Innocent heart murmurs in children

Taking a diagnostic approach

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SUMMARY

Nearly all pediatric murmurs are heard in normal hearts and are not due to cardiac disorders. These murmurs usually can be classified by distinctive features and distinguished from organic murmurs by skillful clinical examination. This article reviews the various types of innocent heart murmurs in children, discusses their differential diagnoses, and suggests an approach to sorting out pediatric murmurs.

RÉSUMÉ

Chez les enfants, presque tous les souffles sont entendus dans des coeurs normaux et ils ne sont pas causés par des pathologies cardiaques. On peut habituellement classifier ces souffles selon leurs caractéristiques distinctes, et l'examen clinique minutieux permet de les distinguer des souffles organiques. Cet article passe en revue les divers types de souffles anorganiques chez les enfants, discute du diagnostic différentiel et propose une approche pour bien distinguer les souffles pédiatriques.

APPROXIMATELY HALF OF ALL children have a detectable murmur when the precordium is auscultated.[1] Yet the incidence of congenital heart disease is only 0.8%.[2] Thus, the problem for primary care physicians is to distinguish murmurs related to an underlying heart defect from murmurs created by the normal flow of blood within a structurally sound cardiovascular system.

Early and accurate identification of congenital heart defects allows for appropriate endocarditis prophylaxis and can lead to early treatment, which can prevent increased morbidity and mortality. Incorrect labeling of a healthy heart as abnormal causes considerable patient morbidity through psychological impact, needless restriction from sports participation, and insurability.[3,4] Although accurate diagnosis is important, investigating every murmur will alarm parents needlessly and add to the burden of a stressed health care system. This paper aims to provide primary care physicians with an effective approach to assessing heart murmurs detected in children.

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History and physical examination

It is important to remember that the heart is a muscular pump. If the heart is malformed and, as a result, produces a murmur, several clues in the history and physical examination of the patient probably suggest the presence of pump malfunction.

History. A patient's family history as well as prenatal and postnatal record can help identify a serious heart murmur. For example, having a sibling with a ventricular septal defect (VSD) results in a recurrence risk of 6%.[2] A history of intrauterine insult should create suspicion that a murmur is organic. For example, it has long been known that infection with rubella can produce structural cardiovascular defects. Also, it is wise to suspect any murmur detected in a baby with a low birth weight. Postnatal symptoms of a poorly functioning heart that should actively be sought include poor feeding, failure to thrive, frequent lower respiratory tract infections (all associated with increased left to right shunting), excess diaphoresis, diminished exercise tolerance, and precordial pain.
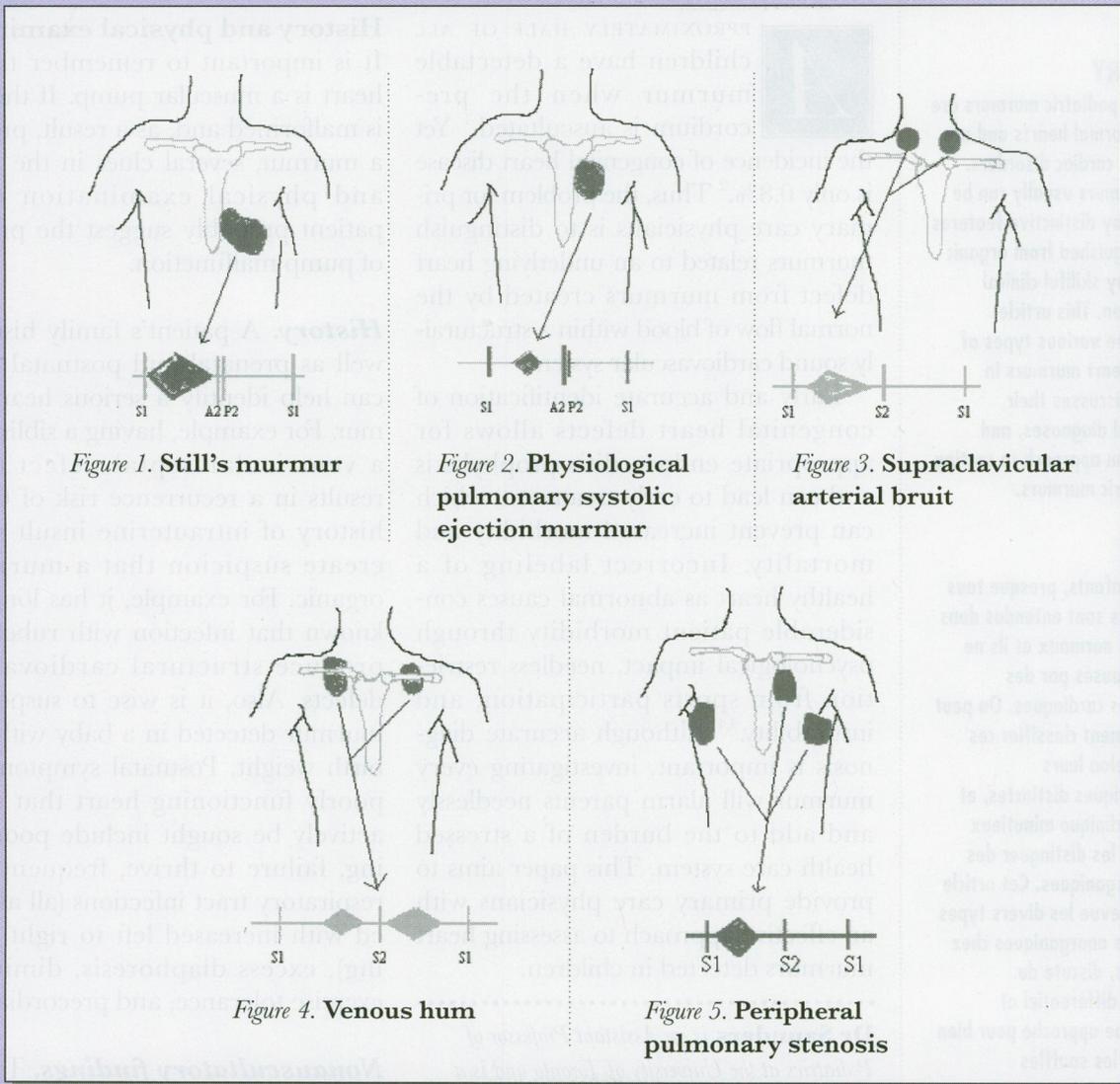
Nonauscultatory findings. To assess the cardiac status of a child, it is helpful to divide the physical examination into

