HYPERTENSION MANAGEMENT FROM NUTRITIONAL AND EXERCISE PERSPECTIVES: A CASE STUDY

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ABSTRACT

A 56-year old patient is newly diagnosed hypertension and obesity. He has been referred to an exercise physiologist for an exercise program to compliment his pharmacological treatment. He is otherwise in reasonable physical condition for his age. The patient is a bureaucrat, lives alone and has been a little bit depressed since his wife’s death two years ago. What nutritional factors do you consider could be relevant to his medical conditions, and why?

Keywords: hypertension, nutrition, exercise

INTRODUCTION

Hypertension is a condition where systolic blood pressure (SBP) is equal or more than 140 mmHg and or diastolic blood pressure (DBP) is equal or more than 90 mmHg (Dosh SA, 2002). Hypertension has been consider as one of the major risk factors for coronary heart disease (Chobanian AV et al, 2003; Ramsay L et al., 1999). In addition, hypertension is also a risk factor for stroke, heart failure, and kidney failure as well as peripheral vascular diseases (Ramsay L et al., 1999; Chobanian AV and Hill M, 2000; Beevers DG, 2001).

Considering the numerous potential impacts of hypertension, its management is now moving from treating hypertension to preventing hypertension. Some efforts towards this are by recognizing individual risks of developing hypertension in the future and by giving more attention to persons in pre-hypertension state. The Joint National Committee (JNC) in the US by re has implemented the latter by redefining hypertension classification. On their seventh report on prevention, detection, evaluation and treatment of high blood pressure, they recommended a lower than 120/80 mmHg normal BP, and introduced a pre-hypertension state which is a BP range between 120-139 for systolic BP and 80-89 for diastolic BP (Chobanian AV et al, 2003).

Table 1. Changes in Blood Pressure Classification (JNC 7, 2003) (Chobanian AV et al, 2003)

<table>
<thead>
<tr>
<th>JNC 6 Category</th>
<th>JNC 7 Category</th>
</tr>
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<tbody>
<tr>
<td>Optimal</td>
<td>Normal</td>
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<tr>
<td>Normal</td>
<td>Prehypertension</td>
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<tr>
<td>Borderline</td>
<td>Hypertension</td>
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<tr>
<td>Hypertension</td>
<td>Stage 1</td>
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<td>Stage 1</td>
<td>Stage 2</td>
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<td>Stage 2</td>
<td>Stage 3</td>
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<td>Stage 3</td>
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<table>
<thead>
<tr>
<th>SBP/DBP</th>
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<tbody>
<tr>
<td>&lt; 120/80</td>
<td>Normal</td>
</tr>
<tr>
<td>120–129/80-84</td>
<td>Prehypertension</td>
</tr>
<tr>
<td>130–139/85–89</td>
<td>Hypertension</td>
</tr>
<tr>
<td>≥ 140/90</td>
<td>Stage 1</td>
</tr>
<tr>
<td>140–159/90–99</td>
<td>Stage 2</td>
</tr>
<tr>
<td>160–179/100–109</td>
<td>Stage 3</td>
</tr>
<tr>
<td>≥ 180/110</td>
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Hypertension management incorporates pharmacological and non-pharmacological treatment (life style modification) (European Society of Hypertension, 2003;Conlin PR, 2001). According to the guidance published by National institutes of Health and National Heart-Lung and Blood Institute (2002), lifestyle intervention for adults with hypertension can be classified into documented efficacy interventions and uncertain or less proven efficacy intervention. Including to the interventions with documented efficacy are increased physical activity, weight loss, reduced sodium intake, potassium supplementation, alcohol intake limitation, and healthy mixed diet (Dietary Approaches to Stop Hypertension – DASH diet). The uncertain and less proven efficacy intervention is the supplementation of calcium, fish oil, and herbal or botanical dietary (National Institutes of Health and National Heart-Lung and Blood Institute, 2003). In addition, smoking cessation is also part of lifestyle modification (European Society of Hypertension, 2003).

