment if it is scheduled within 48 hours of the screening. Experience from this work in Washington, D.C. and elsewhere **indicates that neighborhood clinics should be encouraged by HSAs in subareas with extremely elevated HBP rates. They are inexpensive and effective.**

Special consideration should be given to such screening and treatment programs in minority neighborhoods. Minority areas are particularly important targets of these programs for a variety of reasons. First, the rate of HBP among blacks and other minorities has been demonstrated to be considerably higher than that for whites. Second, these groups tend to be less affluent and less likely to seek good medical care. Also, the quantity and quality of medical services available in poor, minority neighborhoods is low. Residents in these neighborhoods may have been discouraged from seeking medical treatment because of transportation problems, because offices and clinics are only open during the day, because they are more likely to be working during the day, and so forth. These factors are accentuated in the case of HBP, which is usually not accompanied by symptoms.

Screening and treatment programs should anticipate both the language differences with some ethnic groups—e.g., Chicanos—and the suspicion and hostility many feel toward programs from "outside." Considerable experience with federal government and other programs has shown that they often fail because though they may be mandated and funded from Washington or "the top," insufficient care is given to them at the local level. In the case of HBP programs for minority communities, this implies recruiting local residents to act as aides in the process and to serve on planning boards and so forth. This participation by members of the community will go a long way toward reassuring the citizens that the program is not a threat to them.

COSTS OF SCREENING AND TREATMENT PROGRAMS

Accurate costing is extremely difficult to obtain in this field, in large part because those who establish hypertension screening and treatment programs do so for motives other than assessing cost. The Weinstein and Stason book (1976) is an excellent attempt to estimate such costs using the best available data. In addition, we provide cost data about the demonstration projects we describe wherever possi-

ble. Such data should be interpreted with extreme caution. Although there is some consistency in the estimates, costs from one program to another are likely not to be comparable for any one of several reasons. Inflation will affect these figures, such that the same program would yield different costs in 1977 than it did in 1972. Programs in rural states are different from programs targeted at inner-city areas. Costs are affected by the degree to which volunteers and paramedical personnel are used. Estimates are affected by the degree to which testing for conditions other than hypertension occurs, as in a multiphasic screening program. Another factor is whether the screening program represented the establishment of a new operation or was added to an on-going public health clinic. Were secondary screening and referral procedures included? (Of course, there is a huge difference in cost if, indeed, a full work-up to ascertain the likelihood of secondary hypertension was included.)

Finally, some analysts include all screening and treatment expenses in their model, including the money patients pay for drugs. Thus, only a portion of the costs reported in *some* of these projects would be borne by public health agencies. Some of the expenses are private costs to patients. In comparing figures from different projects, the reader should be careful to observe whether such private expenses were included or excluded from the model.

Planners who hope to draw upon these cost data should carefully investigate the demonstration projects to see which ones most closely parallel their own situation. They may wish to contact the directors of the program in question to gather the most recent and detailed information on expenses (and to learn differences between that project and their own).

The Georgia Department of Human Resources has been conducting a hypertension screening program under the direction of Joseph A. Wilbur, M.D. Screenings are held in shopping centers, churches, fairs, etc. The personnel include nurses and many volunteers from such organizations as the Georgia Heart Association.

According to Dr. Wilbur[1] the cost per person for screening and referral in 1976 was $4.00. In addition, it has cost $43.50 per patient per year to do follow-ups on those diagnosed as hypertensive. However, a complete work-up on those patients (history taking, lab examinations, EKG, etc.) would have cost $35 more. That, is the total cost would have been $78.55. Also the cost per patient per year for medication was $34.25 in 1976 (the drugs were bought wholesale). According to Dr. Wilbur, their goal for 1977 is to screen 100,000 people at a total cost of $300,000. To keep expenses down, they plan to screen at places where there are larger concentrations of people and to use more volunteers. They have found that it takes two to three hours to train their volunteers. Finally, they estimate that the overhead cost for an established public health clinic to set up a hypertensive program would be $488 per year.

The South Carolina Department of Health and Environmental Control has been conducting a multiphasic screening program under the direction of David McCallum (1977). Over the past three years they have screened 142,000 people, using paid nurses and volunteers, at public health clinics, public places, and the local health department. This program tests for high blood pressure, breast cancer, diabetes, and other conditions. They report that the total cost per person has been

[1] Personal communication.

