Supplement to: Update of 2008 Scientific Statement on Ambulatory Blood Pressure Monitoring in Children and Adolescents

From the Atherosclerosis, Hypertension & Obesity in Youth Committee of the Cardiovascular Disease in the Young Council of the American Heart Association

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Conditions in which ABPM has proven useful

The most common application of ABPM in pediatric patients is likely confirmation of suspected HTN in patient with elevated office BP readings. This application of ABPM is discussed extensively in the main paper. However, HTN experts have applied ABPM to the evaluation and management of other types of patients. Some of the most pertinent literature is summarized in this supplement. The interested reader is also referred to the comprehensive review by Flynn and Urbina,[1] and to pertinent chapters in the recently updated Pediatric Hypertension.[2]

Renal diseases: ABPM may be especially useful in evaluation for secondary HTN, since elevated BP load,[3] increased BP variability,[4, 5] and reduced nocturnal dipping[6-8] often signal a renal cause for the BP elevation. For this reason, ABPM has been extensively used in children with CKD. Many studies have looked at the association of abnormal ABPM parameters with end-organ damage such as increased LVM,[9, 10] increased cIMT[11] or even abnormal biopsy findings as seen in children with IgA nephropathy, where higher nocturnal BP was associated with adverse histopathology.[12] Other studies in children with CKD have focused on defining the prevalence of HTN using ABPM, which was found to have greater reproducibility than casual BP.[13]

Recent data from the Chronic Kidney Disease in Children (CKiD) study, a large multicenter observational cohort study of children with mild-to-moderate CKD in the United States and Canada, confirmed a high prevalence of ambulatory HTN in this population.[14] Given the increased risk of CV disease in patients with CKD[15, 16] ambulatory BP in this study was considered abnormal when either ambulatory mean or load was elevated. Thus, subjects with 2008 AHA classified pre-HTN (high casual BP, normal mean ambulatory BP and high ambulatory BP load) were classified as hypertensive (i.e., abnormal ABPM) by these investigators. Additionally, those with unclassified AHA BP parameters (normal casual, normal mean ABP, high load) were classified as having MH. Of 332 children in the CKiD study who had ABPM, only 138 (42%) subjects had both normal BP by casual and ambulatory measurements. WCH was diagnosed in only 13 (4%) subjects, while 116 (35%) were classified as having MH. There were 48 (14%) subjects with confirmed HTN, of whom 21 had “severe” ambulatory HTN (loads > 50%). Ambulatory HTN was more common in African Americans and slightly more common among those with glomerular disease as a primary cause of CKD.

The CKiD investigators have also described the association between renal damage (proteinuria) and the presence of abnormal ABPM. Specifically, a one standard deviation increase in urine protein to creatinine ratio in this population (e.g., 2.25-fold increase) was associated with a 31% higher odds of having an abnormal ABPM (OR: 1.31, 95%CI: 1.04, 1.67; p= 0.024) when controlling for confounders. CKiD subjects on ACEi/ARB were less likely to have abnormal ABPM when compared to those taking other classes of antihypertensive medications. [14] These data are complementary to the results of the Effect of Strict Blood Pressure Control and ACE Inhibition on the Progression of Chronic Renal Failure in Pediatric Patients (ESCAPE) trial, which has shown that intensified, ABPM-guided control of HTN led to decreased CKD progression.[17]

Another report from the CKiD study analyzed the association of ambulatory BP with LVH.[18] LVH was more frequent in children with confirmed (34%, p<0.0005) and masked (20%, p=0.039) HTN than in children with normal casual and ambulatory BP (8%) (Figure 1). More importantly, the likelihood of having LVH was four times higher in those children identified as having MH compared to children with normal clinic and ambulatory BP. This is worrisome, since MH is associated with increased CV risk and progression of CKD in adults.[19]

The long-term effect of ABPM-guided treatment on the development of end-organ damage in children with renal transplant has recently been reported.[20] In this study, 22 children had baseline carotid scan and echocardiography and underwent two additional evaluations for a follow-up of 9.1 ± 0.9 years. Antihypertensive therapy was determined according to the recipient's ABPM results, which were performed at yearly intervals. At the last examination, 14 of 17 children with treated HTN had excellent BP control, with an overall prevalence of LVH of just 4.5%, and no progression of cIMT. The authors concluded that the lack of progression of cIMT over time and the low prevalence of LVH might reflect the effect of strict BP control over time.