general appearance, nonauscultatory cardiac findings, and auscultation. The general examination often suggests that a murmur is indeed pathological. For example, the presence of dysmorphism, such as Down's syndrome, would increase one's concern if a murmur were noted. Tachycardia or tachypnea at rest sometimes accompany left to right shunting or failure. Unusually full pulses imply aortic runoff seen in patent ductus arteriosus. Weak femoral pulses are, of course, a sign of aortic coarctation.

The chest wall could reveal a precordial bulge due to chronic cardiac enlargement or, perhaps, a hyperdynamic

heart. Palpating the precordium can reveal a thrill, which implies an organic murmur. Thus, before the examiner actually listens to the heart, much can be learned about its functioning. Conversely, if a cardiac defect is minor, nonauscultatory findings are usually normal.

Auscultation. As in adult patients, more will be learned when listening to children's hearts when one dissects the findings by focusing on each heart sound individually than when listening for clicks and then searching for murmurs in both systole and diastole. For example, an abnormally loud second

Figure 1. **Still's murmur**

Figure 2. **Physiological pulmonary systolic ejection murmur**

Figure 3. **Supraclavicular arterial bruit**

Figure 4. **Venous hum**

Figure 5. **Peripheral pulmonary stenosis**

heart sound (S₂) implies pulmonary hypertension, whereas a widely split and fixed S₂ is heard when an atrial septal defect (ASD) is present. Discovering a click can help distinguish mild semilunar valve stenosis or mitral valve prolapse from an innocent murmur. Remembering to auscultate the newborn's head can result in early diagnosis of an intracranial arteriovenous malformation.

Innocent heart murmurs tend to display certain identifying features. Most arise from turbulence at the origin of the great vessels. Generally, they are of short duration, are low in intensity and poorly transmitted, occur in early systole, and are of the crescendo-decrescendo type. They vary with position, being best heard when the child is supine. Most importantly, patients with an innocent heart murmur display no associated cardiac abnormalities.

On the other hand, an underlying heart defect is likely present whenever the murmur seems very loud, is diastolic or pansystolic, or occurs late in systole; it is especially likely if associated cardiac findings are abnormal.

Nearly all innocent heart murmurs heard in childhood are classified as one of five distinguishable types: Still's murmur (also known as the vibratory systolic murmur), the physiological pulmonary systolic ejection murmur, the supraclavicular arterial bruit, the venous hum, and peripheral pulmonary stenosis of infancy. Each has its own distinctive features and differential diagnoses.

