CME

Guidelines for screening and managing hypertension in children

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ABSTRACT

Pediatric hypertension has risen to an overall prevalence of 16.3%. If left untreated, hypertension in children and adolescents can have significant implications for cardiovascular and renal health into adulthood, including stroke, coronary artery disease, kidney disease, and heart failure. In 2017, the American Academy of Pediatrics (AAP) released updated guidelines for the screening, evaluation, and management of pediatric hypertension. This article reviews the definition of pediatric hypertension, describes why the guidelines were updated, and defines treatment protocol. By familiarizing themselves with and applying these guidelines, clinicians will be able to appropriately screen and manage hypertension in children to prevent morbidity into adulthood.

Keywords: hypertension, pediatric, obesity, screening guidelines, children, elevated BP

Learning objectives

- Define pediatric hypertension.
- Describe why new guidelines for screening children for hypertension were created.
- Apply the 2017 AAP guidelines for screening and management of hypertension in children.
- Recognize common comorbidities in children with hypertension.

Pediatric hypertension remains a prevalent and underrecognized problem in the United States. Using diagnostic criteria from the 2017 American Academy of Pediatrics (AAP) guidelines, 2% to 4% of US children and adolescents ages 1 to 18 years are hypertensive, while

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16.3% have elevated BP.[1] The rise in pediatric hypertension may be directly correlated with the rise of pediatric obesity, especially over the past 20 years. Furthermore, children with high BP are more likely to have persistent hypertension as adults, and if left untreated, pediatric hypertension can have significant cardiovascular and metabolic implications in adulthood.[2] Beyond threats to cardiovascular health, untreated pediatric hypertension increases patient risk for metabolic syndrome later in life and also may lead to chronic kidney disease (CKD).[2] Likewise, children with hypertension have a threefold increase in stroke mortality compared with those who are normotensive, even after accounting for age, sex, body mass index (BMI), height, education, socioeconomic status, and country of origin.[3]

Primary hypertension is the most common cause of high BP in children and adolescents, so clinicians must be able to recognize its associated epidemiology and risk factors.[4] Both elevated BP and hypertension affect boys more than girls, with rates among adolescents higher than those for younger children. Furthermore, high BP is more likely among Hispanic and Black children than among non-Hispanic Whites.[2] In applying the 2017 AAP guidelines, one study showed the prevalence of high BP is greater in males younger than age 13 years who are shorter (less than the 5th percentile for height) and in males age 13 years and older who are taller (greater than the 95th percentile for height).[1] Unsurprisingly, as of 2016, the

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Key points

- Pediatric primary hypertension is a rising diagnosis that should be identified early in primary care settings.
- In 2017, the AAP released updated guidelines for the screening, evaluation, and management of pediatric hypertension.
- Although secondary causes of pediatric hypertension are rare, clinicians should recognize specific signs, symptoms, and laboratory values that necessitate evaluation and intervention.
- Early detection and treatment of pediatric hypertension can help patients preserve their cardiovascular and renal health into adulthood.

overall prevalence of obesity in US children was about 18.5%, similar to the prevalence of diagnosed hypertension, with one study showing 37% of its pediatric sample being codiagnosed with hypertension and overweight or obesity.[1,5] Although a growing body of evidence indicates that racial and ethnic differences in BP appear during adolescence, the cause of these differences and when they develop in childhood are yet to be fully determined.[6,7] The risk of hypertension correlates more with obesity status than with ethnicity or race, although there may be some interaction.[8] At this time, the strength of available evidence is insufficient to recommend using racial, sex, or ethnic factors to inform the evaluation or management of hypertension in children.[2]

According to an educational needs assessment, primary care pediatricians who routinely screen and treat pediatric hypertension described several barriers to successful hypertension diagnosis.[9] Overall, clinicians defined the following as problematic:

- succinct resources defining high BP
- appropriate methods for measuring correct BP
- recognizing and managing comorbidities
- barriers to care
- experience level treating pediatric hypertension.[9]

The 2017 AAP guidelines clearly define appropriate screening and management of pediatric hypertension and should be used as a guide.[2]

TABLE 1. Defining pediatric hypertension[2]