$9.17; the cost per abnormality uncovered has been $59.30. The cost per positive hypertensive patient has been $3.00 for detection.

Workers at the University of Michigan (Foote and Erfurt, 1976) developed a system for screening and detection that was tested at four industrial sites, including a UAW Union, a municipal sanitation department, a post office, and an automobile assembly plant. They estimate the expense per person for the initial screening at $.98; following up on those found to be hypertensive cost $26.17 per person. (Follow-up on these cases meant letters and phone calls to ensure that people were visiting their physicians and complying with their treatment regimens.) The average program cost per person was $6.21. (These figures do not include overhead.) The figures do include training the workers in the first years of this program; cost for subsequent years would be less. The authors argue that, when compared with cost to the company of cardiovascular illness, such a program easily pays for itself. However, it should be noted that companies pay for medication through health insurance with small employee contributions.

Another program was targeted at union employees at Gimbel's and Bloomingdale's department stores in New York City, under the direction of Michael H. Alderman, M.D. (Alderman, 1976). Their findings indicated that the percentages of hypertensives aware of their condition, under treatment, and controlled have increased dramatically since the early 1960s. Alderman suggests that the current challenge is not detection but "the continuing weakness of conventional approaches to the delivery of antihypertensive care." They report annual per patient costs of $125 in the first year and $100 in the second year under their program of treatment at the work site. Additionally, they found that disability and hospitalization costs for these New York employees decreased $293 for each patient per year.

Working with the data provided by the screening at Bloomingdale's and Gimbel's in New York, Hannan (1977) has developed a cost-effectiveness model for evaluation of a hypertension screening and control program in a given work setting. He estimates that the cost for screening an employee is $2.00 to $2.50. He further estimates that the cost for screening and treating each hypertensive employee is $100 per year including nurses' salaries and drugs at wholesale rates. (It should be noted that there were not sufficient data to separate "age by sex" blood pressure cohorts.)

The New York Telephone Company (Collings, 1976) has instituted a multiphasic screening program (MHS) and a Health Care Management program (HCM). The directors of that program estimate that in two fiscal years (1973-1974 and 1974-1975) hypertension and its complications cost the company over $1 million. They enthusiastically observe that in the areas where their HCM program was operating there was a 43 percent reduction in absence costs from hypertension.

Soghikian (1977) has reported on the costs of a hypertension control program in a health maintenance organization (the Oakland Kaiser-Permanente Medical Center). Paraprofessionals were employed under a physician's supervision. Among his findings:

- Total cost per multiphasic blood pressure screening and nurse recheck was $1.11 per person.
- Total cost for secondary blood pressure screening of patients with elevated blood pressure who kept their referral appointments was $11.63.

- The cost of the first year of treatment and follow-up for patients who arrived in the hypertension clinic was $134.18.
- The cost of monitoring labile hypertension for the first year was $12.44 per compliant patient.
- If all patients with elevated blood pressure on multiphasic screening followed up on their referrals, the total first year program cost would have been $18.20 per patient.

The author notes that the program dealt with a large population and involved drugs purchased by patients from pharmacies at retail costs.

We should underscore here a point made earlier. While controlling HBP would represent a tremendous saving in human suffering and lives, and can be justified on that basis, the jury is still out as to whether or not it will represent a savings in medical expenditures. Detecting and reducing HBP requires expenses both by the patient and the community, yet yields savings, for example in treatment of stroke victims. Certainly, HBP programs cannot be justified strictly on the basis of medical savings since, in fact, they may cost more than they save.

This problem can be minimized by carefully targeting efforts to those programs and populations where the benefit is the greatest, and the resource cost is least. Thus, an HSA may choose to focus on compliance and on moderate to severe HBP. Also, cost effectiveness considerations suggest further that greater attention be directed toward the treatment of persons who have other concurrent cardiovascular risk factors, particularly cigarette smoking, elevated serum cholesterol, and perhaps obesity. In borderline cases, these other factors could affect the decision whether to treat a patient. Similarly, they could indicate whether to begin an adherence intervention if compliance is low.

