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Cardiovascular Disease in Elders: Is It Inevitable?

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Abstract

Cardiovascular disease is the major cause of death and disability in America. The burden of cardiovascular disease is higher in elders than in younger populations, presumably because of life-long exposure to risk factors such as hypertension, smoking, abnormal blood lipids, lack of exercise, and/or obesity. Many assume that it is too late to attempt to modify risk factors in elders because behavior is so difficult to change. The purpose of this article is to argue that cardiovascular risk factor modification is effective in elders and should be vigorously pursued for the good of individuals, families, communities, and societies.

Key Words: cardiovascular disease, elders, hypertension, smoking, lipids, exercise, obesity.

Cardiovascular disease (CVD) is the primary cause of death and disability among men and women in the United States and the world. According to the American Heart Association (1999), 58,800,000 Americans (21.6% of the population) have one or more forms of CVD. Elders, defined as individuals age 65 years or older, comprise almost 13% of our population (United States. Census Bureau, 1999). Yet, CVD is disproportionately represented in this group; 65% of the CVD hospitalizations in 1996 were in elders and about 84% of the deaths from CVD occurred in this age group (American Heart Association, 1999). Obviously, CVD is a disease of elders.

Cardiovascular disease significantly affects quality of life and successful aging. Individuals, families, communities, and society as a whole feel the burden of CVD. For example, Medicare spent $24.6 billion on hospitalizations for CVD in 1995—almost a third of their expenditures (American Heart Association, 1999). This amount, although enormous, fails to account for outpatient testing, provider visits, pharmaceutical expenses, and lost days of work among patients and family members.

Many of the factors causing CVD are known and can be modified effectively through life-style changes and therapeutic means. Some clinicians remain doubtful, however, that decades of exposure to cardiovascular risk factors can be reversed by changes begun in later life. The purpose of this article is to argue that CVD risk factor modification is effective in elders but is pursued less vigorously in older people than in younger individuals. This preferential behavior may be related to the fact that individuals over age 65 have been routinely excluded from clinical and epidemiological trials. Thus, recommendations for risk factor modification in elders often must be extrapolated from trials conducted in younger populations.

Overview of Cardiovascular Disease

Cardiovascular disease refers to various diseases of the heart and blood vessels but there is no universally accepted definition of the term CVD. The American Heart Association (1999) defines CVD as including: hypertension (HTN) or high blood pressure, coronary heart disease (also called coronary artery disease), angina pectoris (transient chest pain associated with inadequate blood supply to the heart muscle), myocardial infarction (i.e., heart attack), stroke, rheumatic heart disease, congenital cardiovascular defects, and heart failure.

By far, the most common form of CVD is HTN, which affects fifty million Americans, most of whom are elderly (Joint National Committee-VI, 1997). Heart failure is also a prevalent form of CVD. Almost five million people in the U.S. have heart failure and it is the single most common cause of hospitalization in elders (Cohn, Abraham, Levine, Pina & Silver, 1999).

Most of the diseases grouped under the heading CVD are interrelated (Figure 1). For example, HTN is a major, independent risk factor for both coronary heart disease and heart failure (Kannel, 1996). Coronary heart disease is the primary etiology of heart failure, although a variety of other factors also cause heart failure (e.g., heart valve defects caused by diseases such as rheumatic fever or infection, primary disease of the heart muscle known as cardiomyopathy, and congenital heart disease).

Much CVD is caused by atheromatous plaque build-up on the intima or inner layer of the arterial wall. Coronary heart disease, angina pectoris, and myocardial infarction are primarily atherosclerotic in etiology. Likewise, hypertension and stroke are often manifestations of the same process in arteries of the body and the brain. Thus, a

major decline in CVD can be accomplished through modification of the major risks known to be associated with atherosclerosis: HTN, smoking, abnormal blood lipids, physical inactivity, and obesity. People often focus on the need to reduce their stresses (Fielding, 1987) although the link between CVD and stress remains elusive. Currently, stress is not classified as a major CVD risk factor (American Heart Association, 1999).

Cardiovascular Disease Risk Factors in Elders

As people age, they are even more susceptible to the onset of CVD than they were as younger adults. Some risk factors for CVD, such as HTN, are more likely to occur in older adults while other risk factors, such as smoking and sedentary lifestyle, are behavioral risks whose effects may accumulate over many years to increase the risk of CVD as a person ages. For example, body weight may increase over time and result in obesity if an older adult does not continue to pursue an active lifestyle. Older adults who have a combination of risk factors may be particularly susceptible to CVD. For example, in one study, researchers found that non-smoking older adults with low cholesterol, low blood pressure and no cardiac abnormalities had fewer cardiac events than did those without this low-risk profile (Daviglus, et al., 1998). Obviously, the etiology of CVD is complex and often the result of an accumulation of many seemingly minor transgressions that we all allow ourselves.

Because the risk of CVD is high if an elder has a combination of risks, the mitigation of even one factor should have considerable benefit in the prevention of CVD. There is general consensus that reducing CVD risk factors is beneficial for children, adolescents, and young adults but aggressive risk factor reduction in elders is controversial for three reasons. First, there is debate about the need for aggressive

intervention because some risk factors, such as hyperlipidemia, are less predictive of CVD as a person ages (Kannel, 1997). Second, some believe that efforts at risk factor reduction in elderly persons are not good for society. Smoking cessation programs, for example, can increase health care costs by increasing life span (Barendregt, Bonneux, & van der Maas, 1997). Third, there is controversy about the effectiveness of such strategies in an older, "set-in-their-ways" population. Can elders be helped to modify their CVD risks or are we simply wasting our time?

The remainder of this article addresses the third issue. Each of the major risk factors (HTN, smoking, abnormal blood lipids, sedentary lifestyle, obesity and the commonly cited "stress" factor) is discussed with a focus on the research evidence that CVD risk reduction strategies that are useful for younger persons are also efficacious for elders. Though other factors (e.g., diabetes, insulin resistance, homocysteinemia), are also important contributors to CVD, only the major risk factors modifiable through life-style change are addressed in this article.