Age (years)	Stage	BP (mm Hg)		Percentile for age
Under 13	Normotensive	<120/80		<90
	Elevated BP	120-129/80	or	90-95
	Stage 1 hypertension	130-139/ 80-89	or	>95
	Stage 2 hypertension	>140/90	or	>95
13 and older	Normotensive	<120/80		n/a
	Elevated BP	120-129/80		n/a
	Stage 1 hypertension	130-139/ 80-89		n/a
	Stage 2 hypertension	>140/90		n/a

SCREENING AND DIAGNOSTIC WORKUP

Major gaps in earlier clinical guidelines and screening tools have prevented the implementation of best practices for screening for hypertension in children.[10] The 2004 guidelines for BP screening in children contained multiple complicated tables and criteria and were underused by time-constrained clinicians.[11] Furthermore, these guidelines were never adopted nationally, which led to varying standards of care among institutions.[2] Together, these factors resulted in gross underdiagnosis of hypertension in children.[11] Multicenter studies have shown that 71% of physicians only measured pediatric BP if the child had signs of hypertension, and only 65% compared those BP measurements with guidelines.[11]

Providing care for patients begins with clear protocols that efficiently direct clinicians who screen children in the outpatient preventive care setting. The 2017 guidelines updated screening recommendations to include:

- BP classifications that better align with the American Heart Association and American College of Cardiology adult BP guidelines
- Recommendations to measure BP annually in children age 3 years and older or at every healthcare encounter if they are taking medications known to increase BP or have obesity, renal disease, a history of aortic arch obstruction or coarctation, or diabetes
- Streamlined diagnostic evaluations, education, and recommendations for the management of abnormal BP measurements
- An expanded role for ambulatory BP monitoring to increase measurement accuracy

The 2017 guidelines simplify BP levels based on age and height percentiles and further separate cutoffs for children younger than age 13 years and adolescents ages 13 to 18 years. Further, BP measurements now exclude obese adolescents in calculating average weight, which lowers the threshold for screening and potentially identifies at-risk children who would have previously gone unnoticed.

GUIDELINE-DEFINED PRIMARY HYPERTENSION

The 2017 guidelines for diagnosing pediatric hypertension are summarized in **Table 1**. In a patient with abnormal BP, either oscillometric or auscultatory measurements should be taken twice during the same visit. If the elevation persists at the second measurement, recommend lifestyle interventions and repeat BP measurements at 6 and 12 months. If BP remains elevated after 12 months, order ambulatory BP monitoring.[2] Hypertension (**Figure 1**) should only then be diagnosed if the patient's BP is elevated at three separate visits.[2]

Children with primary hypertension generally are overweight and have a family history positive for hypertension. In obese patients, screening should include hemoglobin A1C, lipid panel, and liver enzymes.[2] Children age 6 years and older do not require an extensive evaluation for secondary causes of hypertension if they have a positive family history of hypertension, are overweight or obese, and/or do not have history or physical examination findings suggestive of a secondary cause of hypertension.[2] Echocardiography is only recommended to assess for cardiac target organ damage at the time that pharmacologic treatment of hypertension is considered in any child.[2]

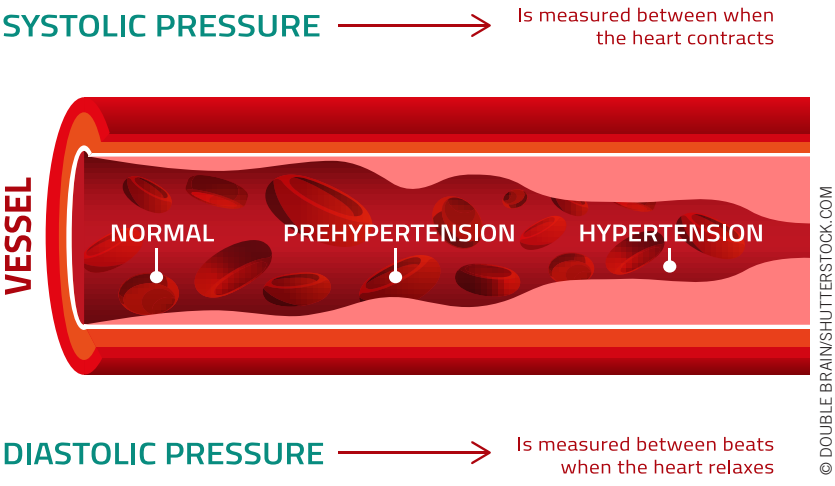

FIGURE 1. Cross-section of a blood vessel illustrating normal BP, prehypertension, and hypertension