Diabetes: Many studies have confirmed the usefulness of ABPM in evaluating CV risk related to HTN in youth with diabetes mellitus. As seen in children with CKD, children with T1DM were often found to have masked or nocturnal HTN, conditions that can be diagnosed only with ABPM.[21] Poor diabetic control may be a contributing factor, as glycated hemoglobin is related to abnormal mean ambulatory SBP[22] and reduced BP dipping.[23] ABPM was also found to be more highly correlated with albuminuria than home BP in youth with T1DM.[24] Monitoring and control of nocturnal BP might actually prevent the development of microalbuminuria, a marker of early kidney injury, as illustrated in the study by Lurbe et al.[25] In this study, 75 adolescents and young adults with T1DM with normal urinary albumin excretion and BP were monitored for more than 5 years. At the end of follow up, nocturnal SBP increased in subjects who ultimately developed microalbuminuria. Moreover, the risk of developing microalbuminuria was 70% lower in subjects with normal nocturnal SBP. Even if normotensive, patients with T1DM who had a non-dipper pattern had greater end systolic LV diameter, end diastolic LV diameter and higher LVM than dippers and they had reduced mean 24-HR, suggesting a degree of autonomic dysfunction.[26] Another study of children with T1DM showed that nocturnal HTN has been associated with higher carotid IMT.[27]

Obesity and ABPM: Several studies have consistently reported positive correlations between ABPM parameters and adiposity (e.g., BMI, waist-hip ratio, waist circumference, subcutaneous and abdominal body fat).[28, 29] The positive associations with BMI could be found in children with both severe ambulatory HTN and with WCH.[30] Many studies have classified more obese children as non-dippers comparing to lean children[29, 31] suggesting a high rate of MH in obese children. A recent multi-ethnic study of obese children and adolescents found that 33% had elevated night time systolic BP.[32] In obese children and adolescents, ambulatory systolic BP and ambulatory pulse pressure correlated positively and significantly with carotid artery IMT and with the presence of LVH, suggesting the potential of ABPM to better identify early target-organ damage.[33]

Obstructive sleep apnea (OSA), which is more prevalent in obese insulin-resistant children, is also linked to higher mean ABPM[34], greater daytime BP variability, and reduced nocturnal dipping.[35] The degree of ABPM abnormality is directly correlated with severity of OSA. Children with an apneic-hypopneic index >5 have significantly higher nocturnal BP levels than less severely affected patients.[36] Children with OSA are also more likely to have a pronounced early morning BP surge.[37] This ABPM pattern is associated with increased risk for adverse CV outcomes in adults.[38] Fortunately, there is some evidence that improvement in OSA after adenotonsillectomy may improve ABPM levels.[39]

ABPM might also be useful in obesity-related conditions such type 2 diabetes and metabolic syndrome. Marcovecchio et al[40] evaluated the correlation between insulin resistance and ABPM parameters in a population of obese pre-pubertal children and found significant correlations among insulin resistance indexes (e.g., HOMA-IR) and 24-hr diastolic BP and non-dipping status. ABPM measures (day and night time systolic BP) and left ventricular mass index (LVMI) are higher in children and adolescents with metabolic syndrome compared with controls.[41]

Genetics of hypertension. ABPM is also useful in evaluating the genetic risk for HTN. Children with hypertensive parents have higher ABPM, but not casual BP.[42, 43] Twin studies have demonstrated the high heritability of ABPM patterns.[44, 45] In a large study of youth with type 1 diabetes, parental ABPM was associated with offspring's BP and maternal DBP was closely related to urinary albumin creatinine ratio in the offspring.[46]