Hypertension

Hypertension is the most important risk factor for CVD in the elderly (National High Blood Pressure Education Program Working Group, 1994). Yet, the treatment of HTN has been plagued by an attitude of "therapeutic nihilism" that remains difficult to overcome (Moser, 1997). Less than a decade ago there was still uncertainty about whether to treat HTN in elders once it was diagnosed (Cushman & Black, 1999). Erroneously, elders were expected to experience a 10 mm Hg increase in systolic blood pressure (BP) with each decade of life, and a BP less than 220/100 mm Hg was termed "mild benign HTN" (Friedberg, 1966). Health care providers today consider a systolic BP

of 140 mm Hg or higher and/or diastolic BP of 90 mm Hg or higher as clinically significant HTN that requires treatment. Isolated systolic HTN is common and particularly malicious (Kannel, 1996). Current recommendations suggest that a BP below 120/80 is ideal (JNC-VI, 1997), although such a goal is difficult to achieve in elders because of the anatomic and physiologic changes that occur with aging (Moser, 1992).

Hypertension is extremely common among elders; 57.3% of men and 60.8% of women between the ages 65 and 74 have documented HTN (American Heart Association, 1999). In individuals 75 years or older, 64.2% of men and 77.3% of women have BP higher than 140/90. Even a relatively small increase in systolic or diastolic BP is associated with an increased risk of stroke, myocardial infarction, sudden cardiac death, coronary heart disease, heart failure, renal disease, and all-cause mortality. Treatment of HTN in elders effectively reduces the risk for CVD morbidity and mortality, including stroke (Cushman & Black, 1999; Moser, 1992). The benefits of treatment for HTN have been demonstrated in individuals with diastolic HTN up to age 80 and with systolic HTN up to age 90 (Rich, 1999).

Recent guidelines from the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (1997) cite the importance of lifestyle modification in the treatment of HTN. Weight control is the most effective nonpharmacologic therapy available. In addition to weight control, the authors of the guidelines advocate aerobic physical activity and dietary modifications (e.g., limiting alcohol, reducing sodium intake, and maintaining adequate potassium intake). A reduction in dietary saturated fats and cholesterol is also recommended, although the direct effect of these dietary changes on uncomplicated HTN is unknown. It is possible

that a reduction of dietary fats may assist in weight control that, in turn, should lower blood pressure. However, there are no data that demonstrate a direct relationship between dietary fat intake and HTN in individuals of normal body weight.

In spite of the prevalence of HTN, it is often inadequately treated. Current estimates indicate that only 27.4% of known hypertensives have good control of their BP (i.e., $\leq$140/90 mm/Hg) (Burt, et al., 1995). The treatment of elders with HTN is particularly problematic. In a survey of general practitioners in the United Kingdom, Coppola and colleagues (1997) found that the thresholds for drug treatment of HTN increased with patient age. In that study, only 68% of systolic HTN, 23% of diastolic HTN, and 9% of isolated systolic HTN was treated in patients between 70 and 79 years of age. Likewise, a study in the U.S. showed that only 7% of elderly HTN patients enrolled in a large health maintenance organization had achieved a BP <140/90 (Barker, Mullooly & Linton, 1998). Berlowitz et al (1998) demonstrated that poor control of BP in a sample of elderly male hypertensives was due to lack of aggressiveness in therapy rather than failure of the treatment program. In that study, those patients who received more intensive medical therapy achieved better BP control, suggesting that the issue was physician attention rather than patient compliance.

These results suggest that aggressive therapy for HTN can effectively lower blood pressure. Yet, many elders with HTN do not receive adequate treatment. In order to achieve a reduction in the prevalence of HTN in older adults, and thus prevent the incidence of CVD in this population, it may be necessary to change the practice of health care providers rather than the behavior of patients.

Smoking

Cigarette smoking caused 418,690 of the two million U.S. deaths in 1990. The percentage of total CVD deaths attributable to smoking is about 29% (Center for Disease Control and Prevention 1993; Jonas, et al, 1992) and many who die of CVD are elders who began smoking many years before the risks of smoking were widely known. Currently, an estimated 14.9% of men and 11.5% of women over age 65 are smokers (American Heart Association, 1999).

Smoking is a well-established risk factor for atherosclerosis that often leads to coronary heart disease, stroke, and myocardial infarction (Rigotti & Pasternak, 1996). Smoking also contributes to hypertension, one of the primary causes of atherosclerotic CVD. In addition, research shows that cigarette smoke interacts with the metabolism of some drugs used to treat atherosclerosis a factor of particular importance to elders, who often take multiple medications daily (Berg, 1999).

Smoking cessation at any age has been shown to dramatically affect cardiovascular health. Reduced cardiovascular mortality can be demonstrated within a year of cessation (Hall, 1997). Further, there may be a benefit to elderly individuals in quitting smoking even after cardiovascular disease has occurred. A longitudinal study of patients who had undergone coronary artery revascularization showed that persistent smokers were 1.44 times more likely to die than those who quit smoking after the surgery (Hasdai, Garratt, Grill, Lerman, & Holmes, 1997).

The decision to quit smoking has health benefits for a smoker of any age and a variety of successful programs have been developed to help smokers quit (Richmond, 1999). According to Prochaska, DiClemente, and Norcross (1992), ending an addictive

behavior such as smoking requires that the smoker be ready to take action to end the habit. Rather than talking about quitting (contemplation stage), or simply reducing the number of cigarettes smoked (preparation stage), a smoker must make the decision to quit and follow through on that decision (action stage).

Like many younger smokers, elderly persons take action to quit smoking if they have experienced symptoms that they attribute to smoking rather than to age (Clark, Hogan, Kviz, & Prochaska, 1999). Hospitalization also prompts elders to quit smoking and several researchers have reported successful smoking cessation interventions in post-surgical and hospitalized elders. For example, counseling by nurses in a thoracic surgery unit led 40% of patients to quit (Di Tullio et al., 1991; Wewers, Jenkins, & Mignery, 1997). In another study, 15% of surgery patients at a Veteran's Administration hospital quit smoking within twelve weeks of receiving in-hospital counseling, nicotine replacement, and follow-up telephone calls compared to 8% in a control group (Simon, Solkowitz, Carmody, & Browner, 1997).