SECONDARY CAUSES OF HYPERTENSION

If history and examination findings warrant, consider secondary causes of hypertension such as renal disease, coarctation of the aorta, environmental exposures, neurofibromatosis, hormonal causes, sleep apnea, and medications.[2] Based on patient history and physical examination findings, a urinalysis, chemistry panel, thyroid function tests, sleep study, complete blood cell (CBC) count, and/or a drug screen may be warranted.[2] An elevated diastolic BP is more predictive of secondary hypertension (specifically renovascular disease), which requires renal ultrasound.[2] Subsequent laboratory abnormalities may prompt referral to specialists for further workup of renal, cardiac, or endocrine disorders as secondary causes of hypertension.[2] **Table 2** offers a summary of clinical presentation and diagnostic workup for common causes of secondary hypertension:

- Renal disease and renovascular disease are among the most common secondary causes of hypertension in children, particularly those younger than age 6 years.[2]
- Coarctation of the aorta is a congenital abnormality of the aortic arch characterized by discrete narrowing, generally at the level of the aortic isthmus. Patients with coarctation can remain hypertensive or develop hypertension even after early and successful repair, with reported prevalence varying from 17% to 77%.[12]
- Several environmental exposures have been associated with higher childhood BP, although most studies are limited to small case series. Among the most prominent are exposures to lead, cadmium, and mercury.[13,14]
- Neurofibromatosis type 1 (NF-1) is a rare autosomal dominant disorder that may manifest with several secondary causes of hypertension, most commonly renal artery stenosis, coarctation of the aorta, middle aortic syndrome, and pheochromocytoma.[2,15,16]
- Many over-the-counter drugs, prescription medications, and recreational drugs can increase BP.[17-19] Usually, the BP elevation is mild in these cases and reversible on discontinuation of the medication.
- Hormonal and endocrine causes are rare and can vary widely. They frequently are due to excess hormones such as thyroid hormone, glucocorticoids, or epinephrine from hormone producing tumors, and often are refractory to pharmacologic measures.[20,21]

If secondary hypertension is strongly suspected, immediately refer patients to the appropriate specialist.

IMPROVING SCREENING COMPLIANCE

Technologic innovations relating to the electronic medical record (EMR) may help increase clinician compliance with screening. One example is the implementation of a clinical decision support tool that would guide clinicians to follow recommended guidelines based on the patient's BP readings. The largest barrier to effective care until now has been the lack of such tools.[6] A 2-year cluster-randomized trial with 20 primary care clinics and 31,579 patients used an electronic clinical decision support tool that recorded each BP measurement and notified the clinician of the appropriate clinical intervention based on the patient's BP reading, guideline tables, and guideline recommendations. Clinics that were using the tool recognized 54.9% of the patients who met the diagnostic criteria for hypertension; in comparison, clinics that were not using the tool only recognized those patients 21.3% of the time.[9] Such tools clearly increase recognition of hypertension and improve adherence to guidelines for management.

MANAGEMENT OF PRIMARY HYPERTENSION

Goals of BP management in children focus on reducing target organ damage in adolescence and cardiovascular risk in adulthood. In children younger than age 13 years diagnosed with hypertension, therapy should aim to reduce BP below the 90th percentile. In adolescents ages 13 to 18 years, therapy should aim for a BP less than 130/80 mm Hg.[2] These

goals can be achieved by lifestyle modifications, nonpharmacologic treatments, pharmacologic treatments, or a combination. Lifestyle modifications involve changing diet and exercise regimens. Nonpharmacologic management can include motivational interviewing and professional counseling and support to encourage adherence to treatment. Pharmacologic treatment consists of antihypertensive agents chosen when BP is refractory to lifestyle modification and nonpharmacologic management alone.