VI. HBP: PROBLEM REASSESSMENT

Problem reassessment is a crucial phase in the development of an HSA campaign against HBP. Only through monitoring and evaluating progress can effective management decisions be made about specific programs or areas requiring additional resources, where the successes and failures are, and so forth. To do an effective assessment, it is necessary to have maintained accurate data about the program from its inception.

Problem reassessment involves the following components:

- Clearly defined goals, as required in the problem recognition phase.
- A profile of the HBP status of area residents prior to intervention.
- A description of all screening and treatment programs.
- A post-treatment assessment of the health status of the community residents.
- Control groups or communities against which to compare progress.

The establishment of clear goals at the outset of the HSA approach to HBP is crucial. Procedures for this were outlined in the problem recognition phase and need not be repeated here. For the problem reassessment to determine whether progress has been made, it is important that there be a criterion against which to define this progress.

Clear and complete records should be kept indicating the status of the citizens of the community with respect to HBP as determined in the problem recognition phase. That is, for each area or subarea under consideration, complete records should be kept about the blood pressure levels, levels of awareness, percent under treatment, and the number of people receiving adequate treatment. Included in the "before" profile of the community should be results of estimates based on demographic distributions, analysis of data from previous screening programs, and analysis of data from any screening conducted by the HSA.

Detailed descriptions should be written and maintained describing existing screening and treatment programs discovered by the HSA in its review of community activities. These would include on-going clinics, health fairs, industrial firm activities, and so forth. In addition, any activities launched by the HSA, or encouraged by the HSA as a result of this HBP campaign, should be described in detail.

If these earlier steps are carried out correctly, the final phase, the post-intervention problem reassessment, should be straightforward. The first step is to gather detailed information about the health status of the population with regard to HBP after the beginning of the HSA campaign. This will include reviewing recent screening efforts by other local agencies and perhaps an additional post-treatment screening by the HSA itself. The same methods to assess screening efforts that were described earlier are appropriate here. For example, in examining the results of screening at an industrial firm after several years of HSA activity, the same questions must be asked about sample size, representativeness, and how the blood pressure was taken.

Examination of these data should yield a new profile of the target area or subarea with respect to blood pressure levels, awareness levels, treatment levels, and percent receiving adequate treatment. Progress then can be measured against two criteria:

- How do the HBP status data now compare with those before the HSA programs were launched?
- How do the HBP status data now compare with the goals and objectives originally defined by the HSA?

The process consists of establishing benchmarks early and then checking to see how well the program did compared with those benchmarks. However, the purpose is not just to see whether the programs worked but to learn which *components* of a program worked and which did not, as a guide for the management of future HBP efforts by the HSA. If the health status of the community has improved dramatically, this may have been due in part to HSA influence and in part to other programs of the American Heart Association, DHEW, and so forth. In a sense, as long as the health status has improved, it does not matter why. But the question of which programs of the HSA or other organizations were responsible is relevant for future efforts. A careful analysis relating the size and scope of each intervention effort—a screening or treatment program—to the HBP health status of the subpopulation against which it was directed will help to indicate which programs contributed to an observed improvement in health status. The purpose is not to rate programs but rather to learn from the process what activities were most productive. This knowledge can then serve as a guide to future HSA screening and detection programs toward the future improvement of the health status of the area or subarea.

The evaluation process, which consists of measuring change in the health status of a target population and relating that to screening and treatment programs, can be a very complex process. For example, if pre- and post-screening samples are compared, it is essential that they be as near identical as possible in terms of how well they represent the population. In addition, it is a difficult theoretical problem to estimate precisely what the health status of the population would have been without intervention. Statistical techniques for answering such complex questions fill scores of textbooks and are highly sophisticated. We are not suggesting that each HSA conduct such an evaluation, although some guidelines are presented in App. A. We are encouraging each HSA to relate interventions to pre- and post-measurements in a common sense fashion along the lines we have outlined here. It may be advisable to call in a consultant who specializes in evaluation research. (If a consultant participates he should be enlisted when the program is designed to ensure that the design is appropriate and the proper data will be collected. If the consultant is not called in until the end, it may not be possible to evaluate the program accurately). He could aid in the process of analyzing data to extract insights about the most productive activities.

If there are data about the health status of the population back in time—that is, longitudinal data—they can be extremely useful to the HSA. Acquisition of such historical data over the past 10 or 15 years, if possible, is encouraged.