Outpatient smoking cessation programs for elders have also been successful. For example, at Mayo Medical Center, 613 patients aged 65-82 received a nicotine dependence consultation that resulted in 24.8% of the patients abstaining from smoking (Dale et al., 1997). Researchers in another study found that a brief counseling session in a physician's office resulted in a 15% smoking cessation rate among a group of smokers aged 50-74, compared to an 8% cessation rate in a group that did not receive counseling (Morgan et al., 1996).

Clearly, elderly smokers can quit smoking when they are ready to do so. Smoking cessation programs can be successful if they are targeted at elders who are ready to take

action because they believe their medical conditions are caused by smoking. Other stimuli that lead elders to quit smoking need to be identified in future research. Because smoking cessation can reduce the risk of death by CVD in as short a time as one year after an elder stops smoking, quitting smoking may be one of the best behavioral changes an elder can make to reduce the risk of CVD.

Abnormal Blood Lipids

Abnormal lipids have been known to be a risk factor for atherosclerosis and CVD for over three decades. Yet, efforts to control lipid levels in elders have been irresolute, probably for three reasons. First, it is difficult to predict who will develop abnormal blood lipids. Some people develop an elevated cholesterol level in spite of adhering to a relatively healthy diet. Second, the strength of the association between lipid levels and coronary heart disease is attenuated with age (Kannel, 1997). For example, lipid levels in men peak in middle age and then decline (Johnson, Rifkind, Sempos et al, 1993). This observation may have convinced many practitioners that elevated cholesterol does not require aggressive treatment. In reality, LDL:HDL ratio is a strong predictor of CVD in the elderly. Elevated triglycerides is an independent risk factor in elderly women but not in elderly men (La Rosa, 1997). Third, although elders respond as well to lipid lowering therapy as do younger individuals, few studies have been conducted to demonstrate outcomes of therapy (e.g., lower mortality). In fact, no studies of lipid lowering therapy have included participants over age 80 (Rich, 1999). The largest trial of lipid lowering therapy to date (West of Scotland Coronary Prevention Study (Shepherd, Cobbe, Ford, et al, 1995) excluded individuals over age 65.

Abnormal blood lipids are diagnosed by assessment of total cholesterol, low and high density lipoproteins (LDL and HDL), and triglycerides. A desirable lipid profile in a low-risk individual without known CVD includes a total cholesterol <200 mg/dL, an LDL <160 mg/dL, an HDL >45 mg/dL in men and >55 mg/dL in women, and triglycerides <200 mg/dL (NCEP, 1994). A prudent, "Step I" (≤30% fat, <10% saturated fats, <300 mg/d cholesterol) diet is recommended for low risk elders with any lipid abnormality (Winston, et al, 2000).

Many elders are high risk (e.g., known CVD, multiple risk factors) and the lipid profile goals are more strict in this population. For example, total cholesterol <180 mg/dL, LDL ≤100 mg/dL, and triglycerides <130 mg/dL are the goals (National cholesterol Education Program, 1994). To achieve these goals, the Society of Geriatric Cardiology recommends six months on a stricter "Step II" (≤30% fat, <7% saturated fats, <200 mg/d cholesterol) diet. The Step II diet is often effective in lowering serum lipids (Winston et al, 2000). For example, Duell (1998) found that a diet in which polyunsaturated fats (e.g., canola oil) replaced saturated fats (e.g., lard) and in which dietary fiber (e.g., bran, legumes) was increased resulted in lower total cholesterol, LDL cholesterol, and triglycerides. The addition of exercise can help raise HDL cholesterol, a desirable effect (Gulanick & Cofer, 2000). However, lifestyle changes such as diet are often not enough to achieve lipid goals.

Failing achievement of lipid goals, lipid-lowering agents remain the most effective approach. These agents have been shown to lower CVD outcomes in the general population. Many physicians limit such medications to those elders with very high cholesterol levels and/or multiple other risk factors because of the lack of clinical trial

data demonstrating effectiveness in this population. There is growing consensus, however, that intensive lipid lowering therapy is justified in everyone with known CVD, regardless of age (Grundy, 1998). A somewhat more conservative but individualized approach is advocated for those individuals without evidence of CVD.

A combined treatment approach to abnormal blood lipids is most effective, regardless of age. Allison and colleagues (1999) tested an aggressive nurse-run secondary-prevention intervention that included diet, exercise, and lipid-lowering medications in a sample of elderly individuals who had completed cardiac rehabilitation. Pharmacotherapy was most effective in achieving LDL goals but 35% of patients reached their lipid goals with a combination of exercise, dietary compliance, and weight loss.

Inactivity

A sedentary lifestyle is a major risk factor for CVD in the general population. A meta-analysis of epidemiological studies suggested that lack of leisure-time activity may be the most important risk factor for CVD, accounting for 22-39% of preventable deaths from CVD, compared to 10-33% for smoking, 9-21% for high total cholesterol, 6-15% for hypertension, and 3-6% for obesity (Haapanen-Niemi,Vuori, & Pasanen, 1999). Fortunately, the key word in the above statistic is “preventable”. Of the major risk factors for CVD, sedentary lifestyle is perhaps the easiest to change, by increasing the physical activity levels of people of all ages, including elders.

Though children and young adults may be physically active without needing to plan regular exercise sessions, older adults are relatively less active. Nearly 40% of people over age 55 report that they do not engage in any leisure-time physical activity (American Heart Association, 1999). In general, elderly women are more sedentary than

elderly men (Berger, 1999). Therefore, elders may need to plan regular exercise activities in order to maintain cardiovascular fitness. Studies have shown that elders who exercise not only reduce the occurrence of new onset diagnoses of CVD (Posner et al., 1990), but also improve balance, increase functional ability, reduce falls, increase mental processing, and reduce musculoskeletal stiffness and bone loss (Elward & Larson, 1992). Almost any exercise that gets an elder moving is useful. Therefore, the American Heart Association includes a variety of activities in its exercise recommendations for older adults, including gardening, shopping, dancing, and housework (1999).