The relationship between diet, physical activity, and BP in children mimics that in adults. The Dietary Approaches to Stop Hypertension (DASH) diet has been the primary dietary intervention for patients with hypertension.[2] The original 1997 DASH clinical trial was performed on adults and showed that a diet high in fruits and vegetables plus low-fat dairy yielded the greatest reduction in BP.[22] Although very few studies have been performed in children, one study investigated the DASH diet in adolescent girls and found that those who ate at least two servings of dairy products plus three servings of fruits and vegetables per day reduced elevated BP by 35%.[23] A proposed mechanism for the effectiveness of this diet is that the fruits, vegetables, and dairy products provide sources of calcium, magnesium, and potassium, which lower BP by regulating vasoconstriction and promoting vasodilation. Additionally, magnesium regulates intracellular concentration of other ions, alters insulin sensitivity, and modulates vascular resistance.[23]

Along with a healthful diet, vigorous physical activity is an essential component of reducing pediatric hypertension and cardiometabolic risk. The Physical Activity Guidelines for Americans, issued by the US Department of Health and Human Services, recommend that children ages 6 through 17 years perform 60 minutes or more of moderate-to-vigorous physical activity daily.[24] However, in children with hypertension and obesity, even 40 minutes of moderate aerobic activity 3 days per week lowered systolic BP by an average of 6.6 mm Hg and helped to prevent vascular system dysfunction.[25] Other nonpharmacologic interventions include motivational interviewing, goal setting, self-monitoring, stimulus control, and professional support to promote adherence to healthful diet and exercise choices.[2,26]

Pharmacologic treatment should be initiated immediately for children who remain hypertensive despite a trial of lifestyle modifications, those who present with symptomatic hypertension (BP greater than 130/80 mm Hg with symptoms such as headache, vision changes, or fatigue), children who have stage 2 hypertension without a clear modifiable risk factor, or those with any stage of hypertension associated with CKD.[2,27] Lifestyle management should continue after the initiation of an antihypertensive agent because it enhances effectiveness. Antihypertensive medications have been effective at reducing BP in adults with few adverse reactions; however, studies evaluating the safety and efficacy of these medications in children are lacking.[2] A retrospective cohort study in 2015 demonstrated a lack of antihypertensive prescriptions for children due to the lack of an initiation hierarchy in the 2004 guidelines.[28]

Historically, renin-angiotensin-aldosterone system (RAAS) blockers have been used as first-line agents in children with hypertension, and even though they are known to be teratogenic were prescribed to adolescent girls of childbearing age.[28] However, the 2017 AAP guidelines state that the

TABLE 2. Secondary causes of pediatric hypertension

Diagnosis	History and physical examination findings	Diagnostic workup
Renal disease	Abdominal mass, back pain, hematuria, frequent urinary tract infections, edema, pallor	Doppler renal ultrasonography or renal arteriography (gold standard)
Coarctation of the aorta	Refractory hypertension or right arm BP that is 20 mm Hg (or more) greater than the lower extremity BP	Echocardiography
Environmental exposures	Headache: loss of appetite; weight loss; vomiting; constipation; fatigue; muscle weakness; pallor; bleeding gums; metallic taste in the mouth; exposure to lead, cadmium, mercury, or phthalates	• CBC count to assess for elevated hemoglobin • Lead or mercury levels • Basic metabolic panel to assess renal function
NF-1	Cafe-au-lait macules, neurofibromas, Lisch nodules of the iris, axillary freckling, optic nerve gliomas	Genetic testing for NF-1 gene
Medication-induced	History of oral contraceptives, corticosteroids, tricyclic antidepressants, stimulants or excessive caffeine, NSAIDs, anabolic steroids, decongestants, cocaine, or other stimulants	Removal of suspected agent and subsequent ambulatory BP monitoring
Hormonal/endocrine (hyperaldosteronism, pheochromocytoma, Cushing syndrome, hyperthyroid, and others)	Acne, hirsutism, weight gain, skin pigment changes (striae/flushing), fatigue, muscle weakness, early-onset hypertension, tachycardia, abdominal pain, family history of select condition	• CBC count • Glucose and potassium levels • Kidney function • Glucocorticoid measurement • Abdominal CT