This paper attempts to review those factors in relation to their effect on blood pressure (BP). The method used is retrieving original articles and article reviews related to the topic by searching through health related databases (e.g., PUBMED, MEDLINE and Academic Search Elite), some internet-accessible journals (e.g., Circulation, American Journal of Clinical Nutrition and Hypertension), and general internet browsers (e.g., Yahoo and Google), as well as printed publications (books, and journals). However, the review will be limited to the nutritional, physical activity and some other case related factors.

NUTRITIONAL ROLE IN HYPERTENSION MANAGEMENT

Sodium Intake

Intake of sodium has been related to raised BP (Law MR et al, 1991a; Law MR et al, 1991b; Frost CD et al, 1991). A big study (the International Study of Salt and Blood Pressure - INTERSALT) recruiting more than 10,000 men and women aged 20-59 was done in 1988 reported that sodium intake was significantly related to the slope of BP with age (Intersalt, 1988). An average difference in systolic BP that ranged from 5 mm Hg at age 15-19 years to 10 mm Hg at age 60-69 was associated with a difference in sodium intake of 100 mmol/24 h (Law MR et al, 1991a).

Sodium intake reduction is associated with decreased BP (Katz A et al, 1999). A reduction in daily sodium intake of 50 mmol (about 3 g of salt), attainable by moderate dietary salt reduction, in people aged 50-59 years would, after a few weeks, lower systolic BP by an average of 5 mm Hg. and by 7 mm Hg in those with high BP (170 mm Hg) (Law MR et al, 1991). Cappuccio et al.(1997) reported that a reduction in sodium intake of 83 mmol/day was associated with a reduction by 7 mm Hg SBP and by 2 mmHg DBP (figure 1) among hypertensive participants (Cappuccio FP et al, 1997).
Figure 1.  BP and urinary sodium excretion at end of each dietary period. SBP=systolic BP; DBP=diastolic BP (Cappuccio FP et al, 1997).

There is an approximate relationship between urine sodium excretion (natriuresis) by the kidney and arterial BP (Cappuccio FP et al, 1997; Aviv A, 2002). This relation ship change in someone with salt-sensitive hypertension (Aviv A, 2002). The kidney injury is proposed to happen prior to the decreased sodium excretion (Figure 2) (Oparil S et al, 2003).
Potassium supplementation

Potassium intake has been associated with BP change. The Intersalt Study found that potassium excretion was negatively correlated with BP (Intersalt, 1988). Coruzzi et al. reported that there was increased systolic BP by 5mmHg in 11 hypertensive participants, after a 10-day period of low potassium intake. The mechanism of this effect is through modification of natriuretic ability and calcium excretion (Coruzzi P et al, 2001). The effects of potassium supplementation appeared greater in those with higher levels of sodium intake (National Institutes of Health, National Heart-Lung and Blood Institute, 2002).

Alcohol intake limitation

Nutrition Committee of the American Heart Association recommended that one or two drinks per day is beneficial in preventing CHD, if no contraindication for alcohol consumption is indicated (Pearson TA, 1996). Some mechanisms underlie this are increased HLD cholesterol level, platelet aggregation inhibition (Gaziano JM et al, 1993; Renaud S and de Lorgeril M, 1992) and fibrinolysis activation (Ridker PM, 1994).

However, heavier consumption is related to a number of health problems such as stroke, alcoholic cardiomyopathy, several kinds of cancer, cirrhosis, and...
pancreatitis, as well as accidents, suicide, and homicide. Uncontrolled hypertension patients are among conditions should not consume any alcohol whatsoever, it may worsen the condition (Pearson TA, 1996).

Klatsky et al. (1977) found a strong relationship between regular use of three or more drinks of alcohol per day and increased BP. This relationship was independent of age, sex, race, smoking, coffee use, former "heavy" drinking, educational attainment and adiposity (Klatsky A, 1977).