It is not surprising that ABPM is useful in other genetic syndromes at high risk for HTN such as neurofibromatosis[47] where one study found ½ of children with renovascular lesions on invasive radiology had normal resting BP but all had abnormal ABPM.[48] Similarly, ABPM is more sensitive in identifying occult HTN in patients with residual coarctation of the aorta,[49] Williams'[50, 51] and Turner's syndromes.[51]

Management of hypertension: ABPM may be a valuable tool for measuring changes in BP associated with interventions in children and adolescents, such as diet, exercise and anti-hypertensive drugs. When compared to traditional office BP measurement, ABPM offers a better appreciation of the temporal effects of drugs, a larger amount of data per reading, greater reproducibility and a more accurate reflection of BP during the relevant, free-living ambulatory state.[52] Still, only a limited number of clinical trials to-date have been performed using ABPM as an outcome measure,[53, 54] due to current limitations in its applicability in research.[55] In existing clinical studies, ambulatory systolic and diastolic BP were shown to decrease with diet and exercise intervention, specifically increases in habitual physical activity and reduced dietary salt and sugar intake.[56] However, in salt-sensitive subjects, day-time but not night-time ABPM was reduced on low salt diet.[57] Exercise alone has also been shown to reduce 24-hour systolic BP measured by ABPM in obese patients, independent of body weight or fat reduction.[58] Breathing awareness meditation was found to be superior in decreasing ABPM as compared to life skills training and health education in school age children.[59]

Pediatric studies have also been conducted measuring ambulatory BP in response to pharmacological anti-hypertensive treatment. Pharmacotherapy with ACE inhibitors (enalapril) and angiotensin receptor type I blockers (losartan) have been shown to reduce ambulatory systolic and diastolic BP. The anti-hypertensive effect of pharmacotherapy administered concurrent to lifestyle interventions has been shown to be greater than that achieved with lifestyle modification alone.[56] ABPM is also useful in determining 24-hour effect of other drugs known to affect BP, such as hydrocortisone[60] and immunosuppressants used after heart transplantation.[61]

References

1. Flynn JT, Urbina EM. Pediatric ambulatory blood pressure monitoring: indications and interpretations. *J Clin Hypertens (Greenwich).* 2012;14:372-382.

2. Flynn JT, Ingelfinger, J., Portman, R. eds., ed. *Pediatric Hypertension.* 3rd ed. New York, NY: Humana Press, Inc.; 2013.

3. Flynn JT. Differentiation between primary and secondary hypertension in children using ambulatory blood pressure monitoring. *Pediatrics.* 2002;110:89-93.

4. Dursun H, Bayazit AK, Cengiz N, Seydaoglu G, Buyukcelik M, Soran M, Noyan A, Anarat A. Ambulatory blood pressure monitoring and renal functions in children with a solitary kidney. *Pediatric Nephrology.* 2007;22:559-564.

5. Patzer L, Seeman T, Luck C, Wuhl E, Janda J, Misselwitz J. Day- and night-time blood pressure elevation in children with higher grades of renal scarring. *J Pediatr.* 2003;142:117-122.

6. Seeman T, Palyzova D, Dusek J, Janda J. Reduced nocturnal blood pressure dip and sustained nighttime hypertension are specific markers of secondary hypertension. *Journal of Pediatrics.* 2005;147:366-371.

7. Dionne JM, Turik MM, Hurley RM. Blood pressure abnormalities in children with chronic kidney disease. *Blood Press Monit.* 2008;13:205-209.

8. Valent-Moric B, Zigman T, Zaja-Franulovic O, Malenica M, Cuk M. The importance of ambulatory blood pressure monitoring in children and adolescents. *Acta clinica Croatica.* 2012;51:59-64.

9. Zeier M, Geberth S, Schmidt KG, Mandelbaum A, Ritz E. Elevated blood pressure profile and left ventricular mass in children and young adults with autosomal dominant polycystic kidney disease. *Journal of the American Society of Nephrology : JASN.* 1993;3:1451-1457.