Although engaging in any activity, such as housework or shopping, is better than living a purely sedentary lifestyle, research shows that a progressive program of planned exercise will reap even more cardiovascular benefits, especially for elders. Walking may be an ideal exercise for older adults, because it is safe, cheap, and easy. If an older adult gradually increases walking to an aerobic level, cardiovascular fitness will be improved. For example, researchers from the Honolulu Heart Program found that elderly men who walked more than a mile a day were half as likely to develop CVD than were those who walked less than a quarter mile a day (Hakim et al., 1999).

The health benefits of walking are evident for even the oldest old. One study found that women over the age of 90 reduced their resting and working heart rates, increased their functional abilities, and improved their morale after a 6-month program of twice-weekly walking (Hamdorf & Penhall, 1999). There is no doubt that physical activity is important to cardiovascular fitness at any age and is particularly important for elders, who tend to become sedentary as they age.

Obesity

Obesity has reached epidemic proportions in the United States. This risk factor for CVD is a particular problem for elders because body weight usually increases as individuals age. Obesity is usually measured in terms of body mass index (BMI), calculated as weight in kilograms divided by the square of the height in meters (weight / height ^{2}). Generally, a BMI of 30 is considered the threshold for defining obesity (Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults, 1998). High BMI is associated with many adverse health outcomes, including CVD, because obesity is directly associated with atherogenic risk factors such as HTN, abnormal blood lipids, and glucose intolerance (Kannel, 1997). In fact, an obese person is three times more likely to develop HTN than a lean person (Wofford, et al., 1999). One study found that men (of all ages) with a BMI $\geq$25 but <30 were 5.5 times more likely to have at least one additional CVD risk factors than were men with a BMI <25 (Lean, Han, & Seidell, 1999). Obese women are also at high risk for CVD. Longitudinal data from the Nurses' Health Study showed that women with a BMI >32 were 4.1 times more likely to die of CVD than were women with a BMI <19 (Manson et al., 1995). Though it is difficult to specify a body weight that optimizes the risk of CVD, a healthy BMI is about 23 for men and 21 for women, regardless of age (Kannel, 1997).

Obesity is primarily associated with a sedentary lifestyle, and the increasing body weight that is usually accepted as a normal part of aging is, in large part, caused by the decreasing activity levels of most older adults, especially women (Brownell & Rodin, 1994; Jensen & Rogers, 1998). Thus, one would expect that increasing physical activity would reduce obesity. However, physical activity alone will do little to reduce BMI unless caloric intake is also reduced. The desirability of dieting for obese older adults is a

controversial subject. On one hand, animal studies have led some to conclude that caloric restriction not only reduces obesity, but also increases longevity by reducing oxidative stresses that cause age-associated diseases (Weindruch & Sohal, 1997). In contrast, restricting calories may be difficult and/or ineffective for many obese older people because obesity is also influenced by genetics, social class, and environmental characteristics, such as the type of food readily available in the American culture (Brownell & Rodin, 1994).

Research on the effectiveness of dieting for reducing body weight in elders is inconclusive. Many dieting studies have been conducted in university and clinical settings but few have followed patients for more than one year to look at long-term maintenance of body weight (Brownell & Rodin, 1994). There are no studies on the success, or lack of success, of the vast majority of people—perhaps as many as 80-95% of dieters—who diet on their own, using books, magazines, diets given to them by others, or by enrolling in commercial weight loss programs (Brownell & Rodin, 1994). In addition to the lack of empirical evidence that dieting can permanently reduce obesity in older adults, some authors warn of the danger that an elder who is encouraged to diet may not eat sufficient nutrients to maintain health (Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults, 1998). Those who have little money, difficulties in cooking and eating, or problems getting to the store might be particularly susceptible to malnutrition if encouraged to reduce their caloric intake without understanding the need for good food choices and vitamin supplementation.

Clearly, obesity is serious risk factor for mortality from many causes, including CVD. However, it is less clear what should, or can, be done to reduce obesity in elders.

Certainly, engaging in physical activity and moderate caloric intake throughout life might prevent obesity in many individuals. However, once a person is over age 65, obesity may be the most difficult CVD risk factor to change. The best course of action for obese older adults is modest modification of diet accompanied by walking or other enjoyable exercise (Jensen & Rogers, 1998). Even if obesity cannot be substantially reduced, the benefits of small weight losses should not be ignored. There is evidence that small reductions in body weight may improve blood pressure and blood lipids, and may be easier to maintain than major weight losses (Brownell & Rodin, 1994).

Stress

Discussion about stress as a risk factor for CVD continues regardless of the fact that the American Heart Association asserts that available data do not support its role as an independent risk factor for CVD. Investigators have explored the relationship between CVD and stress since Sir William Osler, the father of cardiology, spoke of the relationship in 1897. Osler said: "In the worry and strain of modern life, arterial degeneration is not only very common but develops often at a relatively early age" (cited in Ulmer, 1996).

Stress research is plagued by problems of definition and measurement. Everyone feels stress, but the amount perceived and the manner in which individuals respond to it differs. In spite of these difficulties, investigators in this area have successfully identified five specific psychosocial stressors associated with CVD risk: 1) depression (Frasure-Smith, 1993), 2) anxiety (Kawachi, Sparrow, Vokonas & Weiss, 1994), 3) personality factors and character traits (Jorgensen, Johnson, Kolodziej, & Schreer, 1996; Mittleman

et al., 1995), 4) social isolation (Case et al., 1992), and 5) chronic life stress such as low income (Williams et al., 1992).

Two main mechanisms—behavioral and pathophysiological—underlie the relationship between these stressors and CVD (Rozanski, Blumenthal, Kaplan, 1999). The behavioral explanation proposes that stress contributes to unhealthy behavioral patterns such as smoking and a poor diet. The pathophysiological mechanism links stress and sympathetic nervous system activation with endothelial dysfunction, hypercortisolemia, arrhythmogenesis, platelet dysfunction, and increases in blood viscosity, coronary vasoconstriction, and atherosclerosis (Rozanski, et al, 1999). Specific endocrine abnormalities, including sensitization of the hypothalamo-pituitary-adrenal (HPA) axis, have been shown to result from stress as well. Bjorntorp (1997) suggests that stress and some of the behavioral responses to it (e.g., smoking, alcohol consumption) aggravate these endocrine responses and result in visceral fat accumulation, insulin resistance, and hyperinsulinemia.