Healthy mixed diet (Dietary Approaches to Stop Hypertension – DASH diet)

DASH diet, based on their DASH research findings suggested foods that are low in sodium, saturated fat, total fat, and cholesterol, and high in fruits, vegetables, and low fat dairy foods. The DASH diet plan suggests taking low amounts of fats, red meats, sweets, and sugared beverages. It is also high in potassium, calcium, and magnesium, as well as protein and fiber (National Institutes of Health and National Heart-Lung and Blood Institute, 2003).

The original DASH trial in 1997, with 133 hypertensive participants and 326 normal control subjects, showed that DASH diet decreased BP by 11.4/5.5 mmHg in hypertensive participants and by 3.5/2.1 mmHg in those with normal BP (Appel LJ, 1997). This finding was supported by the newer similar trial done in 2001 by Vollmer et al. which resulted in a decrease in BP by 6.6/3.2 mmHg and 5.4/2.7 mmHg respectively in hypertensive and normal participants after following three consecutive 30-day feeding periods (Vollmer WM et al, 2001).

Calcium Supplementation

Adequate calcium intake is critical for optimal BP regulation. Two meta-analyses revealed that calcium supplementation lowered BP in normotensive and hypertensive individuals (Bucher HC, 1996; Allender PS et al, 1996). Bucher et al. (1996) showed an average reduction in systolic BP of -1.27 mm Hg and in diastolic BP of -0.24 mm Hg in all studies (Bucher HC, 1996). In both reviews, the diastolic BP reduction is smaller than the systolic one and hypertensive participants experienced a higher BP reduction than the normotensive ones did (Bucher HC, 1996; Allender PS et al, 1996).

Fish Oil Supplementation

Consumption of fish oil, source of a special class of polyunsaturated fatty acids known as the omega-3 or n-3 fatty acids or n-3 polyunsaturated fatty acid (n-3 PUFA) (Stone NJ, 1996), may reduce the incidence of arterial disease. This potential antithrombotic of fish oil has been attributed to a reduction in platelet activation, a lowering of plasma triglycerides and coagulation factors and/or a decrease in vascular tone. Fish oil diminishes platelet activation in part by lowering the arachidonate content of phospholipids and, thereby, the thromboxane (TxA2) production. Also, fish oil lowers coagulation factor levels, possibly by altering transcriptional activity in the liver. These two effects can reduce thrombus formation by acting together (figure 3) (Vanschoonbeek K et al, 2003).

![Figure 3. The role of fish oil in preventing thrombus formation (Vanschoonbeek K et al, 2003)](image-url)
The effect of fish oil in reducing BP has been noted in some studies. A meta-analysis study of 31 placebo-controlled trials on 1356 subjects demonstrated a significant average decrease of -3.0 mm Hg systolic BP and -1.5 mm Hg diastolic BP. A dose-response effect of fish oil on BP of -0.66/-0.35 mm Hg/g omega-3 fatty acids is documented. This effect is more pronounced in hypertensive subjects and those with clinical atherosclerotic disease or hypercholesterolemia (Morris M, 1993).

Link with depression

Fatty acid and its derivative Prostaglandin E1 has been related with depression (Horrobin DF and Manku MS, 1980). In a study on 20 moderately depressive patient, there was a significant correlation between the ratio of erythrocyte phospholipids (PL) arachidonic acid (AA) to eicosapentaenoic acid (EPA) and severity of depression (Adams PB et al, 1996). This finding was also found by Edwards (1998) (Edwards R et al, 1998).

Vegetarian Diet

A randomized controlled trial documented a strong relationship between vegetarian diet and BP improvement. 58 subjects with mild untreated hypertension were observed for 2 weeks (period 1), then they were randomly allocated into 3 groups for a 2 consecutive 6 weeks time (period 2 and 3), and then asked to maintain their usual diet intake (group 1); to take an ovolactovegetarian diet during period 2 and return to their usual diet during period 3 (group 2); and to maintain ovolactovegetarian diet during period 2 and 3 (group 3). The result showed that there was reduction in systolic BP of the order 5 mmHg occurred during the vegetarian diet compared to the increased systolic BP during eating mixed diet (figure 4) (Margetts BM et al, 1986).

