Letter to the Editor

Importance of Dietary Calcuim in Hypertension

For decades dietary factors have been postulated as being important in the pathogenesis and treatment of arterial hypertension. Almost to the exclusion of other nutrients, sodium has dominated both the clinical arena and research paradigm. In recent years emphasis has also been placed on weight control and alcohol moderation as nutrition-related, life-style factors that might favorably influence blood pressure. Fifteen years ago in a paper in Science [1] we reported that in contrast to commonly held notions, a diet deficient in calcium from dairy products was the dietary pattern that predicted an elevated arterial pressure. In that study cohort there was no evidence of an impact of dietary sodium on blood pressure.

In 1984 we published a second paper in Science [2] which reported the results of an analysis of the first NHANES. Again we observed that as reported dietary calcium and potassium intake decreased, arterial pressure and the risk of being hypertensive increased. Further we reported that a diet low in dairy products and fresh fruits and vegetables were the two dietary patterns most predictive of hypertension in the United States. Besides confirming our 1982 paper, the 1984 Science paper raised the disturbing possibility that a lower sodium intake might actually be associated with an increased risk of hypertension. In spite of these intriguing findings, the extensive data base that emerged to support the calcium deficiency hypothesis [3,4], and the significant disagreement that exists among experts regarding sodium's role in arterial pressure control [5,6], public health policy continues to emphasize sodium reduction as its principle recommendation [7,8].

Two potentially landmark studies [9,10], both funded by the National Heart Lung and Blood Institute, and published in April should finally redirect our emphasis towards the dietary patterns that will benefit the millions of Americans with high blood pressure. The Trials of Hypertension Prevention II (TOHP II) [9] was the largest and longest randomized controlled trial of sodium reduction in a population at high risk of developing hypertension. Over the 48 months of observation there was no evidence that the primary end-point, diastolic blood pressure, was improved by consumption of a reduced sodium chloride diet. Systolic blood pressure was lowered by 0.6 mm Hg, but the reduction in blood pressure could not be related to the level of dietary sodium restriction. Furthermore, there was little evidence that reduced dietary sodium lowers the incidence of new cases of hypertension. As Dr. Pickering noted in his accompanying editorial [11], it is time to move on from recommending sodium restriction as a population-wide strategy to reduce the prevalence of hypertension.

The second study, published in the New England Journal of Medicine, was the Dietary Approaches to Stop Hypertension (DASH) [10]. In stark contrast to the results in TOHP II, DASH demonstrated a significantly beneficial effect of a diet replete in low fat dairy products and fruits and vegetables on systolic (5 to 6 mm Hg) and diastolic (2 to 3 mm Hg) blood pressure in the general population. Weight and sodium intake were held constant and thus were not a factor in the blood pressure reductions observed. In the DASH participants with mild hypertension, the reductions were comparable (systolic 11 to 12 mm Hg and diastolic 5 to 6 mm Hg reductions) to those observed with monotherapy (single drug) regimens. The DASH authors also noted that their results were generalizable to the entire US population since the blood pressure reductions did not stratify based upon age, gender, weight or race.

The DASH diet was also reflective of current nutritional recommendations to reduce the risk of dyslipidemia, osteoporosis, and cancer. Thus, we have compelling additional reasons to promote dietary patterns that emphasize low fat dairy products and fruits and vegetables as the dietary pattern that will most likely reduce the risk of hypertensive heart disease and its attendant complications: coronary heart disease and stroke. It is imperative that the nutrition community—researchers, practitioners, and leaders—accept the challenge of focusing of our preventive and public health programs on the nutritional factors that are most likely to benefit us all [12].