Presumably, if stress is a risk factor for CVD, its effects accumulate over a lifetime. Perhaps this is why little of the stress research focuses on elders. Cardiac and vascular reactivity have been found to be positively associated with increasing age and the presence of hypertension (Jennings et al., 1997). Some have suggested that systolic blood pressure responsiveness to stress may increase with age in women but not men (Steptoe, Fieldman, Evans, & Perry, 1996). Aside from these few studies, little is known about how stress influences CVD in elders.

Perhaps a more productive way of examining the potential effects of stress in elders may be to examine the specific stressors thought to be associated with CVD

outcomes. Of the five stressors noted previously, depression, long-standing personality traits, social isolation, and chronic life stresses such as poverty may be particularly important to elders. Intervention trials on these topics are rare in the older population. The little research that has been conducted with elders typically focuses on individuals who already have CVD, perhaps because it is challenging to find a sample in the older age groups without some form of preexisting CVD.

Descriptive studies in the area of social isolation abound, but few intervention studies have been conducted with elders. Frasure-Smith (1991) conducted a randomized clinical trial in which concerned and supportive attention was provided when stress levels rose during the first year after a myocardial infarction. When the sample of 453 men was divided by stress level, the support intervention reduced both risk of cardiac death and recurrence of myocardial infarction in those in the high-stress group.

Personality factors represent another stressor that could lead to CVD, regardless of age. Stress management interventions aimed at addressing personality characteristics have been effective. For example, the Recurrent Coronary Prevention Project enrolled 1000 Type A men after myocardial infarction. A behavioral modification intervention focused on time, urgency, and hostility reduced Type A behavior and decreased the rate of recurrent cardiac events 45% over a three year interval (Friedman, Thoresen, Gill, et al, 1986).

In summary, stress seems logical as a risk factor for CVD, but the literature is inconclusive. The intervention trials available suggest that modifying stressors in elders with CVD may prevent recurrent cardiac events. Continued research is needed to answer questions about the cumulative effects of stress, the stressors most relevant to elders, and

the effectiveness of various interventions intended to reduce stress. At this point, so little research has been conducted with the elderly population that it is not clear whether efforts to reduce stress in elders would be worth the effort in terms of CVD prevention.

Discussion

This article has examined the risk factors for CVD among elders. The accepted, major lifestyle risk factors for CVD were explored as well as the popular but debated risk factor, stress. We contend that CVD among elders is ubiquitous but not inevitable. Quality, and perhaps quantity, of life may be enhanced if efforts are expanded to modify known CVD risks among elders.

Risk factors for CVD in elderly persons are often not addressed by clinicians. Perhaps some believe that elders cannot make behavioral changes late in life. Rowe (1999) notes that the neglect of health promotion late in life seems to be based on two myths. "The first myth is that the increased risk of disease in older persons reflects 'normal' aging, which is seen as an inevitable, intrinsic process that is largely genetically determined. The second myth is that the aged body has little plasticity and cannot respond to lifestyle changes. Both myths have been disproved." (p. 720-1). Beliefs such as these have been termed "ageism" (Butler, 1990).

In fact, attempts to modify certain risk factors may be more productive in elders than in younger adults. Adoption of a healthier lifestyle late in life can increase active life expectance, decrease disability, and reduce health care costs (Vita, Terry, Aubert & Fries, 1998; Russell, 1998). Research on the various risk factors suggests that efforts to modify HTN, smoking, abnormal blood lipids, and exercise have been successful in elders. Modifying obesity in the aging population is more challenging, but weight reduction has

far-reaching benefits in simultaneous reduction of other risk factors for CVD.

How can elders be helped to successfully reduce their risks for CVD? Clearly, ageist attitudes that elders cannot successfully change behavioral habits, or that changes made by elders have little impact on CVD outcomes must be rejected. However, questions remain even once the challenge of helping an elder reduce the risk of CVD has been accepted. For example, how can one identify those patients who are likely to expend the effort needed to make lifestyle changes? Which behavioral changes will produce the most benefit in reduced risk of CVD?

The first issue, identification of elders who will undertake the job of changing a lifetime habit in order to reduce CVD risk, depends on recognizing when a person is ready to change (Prochaska, DiClemente, & Norcross, 1992). Research has shown that there are two moments when elderly persons are particularly willing to start work on changing CVD risk factors: a) when they are hospitalized or b) when they recognize that physical symptoms, such as shortness of breath or fatigue, are caused by CVD risk factors, not "normal" aging. Clinicians who recognize a person's readiness to take action can introduce a program of risk reduction specifically designed to help that individual make behavioral changes. Clinicians can assess for readiness to change by asking open-ended questions about lifestyle and perceptions of symptoms. Such discussions may open the door for important lifestyle changes and would represent a significant improvement over current practice. For example, 50% of older smokers in one survey reported that they had never been told to quit smoking by their physicians (Rich, 1999).

Historically, some clinicians believed that lifestyle change was so difficult that only one change could be implemented at a time. More recently, clinicians have

developed effective comprehensive programs aimed at modifying several risk factors simultaneously in order to prevent CVD from occurring or recurring (Ornish et al., 1998). For example, nurse-run clinics that focused on preventing recurrence of acute events in patients with CVD were added to 19 general medical practices in northeast Scotland. The comprehensive program at the clinics resulted in significant improvements in blood pressure, lipid levels, physical activity, and dietary management, although no effect was observed in smoking cessation (Campbell et al., 1998). Findings such as these demonstrate the utility of working with elders to modify the aggregate of behaviors that put them at risk for CVD. The risk factors of CVD are so interconnected that modification of several risks will have more benefit than merely changing one behavior.