10. Bircan Z, Duzova A, Cakar N, Bayazit AK, Elhan A, Tutar E, Ozcakar ZB, Ucar T, Kargin E, Erdem S, Karagoz T, Babaoglu A, Sancak B, Noyan A, Soylemezoglu O, Bakkaloglu A, Yalcinkaya F. Predictors of left ventricular hypertrophy in children on chronic peritoneal dialysis. *Pediatric Nephrology.* 2010;25:1311-1318.

11. Mitsnefes MM, Kimball TR, Witt SA, Glascock BJ, Khoury PR, Daniels SR. Abnormal carotid artery structure and function in children and adolescents with successful renal transplantation. *Circulation.* 2004;110:97-101.

12. Seeman T, Pohl M, John U, Dusek J, Vondrak K, Janda J, Stejskal J, Groene H-J, Misselwitz J. Ambulatory blood pressure, proteinuria and uric acid in children with IgA nephropathy and their correlation with histopathological findings. *Kidney Blood Press Res.* 2008;31:337-342.

13. Krmar RT, Berg UB. Long-term reproducibility of routine ambulatory blood pressure monitoring in stable pediatric renal transplant recipients. *Am J Hypertens.* 2005;18:1408-1414.

14. Samuels J, Ng D, Flynn JT, Mitsnefes M, Poffenbarger T, Warady BA, Furth S. Ambulatory blood pressure patterns in children with chronic kidney disease. *Hypertension.* 2012;60:43-50.

15. Parekh RS, Carroll CE, Wolfe RA, Port FK. Cardiovascular mortality in children and young adults with end-stage kidney disease. *The Journal of pediatrics.* 2002;141:191-197.

16. Lilien MR, Groothoff JW. Cardiovascular disease in children with CKD or ESRD. *Nat Rev Nephrol.* 2009;5:229-235.

17. Wuhl E, Trivelli A, Picca S, Litwin M, Peco-Antic A, Zurowska A, Testa S, Jankauskiene A, Emre S, Caldas-Afonso A, Anarat A, Niaudet P, Mir S, Bakkaloglu A, Enke B, Montini G, Wingen AM, Sallay P, Jeck N, Berg U, Caliskan S, Wygoda S, Hohbach-Hohenfellner K, Dusek J, Urasinski T, Arbeiter K, Neuhaus T, Gellermann J, Drozdz D, Fischbach M, Moller K, Wigger M, Peruzzi L, Mehls O, Schaefer F. Strict blood-pressure control and progression of renal failure in children. *N Engl J Med.* 2009;361:1639-1650.

18. Mitsnefes M, Flynn J, Cohn S, Samuels J, Blydt-Hansen T, Saland J, Kimball T, Furth S, Warady B. Masked hypertension associates with left ventricular hypertrophy in children with CKD. *Journal of the American Society of Nephrology : JASN.* 2010;21:137-144.

19. Agarwal R, Andersen MJ. Prognostic importance of clinic and home blood pressure recordings in patients with chronic kidney disease. *Kidney Int.* 2006;69:406-411.

20. Balzano R, Lindblad YT, Vavilis G, Jogestrand T, Berg UB, Krmar RT. Use of annual ABPM, and repeated carotid scan and echocardiography to monitor cardiovascular health over nine yr in pediatric and young adult renal transplant recipients. *Pediatric transplantation.* 2011;15:635-641.

21. Sulakova T, Janda J, Cerna J, Janstova V, Sulakova A, Slany J, Feber J. Arterial HTN in children with T1DM--frequent and not easy to diagnose. *Pediatric diabetes.* 2009;10:441-448.

22. Chatterjee M, Speiser PW, Pellizzarri M, Carey DE, Fort P, Kreitzer PM, Frank GR. Poor glycemic control is associated with abnormal changes in 24-hour ambulatory blood pressure in children and adolescents with type 1 diabetes mellitus. *J Pediatr Endocrinol Metab.* 2009;22:1061-1067.