The American Heart Association has suggested some questions that can guide data gathering foward for evaluating the effectiveness of a given screening or treatment program. Before the data can be useful in an evaluation, HSA standards and criteria must have been set (AHA, 1974).

1. What percentage of individuals eligible to be screened for elevated blood pressure were actually screened in this program?

2. What percentage of those screened were found to have elevated blood pressure?

3. Of those screened and found to have elevated blood pressure according to predetermined criteria, what percentage reported to their personal physician or other source of medical care for further evaluation?

4. How many personal physicians or other services of medical care reported evaluating the referred screenee with elevated blood pressure and when necessary placed him under treatment?

5. How many personal physicians or other sources of medical care reported "no treatment" of the referred screenee although the elevated blood pressure was confirmed?

6. What proportion of hypertensives stayed in treatment and achieved a reduction in their blood pressure?

7. In industrial screening, how many industries were impressed with the implications of the summary report of the company screening program and agreed to include blood pressure screening as part of the company's health program?

8. What percentage of physicians or other sources of medical care requested information about availability of supportive programs such as diet counseling, weight reduction classes, smoking withdrawal programs, exercise programs?

9. What percentage of physicians or other sources of medical care requested information about the treatment of hypertension?

10. How many individuals have requested patient education materials?

11. Did the (local) Heart Association have the capacity to conduct the hypertension control program—i.e.:

    (a) Sufficient funds to support the total program?

    (b) Sufficient staff and volunteers to support the total program?

    (c) Ability to handle follow-up of referrals *promptly*?

    (d) Ability to analyze accumulated data periodically to detect program failures or need for changes?

    (e) Adequate time for planning all phases of the program?

    (f) Did community response exceed the capacity of the Heart Association to conduct the program?

12. What was the cost of the program per individual screened and per individual detected with hypertension?

13. Of individuals detected, what was the cost per individual previously undetected?

14. Were problems encountered that were not planned for in advance of the program?

Theoretically, planners could compare pre- and post-intervention community death rates from heart attacks, strokes, and kidney failure as indicators of the control of HBP. However, we do not encourage this approach for two reasons. First, the time lag for hypertension to advance to these devastating final stages is so long that improvement in HBP status of the community would not be reflected in improved rates in these mortality statistics for many years. Second, causes of death, even such common ones as cardiovascular disease, are too rare to be useful in measuring changes in the HBP health status for a community. Third, a change in death rates would be due to many factors.

Appendix A

STATISTICAL CONSIDERATIONS

In this appendix we discuss the following methodological issues:

1. Choice of criteria and subareas.
2. Significance tests for rates.
3. Are samples representative of a population?
4. Has a program had significant effects?

CHOICE OF CRITERIA AND SUBAREAS

Cardiovascular mortality rates and high blood pressure rates vary over place and time because of differences in the "true" rates, and because of chance fluctuations around the true rates (Kleinman, Feldman and Mugge, 1976). Chance variation makes the observed rate merely an estimate of the true rate. When the people at risk are few, the estimate is not very reliable, and the rate will never be significantly higher than average. For example, for an area with 20 deaths out of 10,000 people at risk, we can be confident only that the true rate is between 10 and 30 deaths per 10,000. For such rare events as death, especially the type of death, a large population base is needed. To get a large enough sample, planners may be forced to aggregate over different subareas, or different years. This leads to problems when the areas are not similar or when major changes have occurred over time.

The minimum sample size needed to detect a significant difference most of the time it occurs depends on the magnitude of the rate (e.g., cardiovascular mortality), the size of the difference to be detected, and the amount of error in screening tolerated.[1] (Because of chance variation, one can never be absolutely sure an area is standard or substandard.) It can be shown that the minimum sample size (n) is approximately

$$n = \frac{(p + x/2)\,(1-p-x/2)\,k}{x^2}$$

where p is the magnitude of the rate, x is the difference to be detected and (k) is a measure of the error tolerated.[2] In all our computations, we will assume k = 6.2.

[1] Sample size is measured in person-years of experience. A person-year is an observation of one person for one year. Thus, three years of data on 1000 person is 3000 person-years of experience.

[2] See Snedacor and Cochrane (1967), pp. 111-114. There are two types of errors to minimize—the error of claiming the area is substandard when it is normal, and the error of calling substandard areas normal. The former is reduced by taking a strict "significance level" and the latter by requiring high "power." The choice of k = 6.2 represents 80 percent power and a one-sided 5 percent or two-sided 10 percent significance level.