Figure 4. Mean BP during diet intervention in mild hypertensive subjects. Broken lines represent ovolactovegetarian diet period (Margetts BM et al, 1986).

Another 6-month randomized controlled trial revealed similar effect of fruit and vegetable consumption on BP reduction. The intervention group experienced a greater BP falls than the control group did. In addition, plasma concentration of antioxidants was also found higher in the intervention group than in controls (John JH et al, 2002).

Vitamin C (Anti-oxidant)

Free radicals, predominantly reactive oxygen species, have been implicated in some diseases including hypertension. Reactive oxygen species may react with and inactivate Nitric oxide (NO), which is very vital in regulating BP. NO acts through promoting
vasodilatation, natriuresis and inhibiting central sympathetic outflow. As the impact of failed NO, hypertension may result. Some studies showed that alleviation of oxidative stress with antioxidant therapy (e.g., ascorbic acid supplementation) improve BP either in animal models or in humans (Koo JR, 2002).

Ascorbic acid has been proved to lower BP. A randomized, double-blind, placebo-controlled study on 45 healthy patients with hypertension done by Duffy et al (1999) indicated that regular consumption 500 mg ascorbic acid daily significantly decreased systolic BP by 13 mmHg (from mean 155 to 142 mmHg), compared to no effect produced by placebo (Duffy SJ et al, 1999).

A meta-analysis study on eighteen cross-sectional studies done by Ness, Chee and Elliot (1997) revealed a consistent inverse association between higher vitamin C intake and lower BP. Some plausible mechanisms explaining this fact include an effect on cytosolic calcium and smooth muscle contractility, an effect of circulating sodium levels and protein fractions, prevention of prostacyclin synthetase inhibition by free radicals, through and effect on leukotriene metabolism, through an effect on nitric oxide and through direct promotion of endothelial prostacyclin production (Ness AR et al, 1997).

**Caffeine**

Caffeine, a substance found in coffee, can raise BP acutely (Lovallo WR et al, 2004). It increases BP through raising peripheral resistance, with no change in cardiac output (Pincomb GA et al, 1985). Caffeine (3.3 mg/kg, equivalent to 2 to 3 cups of brewed coffee) caused nearly identical systolic and diastolic BP elevations in women (4.5 and 3.3 mm Hg, respectively) and men (4.1 and 3.8 mm Hg, respectively) (Hartley TR et al, 2004). In those who take caffeine regularly, a persistent BP effect may develop (Lovallo WR et al, 2004). After caffeine ingestion (3.3 mg/kg), 19% of the high-normal BP groups fell into the hypertensive range (Hartley TR et al, 2000).

**EXERCISE ROLE IN HYPERTENSION MANAGEMENT**

The association between obesity and hypertension has been found (Bosello O and Zamboni M, 2000). A weight reduction of 5-10% is very effective in preventing hypertension in overweight individuals (Vidal J, 2002). Weight loss may also lower BP in overweight hypertensive subjects and in high-normal BP subjects (Stevens VJ et al, 2001). There was a dose-response relationship between the weight loss degree and the BP reduction magnitude (table) (Stevens VJ et al, 2001).

![Figure 5. Mean Change In BP In Respond To Weigh Loss (Stevens VJ et al, 2001)](image-url)
Despite the importance of exercise, Abdel-Hamid (2003) suggested that moderate level of daily exercise alone produces a slightly lower magnitude of weight loss than that produced by diet restriction. However, the weight loss composition was quite different. Exercise treatment contributed 90% weight loss from fat mass and only 10% from free fat mass. This contrasts with the dieting treatment in which 70% of the weight loss was fat mass and 30% was free fat mass (see table) (Abdel-Hamid TK, 2003). The combination of a reduced calorie diet and increased physical activity is recommended, since it produces greater weight loss and reductions in abdominal fat than either diet alone or physical activity alone (National Institutes of Health and National Heart-Lung and Blood Institute, 1998).

