INTRODUCTION

While the prevalence of hypertension (HT) in children and adolescents is not as high as it is in adults, it has increased recently in the context of the epidemic of childhood obesity, to the order of an increased prevalence of about 11% compared to 5% noted in national surveys between the 1960s and the 1990s. Children and adolescents with the combination of HT and obesity manifest more significant cardiovascular outcomes as well. The markers of cardiovascular disease that have been shown to be more significant in obese children include changes in left ventricular mass and carotid intimal medial thickness [1-2]. The findings of fibrous plaques in the aorta and in the carotid arteries at autopsy in the Bogalusa Heart Study have also been correlated with childhood HT, body mass index (BMI) and serum lipid concentrations [3]. There is also known tracking of persistently elevated childhood blood pressure (BP) into adulthood which leads to the belief that children with HT become hypertensive adults. All of these hints about increasing cardiovascular risk point out to the impact that obesity and HT will have on the future of individual patients, the population as a whole, and of the health care system.

BACKGROUND

Hypertension in the pediatric age group historically was considered as originating from an underlying disease and assumed to be secondary to either renal, cardiovascular or endocrine causes. Over the past couple of decades, however, there is increased awareness that HT may be a part of the spectrum of essential HT, linked to obesity and in some, the metabolic syndrome. Hypertension may be defined in a number of ways. Clinically, it can be defined as the sustained level of BP that over time leads to a variety of effects on target organs such as...
the heart (left ventricular hypertrophy), the brain and central nervous system, and the kidneys. Another way of defining HT is to look at it statistically, with BPs that fall above the 95th percentile for age, gender and stature on at least three occasions. The Fourth Report on Blood Pressure in Children and Adolescents recommends that BP should be measured starting at age 3 years during regular medical check-ups and for children at risk for other reasons. The statistical definition of HT is one that is based on normative distribution of BP in healthy children and is stratified by age, gender and stature. In addition to defining HT as BP being > 95th percentile, the National High BP Education Program has more recently gone to defining HT as BP being > 95th percentile, the National Cholesterol Education Program Adult Treatment Panel III criteria. A child is considered overweight when BMI is > 90th percentile and obese when BMI is > 95th percentile. The term metabolic syndrome refers to a cluster of risk factors for the development of cardiovascular disease and diabetes mellitus (DM) that include alterations in serum lipid levels, insulin resistance, obesity, especially the central variety, and HT. There is no consensus as to what defines the metabolic syndrome in children and adolescents, yet several findings are considered co-morbidities in the context of obesity. There have been some modifications made in the definition of the National Cholesterol Education Program Adult Treatment Panel III criteria. These criteria when applied to children and adolescents would require at least three of the following for the diagnosis of metabolic syndrome: serum triglycerides > 95th percentile, high-density lipoprotein (HDL) < 5th percentile, systolic blood pressure (SBP) or diastolic BP (DBP) > 95th percentile, and impaired glucose tolerance [6].

At this time, the non-pharmacologic management of HT in the context of obesity will be discussed.

**MANAGEMENT**

When we consider treatment of HT, we must consider causes, as it is often most effective to manage an illness or condition by treating the underlying disorder. That is often not so easy to do in the area of HT associated with obesity. There are two general approaches to treatment. One area is pharmacologic management, which will not be covered in this paper, and the other is non-pharmacologic management, referred to as Therapeutic Lifestyle Changes (TLC) in the 4th Report. It is generally accepted that patients with pre-HT without evidence of target organ disease should be counseled in ways to affect therapeutic lifestyle changes. In patients with diagnosed HT, either Stage 1 or Stage 2, lifestyle changes should at least be used as adjuncts to drug therapy [5].

**LIFESTYLE CHANGES: GENERAL THOUGHTS ABOUT WEIGHT LOSS AND EXERCISE**

The 4th Report lists diet, exercise and weight loss as potential lifestyle changes. Since weight loss, involvement in aerobic exercise and modifications of the diet have been shown to reduce BP in children and adolescents, it seems reasonable to believe that these approaches should be considered the primary treatment of HT when the HT is related to obesity. There have been both observational and interventional studies showing beneficial effects of weight loss in pediatric patients, and some of these have been reviewed in recent papers [1], yet there have been limited controlled trials. Rocchini and colleagues did a randomized, controlled trial over a 20-week period, and three interventions were studied: diet alone, diet along with exercise and a control group with no intervention at all. This study did show improved changes in systolic BP from baseline in the intervention groups [7].

Even a study like this can only address a limited aspect of the intervention in a defined period of time. The long-term effects of short-term weight loss are unknown.

Weight loss not only reduces BP, but it may also improve some of the other cardiovascular risk factors that cluster with the obesity, such as dyslipidemia and insulin resistance. While this is a benefit to the patient and it makes sense, losing weight is generally a challenge for most patients. When HT is affecting the obese child or adolescent, one cannot overlook the fact that obesity is a part of the complex equation necessary for management of the patient optimally. Another thing to consider when dealing with the child or adolescent with obesity is that it is often a family problem, and it will require buy-in from the family to be successful. While exercise training has also been shown to reduce BP for a limited period of time, on the order of 3-6 months, once the exercise ends, it seems that BP returns to pre-treatment levels [8-9].