The research literature supports several clinical interventions that have proven efficacious in helping elders reduce one or more of the five major CVD risk factors. Hypertension can be treated with a combination of lifestyle changes, such as weight reduction, physical activity, and dietary changes, in addition to medication. Unfortunately, research shows that younger patients receive medication for HTN more often than do elderly persons although elders benefit equally from aggressive therapy. Likewise, abnormal blood lipids can be effectively controlled by medications, especially for high-risk elders who already have CVD. However, dietary changes, such as a low-fat diet, may control abnormal blood lipids in many. Three of the major risk factors for CVD—smoking, inactivity, and obesity—require behavioral changes by the patient, rather than prescription of medications, although smoking cessation can be facilitated by nicotine replacement therapy.

The clinical interventions suggested in the body of the article are based on

research, but there are several gaps in our knowledge of CVD risks in elders that need to be addressed in future studies. For example, there are few data about the efficacy of lipid lowering medications in older patients, so those instituting this therapy in elders are basing their decision on positive results in younger populations. There is a similar lack of evidence in the literature for the safety and efficacy for elders of nicotine patches to aid in smoking cessation. More research data on the distinctions between blood pressure changes that may occur as part of aging and pathological increases in blood pressure would help to settle the disagreement that exists among clinicians about what levels of blood pressure elevation require medication. Another area for research is determining the type of physical activity that produces the most benefits for weight reduction in elders. For example, resistance exercises may provide as much, or more, energy expenditure than endurance exercises in elders (Ortega & Andres, 1998) but more data are needed to confirm this observation. Most importantly, more studies on successful interventions to reduce CVD risk factors should be undertaken and those studies should include participants who are over age 65. Though there is little reason to believe that treatments, programs and counseling that change the risk profiles of younger adults will not be equally useful to help elders reduce their risks of CVD, there is currently little evidence to support this position. More empirical data may result in better, more accurate, and more frequent treatment of CVD risk factors in elders in the future.

The Ministers of Health of Member States in the Americas recently adopted a resolution focusing on the impact that population aging will have on health care, family caregiving, and the distribution of resources throughout the lifespan. They concluded that "the greatest challenge of the millennium will be to keep aging populations active and

free from disabling diseases for as long as possible and that active and healthy aging depends to a large extent on health promotion" (Hegyeli, 1999). Cardiovascular disease is currently the primary cause of death and disability in the United States and a disproportionate number of Americans who are over age 65 are hospitalized each year for CVD. Yet, many older adults are inadequately treated with medications to reduce the risk of CVD, or are not encouraged to adopt lifestyle modifications that could reduce the risk of CVD and increase health-related quality of life. Patients at risk for CVD must be encouraged to reduce those risks, regardless of age.

References

The Agency for Health Care Policy and Research Smoking Cessation Clinical Practice Guideline Panel and Staff. (1996). The Agency for Health Care Policy and Research Smoking Cessation Clinical Practice Guideline. *JAMA, 275,* 1270-1280.

Allison, T.G., Squires, R.W., Johnson, B.D., & Gau, G.T. (1999). Achieving national cholesterol education program goals for low-density lipoprotein cholesterol in cardiac patients: Importance of diet, exercise, weight control, and drug therapy. *Mayo Clinic Proc, 74,* 466-473.

American Heart Association. Heart and Stroke Statistical Update. Dallas, TX: Author. Retrieved August 25, 1999 from the World Wide Web: http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide

Barendregt, J.J., Bonneux, L., & van der Maas, P.J. (1997). The health care costs of smoking. *N Engl J Med, 337,* 1052-7.

Barker, W.H., Mullooly, J.P., & Linton, L.P. (1992). Trends in hypertension prevalence, treatment, and control in a well-defined older population. *Hypertension, 31* (pt2), 552, 1162-1166.

Berg, M. J. (1999). Drugs and smoking. *JGSM, 2*(2), 27-30.

Berger, A. (1999, August 31). Challenging women to walk for healthier hearts. *The New York Times,* pp. D8.

Berlowitz, D.R., Ash, A.S., Hickey, E.C., Friedman, R.H., Glickman, M., Kader, B., & Moskowitz, M.A. (1998). Inadequate management of blood pressure in a hypertensive population. *New Engl J Med, 339* (27), 1957-63.

Bjorntorp, P. (1997). Stress and cardiovascular disease. *Acta Physiologica Scandinavica. Supplementum, 640,* 144-8.

Brownell, K.D. & Rodin, J. (1994). The dieting maelstrom: Is it possible and advisable to lose weight? *American Psychologist, 49*(9), 781-791.

Burt, V.L., Cutler, J.A., Higgins, M. et al. (1995). Trends in the prevalence, awareness, treatment, and control of hypertension in the adult U.S. population: Data from the health examination surveys, 1960-1991. *Hypertension, 26*, 60-69.

Butler, R.N. (1990). A disease called ageism (editorial). *J Am Geriatr Soc, 38*(2), 178-80.

Campbell, N.C., Ritchie, L.D., Thain, J., Deans, H.G., Rawles, J.M., & Squair, J.L. (1998). Secondary prevention in coronary heart disease: A randomised trial of nurse led clinics in primary care. *Heart, 80*, 447-452.

Case, R.B., Moss, A.J., Case, N. et al. (1992). Living along after myocardial infarction. Impact on prognosis. *JAMA, 267,* 515-519.

Centers for Disease Control and Prevention (1993). Cigarette-attributable mortality and years of potential life lost—United States, 1990. MMWR Morbidity and Mortality Weekly Report, 42, 645-649.

Clark, M. A., Hogan, J. W., Kviz, F. J., & Prohaska, T. R. (1999). Age and the role of symptomatology in readiness to quit smoking. , *24*(1), 1-16.

Cohn, J.N., Abraham, W.T., Levine, T.B., Pina, I.L., & Silver M. (1999). Heart failure: Impact and evolving concepts. *Current Issues in Heart Failure, 1*(1), 1-12.

Coppola, W.G., Whincup, P.H., Walker, M., Ebrahim, S. (1997). Identification and management of stroke risk in older people: A national survey of current practice in primary care. *J Human Hypertension, 11* (3), 185-91.