If the events are rare, so that $(1 - p - x/2)$ is approximately 1, formula (1) can be simply represented in terms of the number of events, np, required. Let c be the proportion of increase to be detected, so that $x = cp$.

$$np \simeq \frac{p(p + cp/2)\,k}{(cp)^2} = \frac{(1 + c/2)\,k}{c^2}$$

Thus, to detect a 100 percent increase in mortality from a particular case requires

$$np = \frac{(1.5)\,(6.2)}{1^2} = 9.3 \text{ deaths.}$$

However, to detect a 10 percent increase in mortality requires

$$np = \frac{(1.05)\,(6.2)}{(.1)^2} = 651 \text{ deaths.}$$

Thus, the objectives of the problem analysis have great influence on the sample size required. Even fairly small areas with extremely high mortality can be detected, but slight or subtle differences are only visible between large populations observed over many years.

For program evaluation and comparison between areas, sample sizes must be roughly twice as large in each area. In this case, there will be chance variation in each area or time to contend with.

To illustrate how confining these statistical constraints might be on health planners, we will compute the sample size needed to evaluate high blood pressure control. Suppose a clinic program is started to detect and control blood pressure in a small area. Suppose that the rate of uncontrolled high blood pressure can be reduced from 20 to 10 percent. This might eventually have the effect of reducing the cardiovascular mortality in the small area from 10 to 9 per thousand in the 55-64 year old age group.

How many people must the area have to detect reductions of this size? If we have data on only one year, we need 117,000 55-64 years old to detect the mortality difference, but only 160 55-64 year olds to detect the uncontrolled high blood pressure difference.[3] Since the evidence is good that high blood pressure is a real health problem, and not just a correlate of a real health problem, we may be satisfied with the last comparison.

[3] Computations: When $p = .010$, $x = -.001$, then n_1, the number needed in each area, is twice that given in the first formula and $k = (2.5)^2 = 6.2$.

$$n_1 = \frac{2(.0095)\,(1 - .0095)\,(2.5)^2}{(.001)^2} = 117{,}000 \text{ people at risk.}$$

When $p = .2$, $x = -.1$,

$$n_1 = \frac{2(.15)\,(1 - .15)\,(2.5)^2}{(.1)^2} = 160 \text{ people at risk.}$$

Obviously local areas will not have 117,000 people in that age group. The problem is that the expected difference, 1/1000 deaths, is so small. Cardiovascular mortality is caused by so many factors that the effects of programs to change one of these factors are diluted, and the rates themselves will not change much. Planners interested in program evaluation or comparison of HSA subareas must use measures of high blood pressure and rely on empirical knowledge (that high blood pressure is dangerous) to conclude that their programs are effective, or that the problems of one area are more severe than of another. Mortality measures are useful nationally in validating such knowledge but can be used locally *only* to suggest problem areas.

Because of sample size problems, local planners must avoid making unnecessary distinctions to further reduce their sample. (Males have considerably higher mortality than females, but since the sex ratio is fairly constant between areas, there is little value in analyzing sex-specific statistics.)

SIGNIFICANCE TESTS FOR RATES[4]

In many parts of the algorithm, planners must know whether an observed rate is significantly higher (or lower) than standard. Such significance testing is a common and important part of statistical inference. By convention, the question is posed as follows: Suppose the standard rate were the true rate for the population. How likely would it be to observe a rate as high as the observed rate or higher? If it is less likely than the significance level chosen (usually 5 percent), the observed rate is said to be significantly higher.

The following method can be used for determining in any algorithm step whether an observed rate is significantly different from an HSA standards.

Let N be the denominator on which the rate is based (e.g., people over age 55), and let s be the standard rate and r the observed rate. We assume that sN is sufficiently large that the distribution of rates, if s were the true rate, can be taken to be normal with mean s and variance $s(1 - s)/N$. This assumption leads to the following procedure:

1. Compute $u = (r - s) \sqrt{N/s(1 - s)}$, the standardized normal deviate for r.
2. Find the probability of observing the value r or greater by looking up u in Table A.1.

Assert r is higher than standard if that probability is smaller than the chosen significance level (commonly 5 percent at which level $u = 1.65$).