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Response to the McCarron Letter

For near 100 years, sodium intake has been postulated to be greatly involved in the pathogenesis of elevated blood pressure (BP) [1]. However, results from many studies have not yielded results consistent enough to define the extent of sodium's role in the hypertensive process, even to this day. Despite support for an important role [2], a major effect of moderating sodium intake on lowering BP has not been accepted by all investigators [3,4]. While sodium deprivation would seem to be relevant in prevention and therapy in certain individuals who have a proclivity to increase BP after a sodium challenge [5], recent extensive clinical investigations still leave in doubt an important "BP effect" for sodium deprivation in the overall, normotensive population [6]. Unfortunately, it would appear, as Dr. McCarron points out in his letter, that the general focus on sodium deprivation as the chief non-pharmacologic therapeutic approach has slowed recognition of other non-pharmacologic factors potentially involved in BP regulation—even more so than sodium, i.e., many other nutritional modifications that could influence BP favorably [7].

Having attended the Conference on Dietary Sodium and Health sponsored by the International Life Sciences Institute (ILSI) in Arlington VA in 1994 [6], it became apparent during discussions that caloric restriction is important, perhaps even more important overall than sodium deprivation, in lowering elevated BP. The association of altered BP with body mass is based on a number of findings. First, the risk of developing hypertension is five times greater in obese individuals than normal-weight adults [8]. Second, a significant proportion of hypertensive subjects, as many as 20 to 33%, are overweight [9]. Third, body weight and/or body mass indices show a positive correlation with BP, especially systolic BP in humans. Central distribution of body fat shows the best correlation [10]. Finally, well-controlled investigations consistently point out that reduced body weight lowers BP significantly [11,12].

Worth reemphasizing, recent studies give reasons to look at other nutritional factors that could affect BP favorably [13,14]. Indeed, other nutritional interventions to influence BP via dietary micronutrients are recognized [15–18]. Certainly, micronutrients like potassium, calcium, and magnesium may be important. As Dr. McCarron emphasizes, the effects of these minerals suggest a significant role of low fat dairy products, fruits, and vegetables, rich in these micronutrients and fibers, in BP regulation [14,15].

Considering minerals and electrolytes, even less emphasis has been placed on whether macronutrients influence BP. Data from laboratory experiments on rodents suggest that carbohydrates with a rapid absorption such as sugars, rather than complex carbohydrates, are more likely to raise BP [16]. In turn, use of soluble fibers which slow sugar absorption may counteract their unfavorable influence on BP. To maintain a lower BP, polyunsaturated fats are preferable to saturated ones [16]. Considering herbs, garlic, with its ACE inhibitory properties [19], is recognized as a BP-regulating nutrient [20]. Recently, we have been able to show that chromium [21] and cinnamon [22] given to rats can lower elevated BP. In an interesting turn of events, it has been found that some agents used specifically as antioxidants are beneficial in lowering elevated BP [23–28]. Accordingly, there are many aspects of diet that control the BP, and it is possible that a concerted effort to put many of these observations into practice would be highly beneficial.

While many nutritional factors, both micro and macronutrients, may be important in regulating BP, a significant role for sodium should not be written off entirely. As mentioned earlier, many in the population are sodium-sensitive [5]. At least half of the designated hypertensives may be sodium-sensitive. Certainly, these individuals must watch their salt consumption carefully. Secondly, salt may have a permissive effect in bringing about the pressure changes of other dietary constituents, e.g., we have found that an adequate amount of salt must be present in the diet of spontaneously hypertensive rats (SHR) to bring about elevations of BP at lower levels of sugar ingestion [29].

The take-home message is that many dietary elements, not just sodium and calories, are important in BP regulation. Better

responses may occur when many aspects of the diet are controlled rather than one or two factors exclusive of others [14]. Reducing certain dietary constituents like sugars and saturated fats, and increasing some like potassium, calcium, magnesium, and soluble fibers may be beneficial. In addition, increasing the intake of supplements like chromium and certain antioxidants and flavorings such as garlic and cinnamon may be very helpful. The message of the McCarron letter is clear, let's examine other nutritional factors, alone and in combination, in order to determine the best natural dietary means to control elevated BP.

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