Cushman, W.C. & Black, H.R. (1999). Hypertension in the elderly. *Cardiology Clinics*, *17*(1): 79-92.

Dale, L. C., Olsen, D. A., Patten, C. A., Schroeder, D. R., Croghan, I. T., Hurt, R. D., Offord, K. P., & Wolter, T. D. (1997). Predictors of smoking cessation among elderly smokers treated for nicotine dependence. *Tob Control, 6*(3), 181-7.

Daviglus, M.L., Liu, K., Greenland, P., Dyer, A.R., Garside, D.B., Manheim, L., Lowe, L.P., Rodin, M., Lubitz, J., & Stamler, J. (1998). Benefit of a favorable cardiovascular risk-factor profile in middle age with respect to medicare costs. *New Engl J Med, 339,* 1122-9.

DiTullio, M., Granata, D., Taioli, E., Broccolino, M., Recalcati, F., Zaini, G., & Belli, C. (1991). Early predictors of smoking cessation after myocardial infarction. *Clin Cardiol, 14,* 809-812.

Duell, P.B. (1998). The role of dietary modification in the treatment of hyperlipidemia. CVR&R, August: 35-46.

Elward, K., & Larson, E. B. (1992). Benefits of exercise for older adults. A review of existing evidence and current recommendations for the general population. *Clin Geriatr Med, 8*(1), 35-50.

Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults. (1998). Executive summary of the clinical guidelines on the identification,

evaluation, and treatment of overweight and obesity in adults. *Arch Intern Med, 158*, 1855-1867.

Fielding, R. (1987).Patients' beliefs regarding the causes of myocardial infarction: Implications for information giving and compliance. *Patient Education and Counseling; 9*, 121-134.

Friedberg, C.K. (1966). Diseases of the Heart, W.B. Saunders & Co., Philadelphia, PA.

Friedman, M., Thoresen, C.E., Gill, J.J., Ulmer, D., Powell, L.H., Price, V.A., Brown, B., Thompson, L., Rabin, D.D., & Breall, W.S. (1986). Alteration of type A behavior and its effects on cardiac recurrences in postmyocardial infarction patients: summary results of the Recurrent Coronary Prevention Project. *Am Heart J, 112*, 653-665.

Frasure-Smith. N. (1991). In-hospital symptoms of psychological stress as predictors of long-term outcome after acute myocardial infarction in men. *Amer J Cardiol, 67*, 121-127.

Frasure-Smith, N., Lesperance, F., & Talajic, M. (1993). Depression following myocardial infarction. Impact on 6-month survival. *JAMA, 270*, 1819-1825.

Gulanick, M. & Cofer, L.A. (2000). Coronary risk factors: Influences on the lipid profile. *J Cardiovasc Nurs, 14*(1), 27-34.

Grundy, S.M. (1998). The role of cholesterol management in coronary disease risk reduction in elderly patients. *Endocrinology and Metabolism Clinics of North America, 27*(3), 655-675.

Haapanen-Niemi, N., Vuori, I., & Pasanen, M. (1999). Public health burden of coronary heart disease risk factors among middle-aged and elderly men. *Prev Med, 28*(4), 343-8.

Hakim, A. A., Curb, J. D., Petrovitch, H., Rodriguez, B. L., Yano, K., Ross, G. W., White, L. R., & Abbott, R. D. (1999). Effects of walking on coronary heart disease in elderly men: the Honolulu Heart Program [see comments]. *Circulation, 100*(1), 9-13.

Hall, N. K. (1997). Health Maintenance and Promotion. In R. J. Ham & P. D. Sloane (Eds.), *Care Geriatrics: A Case-Based Approach* (3rd ed.,). Primary St. Louis, Missouri: Mosby.

Hamdorf, P. A., & Penhall, R. K. (1999). Walking with its training effects on the fitness and activity patterns of 79-91 year old females. *Aust N Z J Med, 29*(1), 22-8.

Hasdai, D., Garratt, K.N., Grill, D.E., Lerman, A., Holmes, D.R. (1997). Effect of smoking status on the long-term outcome after successful percutaneous coronary revascularization. *N Engl J Med, 336*, 755-61.

Hegyeli, R.J. (1999). Brief Report: International intitiatives to improve the quality of health in the Elderly. *Amer J Geriatric Cardiology, 8*(4), 155-156.

Jennings, J.R., Kamarck, T., Manuck, S., Everson, S.A., Kaplan, G., & Salonen, J.T. (1997). Aging or disease? Cardiovascular reactivity in Finnish men over the middle years. *Psychology & Aging, 12*(2), 225-38.

Jensen, G. L., & Rogers, J. (1998). Obesity in older persons. *J Am Diet Assoc, 98*(11), 1308-11.

Johnson, C.L., Rifkind, B.M., Sempos, C.T., et al. (1993). Declining serum total cholesterol levels among US adults. The national health and nutrition examination surveys. *JAMA, 169,* 3002-3008.

Joint National Committee. (1997). The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Bethesda, MD: National Institutes of Health, National Heart, Lung, and Blood Institute, National High Blood Pressure Education Program, *NIH publication* No. 98-4080.

Jonas, M.A., Oates, J.A., Ockene, J.K., et al, (1992). Statement on smoking and cardiovascular disease for health care professionals: AHA Medical/Scientific Statement. *Circulation, 86,* 1664-1669.

Jorgensen, R.S., Johnson, B.T., Kolodziej, M.E., Schreer, G.E. (1996). Elevated blood pressure and personality: A meta-analytic review. *Psychological Bulletin, 120*(2), 293-320.

Kannel, W.B. (1996). Blood pressure as a cardiovascular risk factor: Prevention and treatment. *JAMA, 275*(24), 1571-76.

Kannel, W.B.(1997). Cardiovascular risk factors in the elderly. *Coronary Artery Disease, 8*, 565-575.

Kawachi, I., Sparrow, D., Vokonas, P.S., & Weiss, S.T. (1994). Symptoms of anxiety and risk of coronary heart disease. The Normative Aging Study. *Circulation, 90*, 2225-2229.