23. Dost A, Klinkert C, Kapellen T, Lemmer A, Naeke A, Grabert M, Kreuder J, Holl RW. Arterial hypertension determined by ambulatory blood pressure profiles: contribution to microalbuminuria risk in a multicenter investigation in 2,105 children and adolescents with type 1 diabetes. *Diabetes Care.* 2008;31:720-725.

24. Stergiou GS, Alamara C, Drakatos A, Stefanidis CJ, Vazeou A. Prediction of albuminuria by different blood pressure measurement methods in type 1 diabetes: a pilot study. *Hypertens Res.* 2009;32:680-684.

25. Lurbe E, Redon J, Kesani A, Pascual JM, Tacons J, Alvarez V, Batlle D. Increase in nocturnal blood pressure and progression to microalbuminuria in type 1 diabetes. *N Engl J Med.* 2002;347:797-805.

26. Karavanaki K, Kazianis G, Konstantopoulos I, Tsouvalas E, Karayianni C. Early signs of left ventricular dysfunction in adolescents with type 1 diabetes mellitus: the importance of impaired circadian modulation of blood pressure and heart rate. *Journal of endocrinological investigation.* 2008;31:289-296.

27. Lee SH, Kim JH, Kang MJ, Lee YA, Won Yang S, Shin CH. Implications of nocturnal hypertension in children and adolescents with type 1 diabetes. *Diabetes Care.* 2011;34:2180-2185.

28. Babinska K, Kovacs L, Janko V, Dallos T, Feber J. Association between obesity and the severity of ambulatory hypertension in children and adolescents. *Journal of the American Society of Hypertension : JASH.* 2012;6:356-363.

29. Ben-Dov IZ, Bursztyn M. Ambulatory blood pressure monitoring in childhood and adult obesity. *Curr Hypertens Rep.* 2009;11:133-142.

30. Lurbe E, Alvarez V, Liao Y, Tacons J, Cooper R, Cremades B, Torro I, Redon J. The impact of obesity and body fat distribution on ambulatory blood pressure in children and adolescents. *American journal of hypertension.* 1998;11:418-424.

31. Shatat IF, Flynn JT. Relationships between Renin, aldosterone, and 24-hour ambulatory blood pressure in obese adolescents. *Pediatr Res.* 2011;69:336-340.

32. Aguilar A, Ostrow V, De Luca F, Suarez E. Elevated ambulatory blood pressure in a multi-ethnic population of obese children and adolescents. *J Pediatr.* 2010;156:930-935.

33. Stabouli S, Kotsis V, Karagianni C, Zakopoulos N, Konstantopoulos A. Blood pressure and carotid artery intima-media thickness in children and adolescents: the role of obesity. *Hellenic journal of cardiology : HJC = Hellenike kardiologike epitheorese.* 2012;53:41-47.

34. Leung LC, Ng DK, Lau MW, Chan CH, Kwok KL, Chow PY, Cheung JM. Twenty-four-hour ambulatory BP in snoring children with obstructive sleep apnea syndrome. *Chest.* 2006;130:1009-1017.

35. Amin RS, Carroll JL, Jeffries JL, Grone C, Bean JA, Chini B, Bokulic R, Daniels SR. Twenty-four-hour ambulatory blood pressure in children with sleep-disordered breathing. *American Journal of Respiratory & Critical Care Medicine.* 2004;169:950-956.

36. Li AM, Au CT, Sung RY, Ho C, Ng PC, Fok TF, Wing YK. Ambulatory blood pressure in children with obstructive sleep apnoea: a community based study. *Thorax.* 2008;63:803-809.

37. Amin R, Somers VK, McConnell K, Willging P, Myer C, Sherman M, McPhail G, Morgenthal A, Fenchel M, Bean J, Kimball T, Daniels S. Activity-adjusted 24-hour ambulatory blood pressure and cardiac remodeling in children with sleep disordered breathing. *Hypertension.* 2008;51:84-91.