Sometimes, when rates are very small, the actual numbers of events are used instead of rates. In this case, step 1 is slightly modified. Take u to be $(o - e)/\sqrt{e}$ where o is the observed numbers of events and e is the number of events under the standard. Proceed with steps 2 and 3, as before.

Example: Suppose the standard for uncontrolled high blood pressure in adults over 30 is 10 percent. Suppose a well-conducted random sample of such people finds

[4] Snedacor and Cochrane (1967), pp. 211-213.

Table A.1

SIGNIFICANCE OF OBSERVED STANDARD DEVIATIONS
(areas in tail of a normal distribution)

Standard Deviates	.85	1.28	1.65	1.96	2.33
One-tailed area[a]	.2	.1	.05	.025	.01
Two-tailed area[b]	.4	.2	.1	.05	.02

[a]Level of significance for testing whether an observed rate is significantly higher than a standard rate. The number is the probability that a normally distributed random variable is greater than this many standard deviations above its mean. Thus, only 5 percent of normal random values are larger than 1.65 standard deviations above the mean.

[b]Level of significance for testing whether observed rates in two areas are significantly different from each other, or for testing whether a program has had significant effects.

60 of 500 with uncontrolled high blood pressure. Then, $s = .1$, $r = 60/500 = .12$, and $n = 500$, so

$$u = (.12-.1)\sqrt{\frac{500}{.1(1-.1)}} = 1.49.$$

Since u is less than 1.65, the high blood pressure rate of the sample is not significantly higher than standard.

A TEST FOR WHETHER SAMPLES COULD BE REPRESENTATIVE OF A KNOWN LARGE POPULATION

We describe here an approximate procedure for use when the sample size, n, is fairly large (i.e., 100 or more). Unless sampling is very expensive, small samples should be avoided. However, if smaller samples are unavoidable, t tests (Snedacor and Cochrane, 1967, pp. 94-116) and more formal methods of multiple comparisons (ibid., pp. 271-275) would have to be used to check for unrepresentativeness.

1. Select a set of demographic variables of interest and for which average values, μ, or proportion, π, for the known large population can be obtained. In a sample taken near a Census year, the average values are given by the Census. Otherwise, one must rely on whatever values are available from the state, or assume that values from earlier years have not changed much. These variables may be categorical (e.g., sex, race) or continuous (age, income).

2. For each categorical variable, compute the proportion p in the sample in each category and set

$$t = (p-\pi)\sqrt{\frac{n}{\pi(1-\pi)}}$$

3. For each continuous variable, compute the average $\bar{x} = \Sigma x_i/n$ sample and the standard deviation

$$s = \sqrt{\frac{\Sigma(\bar{x}_i - \bar{x})^2}{n-1}}$$

and set

$$t = \frac{\bar{x} - \mu}{s}\sqrt{n}$$

4. Inspect the set of t values. For variables with a "large" $|t|$ the sample is significantly different in that variable.[5] The cutoff point should be considerably higher than 1.65 because we now care about all differences, high or low, and because with several comparisons being made, it is more likely that by chance one of them might be fairly large.

5. Assert the sample is not representative if one t-value is over 2.5, or several are over 2.

Example: Suppose the sample is 100 people over 30 and that age, years of schooling, sex, and race are known about the large population. Suppose the proportions, averages, and standard deviation are given by the table below.

	Female (Proportion)	Black (Proportion)	Age (Average Years)	Education (Average Years)
Sample statistics	.45	.16	50	11.1
Sample standard deviation	—	—	14	3
Population values	.50	.20	52	10.5

Sample size = 100

$$t_F = (.45 - .50)\sqrt{\frac{100}{.5(1-.5)}} = -1$$

$$t_B = (.16 - .20)\sqrt{\frac{100}{.2(1-.2)}} = -1$$

$$t_A = \frac{(50 - 52)}{14}\sqrt{100} = 1.4$$

$$t_E = \frac{(11.1 - 10.5)}{3}\sqrt{100} = 2$$

Since none are over 2.5, and only one is 2, we conclude that these differences are consistent with the sample being drawn randomly from the known population. This sample is not significantly unrepresentative. However, the prevalence figures from

[5] The symbol "$|x|$" means absolute value, ignoring sign. Thus, $|2| = 2$, and $|-3| = 3$.

such a sample can be improved by adjusting for known differences between the sample and the population. For example, since high blood pressure in blacks is approximately twice as common as in whites, the prevalence for the population can be expected to be $(2 \times .2 + 1 \times .8)/(2 \times .16 + .84) = 1.03$ times as high as for the sample. Similar adjustments can be made for other characteristics for which national prevalence data are available.