![Figure 6. Diet vs Exercise (Abdel-Hamid TK, 2003)](image)

In respect to exercise intensity level, Abdel-Hamid showed that low intensity exercise yielded a greater weight loss than that caused by moderate and high intensity exercise. However, a greater body fat loss occurred on the subjects who did moderate and high intensity exercise (table) (Abdel-Hamid TK, 2003).

![Figure 7. Impact of different exercise intensity on weight loss (Abdel-Hamid TK, 2003)](image)
Most recent studies show that aerobic exercise training can lower BP in patients hypertension (Kokkinos PF et al, 2001; American College of Sports Medicine, 1993). The average reduction in BP is 10 mmHg for systolic and diastolic BP in individual with mild hypertension. ACSM (American College of Sports Medicine) recommended large muscle activities 3-5 days per week, for 20-60 minutes in moderate intensity (50-85% of maximal oxygen uptake). Resistance training is not recommended as the only form of exercise program, but can be part of the circuit training (American College of Sports Medicine, 1993), because resistance training exercise alone has not consistently shown to significantly lower BP (Kokkinos PF et al, 2001; American College of Sports Medicine, 1993). Significant reductions in BP and left ventricular hypertrophy (LVH) regression in patients with stage 3 hypertension have also been reported following aerobic exercise training (Kokkinos PF et al, 2001). The research indicates that low to moderate intensity exercise training may be just as effective as higher intensity training for reducing BP in individual with hypertension (Hagberg JM et al, 2000).

The exercise program for overweight or obese hypertensive patients should aim to promote a caloric expenditure of 300 to 500 Kcal per day and 1000 to 2000 Kcal per week. Such an approach, combined with a prudent diet, is likely to reduce body weight. The mechanisms mediating exercise-induced BP reduction are poorly understood. BP reductions appear to be independent of changes in body weight or body composition (Kokkinos PF et al, 2001).

There are also no indications of age or gender-related differences in BP response to exercise (Kokkinos PF et al, 2001), although Hagberg et al (2000) found that women with hypertension reduce their BP somewhat more and somewhat more consistently with exercise training than men.

Excessive BP response during exercise has not been well-documented (Kokkinos PF and Papademetriou V, 2000). However, SBP ≥ 200 mmHg during 6 minutes of exercise at an initial workload of 600 kpm/min (a standardized bicycle test, nearly equal to 100 W, 5880 J/min) has been reported to be a stronger predictor of cardiovascular morbidity and mortality than resting BP (Mundal R, 1996)

**Exercise and depression**

In addition to its physical benefit, exercise also has psychological benefits. In one study of 1,536 Germans, depression was found more than three times higher in sedentary individuals than in active persons (Weyerer S, 1992). Blumenthal et al. (1999) reported that after 16 week training, exercise is as effective as antidepressant medication in relieving depression (figure 6) (Blumenthal JA et al, 1999).

**CONCLUSION**

Dietary intake modification and exercise are integral parts of hypertension management. In conclusion, nutritional factors consideration suggested for hypertensive individuals are: to reduce sodium intake and to increase potassium and calcium intake, fish oil supplementation and to limit alcohol and caffeine consumption. Other alternatives include increased fruit and vegetable intake or adopting the whole comprehensive DASH diet. Recommended exercises for hypertension should involve large muscle activities, and be performed 3-5 days per week, for 20-60 minutes in moderate intensity (50-85% of maximal oxygen uptake).

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**Figure 8.** Observed mean depression scores before and after treatment. HAM-D indicates Hamilton Rating Scale for Depression; BDI, Beck Depression Inventory (Blumenthal JA et al, 1999).
REFERENCES