38. Head GA, McGrath BP, Mihailidou AS, Nelson MR, Schlaich MP, Stowasser M, Mangoni AA, Cowley D, Brown MA, Ruta LA, Wilson A. Ambulatory blood pressure monitoring in Australia: 2011 consensus position statement. *Journal of hypertension.* 2012;30:253-266.

39. Ng DK, Wong JC, Chan CH, Leung LC, Leung SY. Ambulatory blood pressure before and after adenotonsillectomy in children with obstructive sleep apnea. *Sleep Med.* 2010;11:721-725.

40. Marcovecchio ML, Patricelli L, Zito M, Capanna R, Ciampani M, Chiarelli F, Mohn A. Ambulatory blood pressure monitoring in obese children: role of insulin resistance. *Journal of hypertension.* 2006;24:2431-2436.

41. Bostanci BK, Civilibal M, Elevli M, Duru NS. Ambulatory blood pressure monitoring and cardiac hypertrophy in children with metabolic syndrome. *Pediatr Nephrol.* 2012;27:1929-1935.

42. Alpay H, Ozdemir N, Wuhl E, Topuzoglu A. Ambulatory blood pressure monitoring in healthy children with parental hypertension. *Pediatric Nephrology.* 2009;24:155-161.

43. Malbora B, Baskin E, Bayrakci US, Agras PI, Cengiz N, Haberal M. Ambulatory blood pressure monitoring of healthy schoolchildren with a family history of hypertension. *Ren Fail.* 2010;32:535-540.

44. Somes GW, Harshfield GA, Alpert BS, Goble MM, Schieken RM. Genetic influences on ambulatory blood pressure patterns. The Medical College of Virginia Twin Study. *American journal of hypertension.* 1995;8:474-478.

45. Wang X, Ding X, Su S, Harshfield G, Treiber F, Snieder H. Genetic influence on blood pressure measured in the office, under laboratory stress and during real life. *Hypertension research : official journal of the Japanese Society of Hypertension.* 2011;34:239-244.

46. Marcovecchio ML, Tossavainen PH, Acerini CL, Barrett TG, Edge J, Neil A, Shield J, Widmer B, Dalton RN, Dunger DB. Maternal but not paternal association of ambulatory blood pressure with albumin excretion in young offspring with type 1 diabetes. *Diabetes Care.* 2010;33:366-371.

47. Tedesco MA, Di Salvo G, Ratti G, Natale F, Calabrese E, Grassia C, Iacono A, Lama G. Arterial distensibility and ambulatory blood pressure monitoring in young patients with neurofibromatosis type 1. *American journal of hypertension.* 2001;14:559-566.

48. Fossali E, Signorini E, Intermite RC, Casalini E, Lovaria A, Maninetti MM, Rossi LN. Renovascular disease and hypertension in children with neurofibromatosis. *Pediatr Nephrol.* 2000;14:806-810.

49. Parrish MD, Torres E, Peshock R, Fixler DE. Ambulatory blood pressure in patients with occult recurrent coarctation of the aorta. *Pediatric Cardiology.* 1995;16:166-171.

50. Giordano U, Turchetta A, Giannotti A, Digilio MC, Virgilii F, Calzolari A. Exercise testing and 24-hour ambulatory blood pressure monitoring in children with Williams syndrome. *Pediatric Cardiology.* 2001;22:509-511.

51. Gravholt CH, Hansen KW, Erlandsen M, Ebbehoj E, Christiansen JS. Nocturnal hypertension and impaired sympathovagal tone in Turner syndrome. *Journal of hypertension.* 2006;24:353-360.

52. Mansoor GA. Ambulatory blood pressure monitoring in clinical trials in adults and children. *American Journal of Hypertension.* 2002;15:38S-42S.

53. Soergel M, Verho M, Wuhl E, Gellermann J, Teichert L, Scharer K. Effect of ramipril on ambulatory blood pressure and albuminuria in renal hypertension. *Pediatr Nephrol.* 2000;15:113-118.

54. Tallian KB, Nahata MC, Turman MA, Mahan JD, Hayes JR, Mentser MI. Efficacy of amlodipine in pediatric patients with hypertension. *Pediatric Nephrology.* 1999;13:304-310.