La Rosa, J.C. (1997). Triglycerides and coronary risk in women and the elderly. *Arch Intern Med, 157*, 961-968.

Lean, M. E., Han, T. S., & Seidell, J. C. (1999). Impairment of health and quality of life using new US federal guidelines for the identification of obesity. *Arch Intern Med, 159*(8), 837-43.

Manson, J.E., Willett, W.C., Stampfer, M.J., Colditz, G.A., Hunter, D.J., Hankinson, S.E., Hennekens, C.H., & Speizer, F.E. (1995). Body weight and mortality among women. *New Engl J Med, 333*, 677-85.

Mittleman, M.A., Maclure, M., Sherwood, J.B. et al.(1995). Triggering of myocardial infarction by episodes of anger. *Circulation, 92*, 1720-1725.

Morgan, G. D., Noll, E. L., Orleans, C. T., Rimer, B. K., Amfoh, K., & Bonney, G. (1996). Reaching midlife and older smokers: tailored interventions for routine medical care. *Prev Med, 25*(3), 346-54.

Moser, M. (1992). Management of hypertension in the elderly. *American J Geriatric Cardiology, May/June,* 22-35.

Moser, M. (1997). Myths, misconceptions, and heroics: The story of the treatment of hypertension from the 1930s. Le Jacq Communications, Inc.

National Cholesterol Education Program Second Report of the Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II). (1994). *Circulation, 89*, 1333-1345.

National High Blood Pressure Education Program Working Group (1994). National High Blood Pressure Education Program on Hypertension in the Elderly. *Hypertension, 23*, 275-285.

Ornish, D., Scherwitz, L.W., Billings, J.H., Gould, K.L., Merritt, T.A., Sparler, S., Armstrong, W.T., Ports, T.A., Kirkeeide, R.L., Hogeboom,, C., & Brand R.J. (1998). Intensive lifestyle changes for reversal of coronary heart disease. *JAMA, 280*(23), 2002-2007.

Ortega, R.M. & Andres, P. (1998). Is obesity worth treating in the elderly? *Drugs & Aging, 12*(2), 92-101.

Posner, J. D., Gorman, K. M., Gitlin, L. N., Sands, L. P., Kleban, M., Windsor, L., & Shaw, C. (1990). Effects of exercise training in the elderly on the occurrence and time to onset of cardiovascular diagnoses. *J Am Geriatr Soc, 38*(3), 205-10.

Prochaska. J.O., DiClemente, C.C., & Norcross, J.C. (1992). In search of how people change: Applications to addictive behaviors. *American Psychologist, 47* (9), 1102-1114.

Rich, M.W. (1999). Aggressive risk factor management in the elderly: Are you ever too old? *Amer J Geriatric Cardiology, 8*(2), 72-80.

Richmond, R. L. (1999). Physicians can make a difference with smokers: evidence-based clinical approaches. Presentation given during the Symposium on Smoking Cessation at the 29th World Conference of the IUATLD/UICTMR and Global Congress on Lung Health, Bangkok, Thailand, 23-26 November 1998. International Union Against Tuberculosis and Lung Disease. *Int J Tuberc Lung Dis, 3*(2), 100-12.

Rigotti, N.A. & Pasternak, R.C. (1996). Cigarette smoking and coronary heart disease: Risks and management. *Cardiology Clinics, 14*(1), 51-68.

Rowe, J.W. (1999). Geriatrics, prevention, and the remodeling of medicare. *New Engl J Med, 340*(9), 720-721.

Rozanski. A., Blumenthal, J.A., & Kaplan, J.(1999). Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation, 99* (16), 2192-217.

Russell, L.B. (1998). Prevention and Medicare costs. *New Engl J Med. 339*, 1158-60.

Shepherd, J., Cobbe, S.M., Ford, I., et al. (1995). Prevention of coronary heart disease with pravastatin in men with hypercholesterolemia. *New Engl J Med, 333*, 1301-1307.

Simon, J. A., Solkowitz, S. N., Carmody, T. P., & Browner, W. S. (1997). Smoking cessation after surgery. A randomized trial. *Arch Intern Med, 157*(12), 1371-6.

Steptoe, A., Fieldman, G., Evans, O., Perry, L. (1996). Cardiovascular risk and responsivity to mental stress: the influence of age, gender and risk factors. *J Cardiovasc Risk, 3*(1), 83-93.

Ulmer, D. (1996). Stress management for the cardiovascular patient: a look at current treatment and trends. *Progress in Cardiovasc Nurs, 11*(1), 21-29.

United States Census Bureau (1999). Resident population estimates of the United States by age and sex: April 1, 1990 to June 1, 1999. Washington, DC: Author. Retrieved August 25, 1999 from the World Wide Web: http://www.census.gov/population/estimates/nation/infile2-1.txt

Vita, A.J., Terry, R.B., Hubert, H.B., Fries, J.F. (1998). Aging, health risks, and cummulative disability. *New Engl J Med, 338,* 1035-41.

Weindruch, R., & Sohal, R. S. (1997). Seminars in medicine of the Beth Israel Deaconess Medical Center. Caloric intake and aging. *N Engl J Med, 337*(14), 986-94.

Wewers, M. E., Jenkins, L., & Mignery, T. (1997). A nurse-managed smoking cessation intervention during diagnostic testing for lung cancer. *Oncol Nurs Forum, 24*(8), 1419-22.

Williams, R.B., Barefoot, J.C., Califf, R.M., et al. (1992). Prognostic importance of social and economic resources among medically treated patients with angiographically documented coronary artery disease. *JAMA, 267,* 520-524.

Winston, M., St. Jeor, S., Ashley, J. (2000). Diet controversies in lipid therapy. *J Cardiovascular Nursing, 14*(2), 29-38.

Wofford, M.R., Andrew, M.E., Brown, A., King, D., Pickett, R.A., Stevens, J., Wyatt, S., & Jones, D.W. (1999). Obesity hypertension in the atherosclerosis risk in communities cohort: Implications of obesity guidelines. *J Clinical Hypertension, 1*, 27-32.