initial agent chosen for the treatment of hypertension in a child should be an angiotensin-converting enzyme (ACE) inhibitor (a subclass of RAAS blockers), an angiotensin II receptor blocker (ARB, another subclass of RAAS blockers), a long-acting calcium channel blocker, or even a thiazide diuretic in pediatric dosages. In children with hypertension and comorbidities such as CKD, proteinuria, or diabetes, RAAS blockers (ACE inhibitors and ARBs) are the recommended initial agent unless the child has absolute contraindications. Black children do not always respond fully to an RAAS blocker, so higher dosages should be considered in that population. Additionally, RAAS blockers are contraindicated in pregnancy, so the clinician should educate adolescent girls on potential risks. Beta-blockers should not be first-line choices in children because they have been shown to have an increased prevalence of unique adverse reactions, such as nightmares, confusion, and tiredness, compared with adults.[2,29,30] Reserve use of beta-blockers for children who have hypertension in addition to heart failure (of any cause), if first-line treatments fail to work, or if the child has additional specific diagnoses such as migraines or tachycardia in which beta-blockers are specifically indicated.[30,31]

Ambulatory BP monitoring is recommended to evaluate the success of treatment. The AAP guidelines give a grade B recommendation for ambulatory BP monitoring, stating that benefits outweigh any potential inconvenience especially when clinic and/or home BP measurements suggest an insufficient response to treatment. Medication can be titrated every 2 weeks based on ambulatory or home BP measurements, or every 4 to 6 weeks based on office measurements, until hypertension is controlled. The goal of titration is to achieve a BP below the 90th percentile. If this cannot be achieved with maximal use of the initial drug, a second drug can be added and titrated as with the initial drug. If an RAAS blocker was used first-line, a thiazide diuretic is the preferred choice as a second agent.[2] **Table 3** offers a summary of treatment options.

REFERRAL

Coordination of care among primary care providers (PCPs) and specialist pediatricians is a delicate balance. Lack of appropriate referral timing by PCPs was noted as problematic by both pediatric cardiologists and nephrologists.[32] Cardiologists often received patients with inaccurate BP readings who did not yet need to be monitored by a cardiologist. Conversely, nephrologists often received patients too late, after hypertension had already caused kidney damage. Both specialties agreed that PCPs should make the hypertension diagnosis, initiate lifestyle changes, and comanage monitoring of patient BP control and medication adverse reactions. However, initiation of antihypertensive medication should take place in the specialty setting.[32]

TABLE 3. Treatment options for pediatric hypertension[2]

Lifestyle
- Diet—DASH diet or increased fruits and vegetables
- Exercise—40 minutes of moderate aerobic activity 3 days per week
- Motivational interviewing and counseling

Pharmacologic
- First-line, and if patient has CKD, proteinuria, or diabetes: ACE inhibitor (captopril, enalapril, fosinopril, lisinopril, ramipril, or quinapril) or ARB (candesartan, irbesartan, losartan, olmesartan, valsartan) or long-acting calcium channel blocker (amlodipine, felodipine, isradipine, nifedipine extended release)
- Second agent if needed (also can be first-line): thiazide diuretic (chlorthalidone, chlorothiazide, hydrochlorothiazide)
- If the patient has heart failure, if first-line treatments fail to work, or if the patient has a specific diagnosis for which beta-blockers are indicated, prescribe beta-blockers.

Referral
- Nephology or cardiology, pending laboratory results and after a diagnosis of hypertension has been confirmed.

COMORBIDITIES

Pediatric hypertension rarely occurs in isolation. Common comorbidities include type 1 diabetes, type 2 diabetes, and obesity.[33] The pathophysiology of such comorbidities is multifaceted and includes insulin as well as leptin sensitivity, increased sympathetic activity, RAAS activation, sodium reabsorption, and obstructive sleep apnea.[26] Awareness of these comorbidities is part of the effective management of pediatric hypertension.