55. Mansoor GA. Ambulatory blood pressure monitoring in clinical trials in adults and children. *American journal of hypertension.* 2002;15:38S-42S.

56. Litwin M, Niemirska A, Sladowska-Kozlowska J, Wierzbicka A, Janas R, Wawer ZT, Wisniewski A, Feber J. Regression of target organ damage in children and adolescents with primary hypertension. *Pediatr Nephrol.* 2010;25:2489-2499.

57. Simonetti GD, Farese S, Aregger F, Uehlinger D, Frey FJ, Mohaupt MG. Nocturnal dipping behaviour in normotensive white children and young adults in response to changes in salt intake. *Journal of hypertension.* 2010;28:1027-1033.

58. Farpour-Lambert NJ, Aggoun Y, Marchand LM, Martin XE, Herrmann FR, Beghetti M. Physical activity reduces systemic blood pressure and improves early markers of atherosclerosis in pre-pubertal obese children. *J Am Coll Cardiol.* 2009;54:2396-2406.

59. Gregoski MJ, Barnes VA, Tingen MS, Harshfield GA, Treiber FA. Breathing awareness meditation and LifeSkills Training programs influence upon ambulatory blood pressure and sodium excretion among African American adolescents. *J Adolesc Health.* 2011;48:59-64.

60. Liivak K, Tillmann V. 24-hour blood pressure profiles in children with congenital adrenal hyperplasia on two different hydrocortisone treatment regimens. *J Pediatr Endocrinol.* 2009;22:511-517.

61. Roche SL, Kaufmann J, Dipchand AI, Kantor PF. Hypertension after pediatric heart transplantation is primarily associated with immunosuppressive regimen. *J Heart Lung Transplant.* 2008;27:501-507.

Figure 1

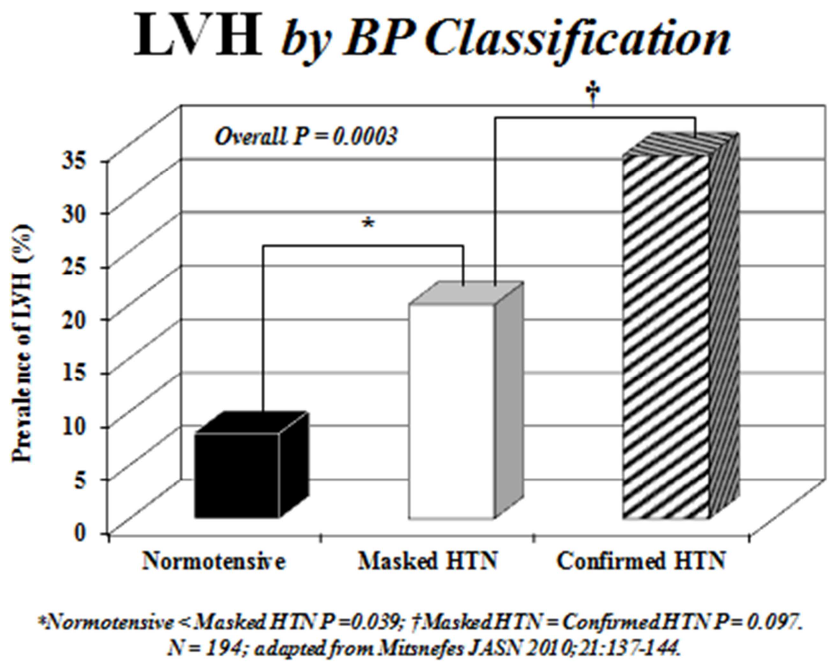

Figure 1. Prevalence of LVH for 9-15 year olds with CKD by BP category from the CKiD study. Normotensive < Masked HTN; **P*=0.039; Masked HTN = Confirmed HTN; †*P*=0.097. Modified from Mitsnefes et al[18] with permission of American Society of Nephrology in the format Republish in a journal/magazine via Copyright Clearance Center.