A TEST FOR WHETHER A PROGRAM HAS HAD SIGNIFICANT EFFECTS

We describe here a simple evaluation procedure based on a comparison of measured differences over time in the population affected by the program and measured differences over time in a control group. In most cases, the control group will be the country as a whole, or the comparable demographic subgroup of the country as a whole. We assume that the sample sizes in the n_1 and n_2 are fairly large, and that national values are known precisely. If the samples are small, or control methods are more sophisticated, more complicated statistical methods will be needed.

1. Select a set of program outcomes of interest and for which average values, μ_1, μ_2, or proportions, π_1, π_2, can be obtained for national populations with similar demographics at the same times the program measurements were taken.

2. For each proportion (e.g., proportion uncontrolled high blood pressure), compute

$$s = \sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$$

and set

$$t = \frac{[(p_1 - p_2) - (\pi_1 - \pi_2)]}{s}.$$

3. For each continuous variable (diastolic blood pressure), compute the mean differences, $\bar{x}_1 - \bar{x}_2$, the standard deviation of the estimate,

$$s = \sqrt{\frac{\Sigma(x_{1i} - \bar{x}_1)^2}{n_1^{\,2}} + \frac{\Sigma(x_{2i} - \bar{x}_2)^2}{n_2^{\,2}}},$$

and set

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{s}.$$

4. Inspect the set of t values. For variables with a large $|t|$, the sample is significantly different in that variable. If only one outcome is being considered, we can take 1.65 as the 5 percent significance cutoff, but if several outcomes are being

considered, we should take a somewhat larger value because it is more likely by chance that one difference might be fairly large.

5. Assert the program has made a significant difference if one t-value is over 2.3, or several are over 1.65.

Example: Suppose that 1975 and 1980 random samples of black adults over 30 in an area show that 100 of 500 in 1975 and 50 of 500 in 1980 have uncontrolled high blood pressure. Suppose that national rates of uncontrolled high blood pressure for such people are .18 in 1975 and .14 in 1980.

Then $p_1 = 100/500 = .2$, $p_2 = 50/500 = .1$, $n_1 = n_2 = 500$ and $(\pi_1 - \pi_2) = (.18 - .14) = .04$. Hence

$$s = \sqrt{\frac{.2(1-.2)}{500} + \frac{.1(1-.1)}{500}} = .022,$$

and so

$$t = \frac{(.2 - .1) - .04}{.022} = 2.68.$$

Since only one outcome is considered, the cutoff is 1.65. Since 2.68 is greater than 1.65, the area has done significantly better than the country as a whole over the period 1975-1980.

Appendix B

DEATH CERTIFICATE

(PHYSICIAN, MEDICAL EXAMINER OR CORONER)
U.S. STANDARD
CERTIFICATE OF DEATH

Form Approved
OMB No. 68R 1901

LOCAL FILE NUMBER
STATE FILE NUMBER

TYPE OR PRINT IN **PERMANENT INK**
FOR INSTRUCTIONS SEE HANDBOOK

DECEDENT

DECEDENT—NAME FIRST MIDDLE LAST — 1.
SEX — 2.
DATE OF DEATH (Mo., Day, Yr.) — 3.
RACE (e.g. White, Black, American Indian, etc.) (Specify) — 4.
AGE—Last Birthday (Yrs.) — 5a.
UNDER 1 YEAR: MOS. DAYS — 5b.
UNDER 1 DAY: HOURS MINS — 5c.
DATE OF BIRTH (Mo., Day, Yr.) — 6.
COUNTY OF DEATH — 7a.
CITY, TOWN OR LOCATION OF DEATH — 7b.
HOSPITAL OR OTHER INSTITUTION—Name (If not in either, give street and number) — 7c.
IF HOSP. OR INST. Indicate DOA, OP/Emer. Rm., Inpatient (Specify) — 7d.
STATE OF BIRTH (If not in U.S.A., name country) — 8.
CITIZEN OF WHAT COUNTRY — 9.
MARRIED, NEVER MARRIED, WIDOWED, DIVORCED (Specify) — 10.
SURVIVING SPOUSE (If wife, give maiden name) — 11.
WAS DECEDENT EVER IN U.S. ARMED FORCES? (Specify Yes or No) — 12.
SOCIAL SECURITY NUMBER — 13.
USUAL OCCUPATION (Give kind of work done during most of working life, even if retired) — 14a.
KIND OF BUSINESS OR INDUSTRY — 14b.