Hypertension is extensively underdiagnosed in patients with type 1 diabetes, which is concerning because these two conditions independently pose serious health risks.[33,34] Compared with children who do not have type 1 diabetes, 4% to 16% of children with type 1 diabetes have hypertension along with an increased risk of cardiovascular disease and mortality.[34] Furthermore, 12% to 31% of children with type 2 diabetes have hypertension, making hypertension even more prevalent in this population.[2] In type 2 diabetes, hypertension develops early in disease progression and is associated with rapid onset of cardiovascular changes.[2] At baseline, most of the participants with type 2 diabetes in one study had clinical and/or biochemical abnormalities including hypertension, microalbuminuria, and dyslipidemia.[33] All children with diabetes should be screened for hypertension at every visit.[2]

Only a fraction of children with hypertension and diabetes are being treated pharmacologically.[2] New guidelines recommend a more aggressive treatment for hypertension and dyslipidemia in patients with type 1 diabetes because of their increased risk for cardiovascular disease.[34] According to Katz and colleagues, clinician barriers to treating hypertensive patients with diabetes and dyslipidemia

included limited clinician training, lack of patient education resources, and a shortage of time.[34] The strongest barriers, however, were lack of patient motivation, support, and self-efficacy. Lifestyle changes remain the most common and difficult barrier.[34] Hypertension and dyslipidemia have similar risk factors, including unhealthful diet, sedentary lifestyle, and obesity.[2] Furthermore, both hypertension and dyslipidemia can lead to atherosclerosis and, therefore, are risk factors for cardiovascular disease.[34]

Obesity is a known risk factor in the development of cardiovascular disease, and at least 75% of pediatric hypertension is thought to be precipitated by obesity.[26,33] Rates of pediatric hypertension increase in a stepwise manner as degree of adiposity increases.[2,35] Those with larger (greater than the 85th percentile) waist circumferences had higher sustained 24-hour daytime and nighttime systolic and diastolic BP.[36] Because obesity continues to be the strongest predictor of adolescent hypertension, clinicians should work with dietitians and counselors to promote healthful lifestyle choices for patients and their families.

To effectively prevent and manage hypertension, clinicians must understand the multidimensional nature of the condition. Cardiovascular disease risk increases significantly when risk factor burden is high. Hypertension is the dominant risk factor for stroke, the dominant risk factor for heart failure, and a major risk factor for renal disease. Understanding the systemic effect of hypertension is critical, as is understanding the effect of other conditions on BP. Therefore, when approaching hypertension, clinicians must address the BP itself, as well as comorbidities and risk factors.[26]

TABLE 4. Screening and management summary

- Screen all patients age 3 years and older annually or at every visit if they have obesity, are taking medications known to increase BP, or have renal disease, a history of aortic arch obstruction or coarctation, or diabetes.
- If BP is greater than 120/80 mm Hg without known cause, screen for secondary causes of hypertension by history and physical examination. Work up diagnostically if appropriate (renal ultrasound, laboratory tests).
- If no secondary causes are found on history, physical examination, or diagnostics, initiate lifestyle and behavior modifications (diet, exercise, and stress management).
- Repeat screening by home measurements and at 6-month and 12-month follow-up visits. Consider A1C, lipid, and liver function testing in obese patients.
- If patient has symptomatic hypertension, or if nonpharmacologic interventions fail and BP remains greater than 130/80 mg Hg, initiate pharmacologic therapy (ACE inhibitors, ARBs, and calcium channel blockers are first-line).
- Obtain an echocardiogram to assess for cardiac damage at the time of consideration of pharmacologic treatment of hypertension.
- Titrate medication every 2 to 4 weeks using home BP measurements. The patient should be seen by a clinician every 4 to 6 weeks until BP has normalized.

CONCLUSION

Between 1.5 and 3 million children in the United States have hypertension, so the need to identify and treat this condition remains high. Elevated BP in childhood increases the risk for adult hypertension, metabolic syndrome, and target organ damage.[2] PCPs are the first point of care for recognizing and treating pediatric hypertension and thus have a responsibility to use new guidelines for screening and management (**Table 4**). New tools that can be incorporated into EMR systems reduce steps for clinicians, help initiate appropriate referrals, prompt cholesterol screening, and overall improve compliance with guidelines.[9,11]

Areas for the future study of pediatric hypertension are broad. Large-scale long-term cohort studies are needed to better establish the distant effects of adolescent hypertension and provide further evidence of the importance of early screening and management.[1,3] Long-term studies on the safety of antihypertensive medications in adolescents and the effect on future cardiovascular disease also are needed.[2] Finally, because of the severe consequences of long-term hypertension, public health campaigns to raise the awareness of clinicians as well as parents and other caregivers are imperative.[28] Only widespread education is likely to meaningfully reduce the prevalence and long-term consequences of pediatric hypertension.[2] **JAAPA**

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