The types of exercise felt to be most beneficial are aerobic forms such as running, brisk walking, swimming or cycling, as opposed to static forms of exercise such as weight-lifting. Some children may be participating in group activities in school physical education classes or in team sports, but they may need to increase the intensity of their involvement frequency at which they do...
these activities. While increasing these activities, attention should also be paid to reducing the amount of screen time a child has, such as time in front of a television or computer. Clearly, these interventions are the safest and least prone to having side effects or adverse effects, yet they remain challenging for families to pursue, and there is minimal evidence as well that these interventions are efficacious [4]. It is also important to consider giving children and families some very concrete guidelines, rather than providing the general advice to “increase activity”. Torrance and colleagues would suggest that children do 40 minutes of moderate to vigorous aerobic exercise three to five days per week [10]. This could be a goal to achieve, yet it would certainly require a high degree of motivation on the part of not only the patient, but also the patient’s family.

**LIFESTYLE CHANGES: DIETARY INTERVENTIONS**

It is very important to consider dietary strategies in this setting of obesity-associated HT. It certainly stands to reason that if obesity is a cause or at least the primary contributor to HT for the child, then one must tackle obesity as the underlying problem. There have been studies addressing dietary management of obesity-associated HT, and even some in children. Of the various types of therapeutic lifestyle changes, or non-pharmacologic management strategies, dietary interventions are ones that seem to be most often studied.

A number of nutrients have been examined such as sodium, potassium, calcium, folate, and caffeine; with sodium probably being the most extensively studied. While not every individual will be salt-sensitive, modest sodium reduction would be beneficial, given the typical diet of most children and adolescents in the United States. While dietary advice is recommended as first line of therapy, there is little evidence that it works. In a recent two year trial of potassium and calcium dietary supplementation in Chinese children who had salt-sensitive hypertension, improvement in systolic blood pressure was observed [11]. Relative to obesity in general, there are many studies showing that diet, exercise and behavior modification can lead to improvement of HT in children, however, there is also a high rate of recurrence.

When looking more specifically at children with HT, one can see that a few studies have looked at diet as a modifiable element of a child’s life that can result in improvement. Moore et al. looked at a group of children enrolled in the Framingham Heart Study, and they showed some beneficial effects on BP of a diet rich in fruits, vegetables and dairy products [12].

The DASH diet, which stands for Dietary Approaches to Stop Hypertension, has been proven to lower BP primarily in adults, but there have been some study in children using a similar plan. The DASH diet goes beyond a low sodium diet and provides guidance for a diet rich in fruits and vegetables as well as low-fat or non-fat dairy products. This diet is one that is low in sodium and enriched with potassium and calcium, and it also incorporates a higher intake of micronutrients such as folate and measures to reduce dietary fat intake. The reduction in dietary fat intake is important, given the likelihood for diets higher in fat content to promote weight gain as well as alterations in lipid levels.

A study by Gunther and colleagues in children and adolescents with diabetes mellitus and hypertension explored the associations of the DASH diet in this population. It showed that children with type 1 DM following DASH guidelines had a markedly decreased chance of having HT, but this was not observed in children with type 2 DM. In that study, the majority of subjects with type 2 DM were obese [13].

Couch and colleagues compared an intensive three-month intervention to a more routine type of nutritional intervention in adolescents referred to a tertiary care center HT clinic and diagnosed with either pre-HT or HT [14]. That study warrants some attention here. Two groups of children were studied over a three-month period. One group was called the DASH intervention. This group received extensive counseling as well as very close follow-up. This included a one hour face-to-face counseling session between a dietician, the subject and parent, a manual to take from the study center, eight weekly and two bi-weekly phone calls by a trained interventionist and four bi-weekly mailings. The routine care group compared received a more standard dietary intervention, with the one-hour counseling session done in the clinic setting and provision of a booklet to take with them that basically discussed reduction of sodium intake, weight control by limiting high fat foods, reduction of portion control and eating nutrient-dense forms of food. In addition to a beneficial effect on systolic BP, the DASH group also had significant improvement in diet quality with increased intake of fruits, vegetables and low fat dairy products.

**LIFESTYLE CHANGES: OTHER ELEMENTS TO CONSIDER**

While there may be no data in children and adolescents regarding avoidance of tobacco, alcohol and stress on BP control, it seems prudent to counsel pediatric and adolescent patients about these practices.

**SUMMARY**

Treatment for children and adolescents with HT in the context of obesity must include a number of strategies aimed at reducing overall cardiovascular morbidities. Not every intervention will work to the same extent or degree with every individual, yet by applying a number of strategies, there may be some opportunities for success. Treatment strategies should not be considered “either-or”. Most, if not all, obese patients will benefit from strategies aimed at weight reduction. How to achieve that goal may require a number of different interventions, and a high degree of motivation.
REFERENCES