IF DEATH OCCURRED IN INSTITUTION, SEE HANDBOOK REGARDING COMPLETION OF RESIDENCE ITEMS

RESIDENCE—STATE — 15a.
COUNTY — 15b.
CITY, TOWN OR LOCATION — 15c.
STREET AND NUMBER — 15d.
INSIDE CITY LIMITS (Specify Yes or No) — 15e.

PARENTS

FATHER—NAME FIRST MIDDLE LAST — 16.
MOTHER—MAIDEN NAME FIRST MIDDLE LAST — 17.
INFORMANT—NAME (Type or Print) — 18a.
MAILING ADDRESS STREET OR R.F.D. NO. CITY OR TOWN STATE ZIP — 18b.

DISPOSITION

BURIAL, CREMATION, REMOVAL, OTHER (Specify) — 19a.
CEMETERY OR CREMATORY—NAME — 19b.
LOCATION CITY OR TOWN STATE — 19c.
FUNERAL SERVICE LICENSEE OR Person Acting As Such (Signature) — 20a. ▶
NAME OF FACILITY — 20b.
ADDRESS OF FACILITY — 20c.

CERTIFIER

To be Completed by CERTIFYING PHYSICIAN Only

21a. To the best of my knowledge, death occurred at the time, date and place and due to the cause(s) stated.
(Signature and Title) ▶
DATE SIGNED (Mo., Day, Yr.) — 21b.
HOUR OF DEATH — 21c. M
NAME OF ATTENDING PHYSICIAN IF OTHER THAN CERTIFIER (Type or Print) — 21d.

To be Completed by MEDICAL EXAMINER or CORONER Only

22a. On the basis of examination and/or investigation, in my opinion death occurred at the time, date and place and due to the cause(s) stated.
(Signature and Title) ▶
DATE SIGNED (Mo., Day, Yr.) — 22b.
HOUR OF DEATH — 22c. M
PRONOUNCED DEAD (Mo., Day, Yr.) — 22d. ON
PRONOUNCED DEAD (Hour) — 22e. AT M

NAME AND ADDRESS OF CERTIFIER (PHYSICIAN, MEDICAL EXAMINER OR CORONER) (Type or Print) — 23.

REGISTRAR — 24a. (Signature) ▶
DATE RECEIVED BY REGISTRAR (Mo., Day, Yr.) — 24b.

CAUSE OF DEATH

CONDITIONS, IF ANY, WHICH GAVE RISE TO IMMEDIATE CAUSE, STATING THE UNDERLYING CAUSE LAST

25. IMMEDIATE CAUSE (ENTER ONLY ONE CAUSE PER LINE FOR (a), (b), AND (c).)

PART I
(a) — Interval between onset and death
DUE TO, OR AS A CONSEQUENCE OF
(b) — Interval between onset and death
DUE TO, OR AS A CONSEQUENCE OF
(c) — Interval between onset and death

PART II OTHER SIGNIFICANT CONDITIONS—Conditions contributing to death but not related to cause given in PART I (a)
AUTOPSY (Specify Yes or No) — 26.
WAS CASE REFERRED TO MEDICAL EXAMINER OR CORONER (Specify Yes or No) — 27.

ACC., SUICIDE, HOM., UNDET., OR PENDING INVEST. (Specify) — 28a.
DATE OF INJURY (Mo., Day, Yr.) — 28b.
HOUR OF INJURY — 28c. M
DESCRIBE HOW INJURY OCCURRED — 28d.
INJURY AT WORK (Specify Yes or No) — 28e.
PLACE OF INJURY—At home, farm, street, factory, office building, etc. (Specify) — 28f.
LOCATION STREET OR R.F.D. No. CITY OR TOWN STATE — 28g.

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