Still's (vibratory systolic) murmur
Features. The vibratory systolic or Still's murmur is a common, low-frequency, early systolic ejection murmur that is best heard at the left lower sternal border and extending to the apex cordis. The murmur is most likely to be noted after infancy and has a peak incidence in 3- to 7-year-olds. A vibratory or buzzing quality to the murmur is best appreciated listening with the

bell of the stethoscope while the patient is supine. The intensity of Still's murmur will be reduced by the Valsalva maneuver (*Figure 1*).

Differential diagnoses. The chief differential diagnoses of Still's murmur are idiopathic hypertrophic subaortic stenosis and a small VSD.[5]

Idiopathic hypertrophic subaortic stenosis: This familial cardiomyopathy can cause a relatively quiet murmur in the middle of the left sternal border. It is associated with outflow obstruction due to ventricular hypertrophy, arrhythmias, and even sudden death. Clinically, it can be distinguished from Still's murmur by the Valsalva maneuver. In idiopathic hypertrophic subaortic stenosis, the murmur intensifies with the Valsalva maneuver because reduced venous return causes the outflow tract to narrow. Still's murmur is reduced by the Valsalva maneuver. Furthermore, the murmur of idiopathic hypertrophic subaortic stenosis lacks the low-pitched musical quality of the Still's; pulses tend to be brisk, and the electrocardiogram displays left ventricular hypertrophy.

Small ventricular septal defect: Murmur characteristics of a VSD generally vary with the size of the defect. A small or closing VSD can be difficult to distinguish from the innocent vibratory systolic murmur, as it can present as an early systolic murmur maximal in the third left interspace. Generally, however, murmurs associated with the VSD are pansystolic and more regurgitant in quality.

Physiological pulmonary systolic ejection murmur
Features. The physiological pulmonary systolic ejection murmur is an early systolic crescendo-decrescendo sound heard best with the diaphragm in the left second interspace (*Figure 2*). It is usually Grade 2 in intensity with limited radiation. It is louder when patients lie supine or during inspiration and is more obvious in slightly built subjects or in situations of

increased cardiac output, such as fever or exercise.

Differential diagnoses. Atrial septal defects and pulmonary stenosis cause physiological pulmonary systolic ejection murmurs.

Atrial septal defect: It is, perhaps, most important not to mistake an ASD for an innocent pulmonic murmur. Although the ASD's murmur is also a Grade 2 to 3 systolic ejection murmur maximal in the left second intercostal space, several associated findings help to distinguish it. The right ventricular impulse is prominent; the second component of the first heart sound is loud, and the second heart sound is fixed and widely split. The ECG often shows signs of right conduction delay with or without right axis deviation or ventricular hypertrophy.

Pulmonary stenosis: The murmur of pulmonary stenosis sometimes resembles that of the physiological pulmonary murmur. Yet it is commonly associated with a click or thrill or a wider radiation, which helps separate it from its innocent counterpart.

Other diagnoses: Other entities to consider include small VSD and mitral or tricuspid insufficiency, which should be distinguishable by their clinical findings (especially the more blowing pansystolic nature).

Supraclavicular arterial bruit
Features. The supraclavicular arterial bruit is a relatively harsh, early systolic murmur heard best with the bell of the stethoscope *above* the clavicles (*Figure 3*), particularly on the right side. It is louder when patients sit, and its intensity can be reduced by hyperextending patients' shoulders with their elbows bent. The murmur is heard at any age, but especially midchildhood. It is thought to result from turbulence in the brachiocephalic or carotid arteries.[6]

Differential diagnosis. Be careful to check for a thrill in the suprasternal notch; this usually implies a pathological

murmur, particularly aortic valve stenosis. This malformation, as well as bicuspid aortic valve, is often associated with an ejection click; clicks should actively be sought. Furthermore, the murmur in aortic valve lesions tends to be loudest below the right clavicle and is not diminished by shoulder hyperextension.

Venous hum
Features. The cervical venous hum is a relatively high-frequency, soft, blowing, continuous murmur heard best when the patient is sitting down. It is a common murmur, most frequently noted when the child is between 3 and 8 years. Although potentially bilateral, it is most prominent to the right of the sternum anywhere from the supraclavicular area to the base (*Figure 4*). It can be intensified by rotating the patient's head to the contralateral side while listening with the bell in the supraclavicular space. Digital compression of the ipsilateral internal jugular vein will reduce or eliminate the murmur when auscultating in the same position. The hum is much quieter when the patient is in the supine position.

Differential diagnosis. The cervical venous hum should be differentiated from a patent ductus arteriosus. Whereas the venous hum is diminished when the patient is supine and can be obliterated by compressing the internal jugular vein, the patent ductus arteriosus is not and cannot. The venous hum is similar to the continuous ductal murmur except that the diastolic component is high-pitched and the hum is truly a continuous ceaseless murmur, whereas the diastolic component of the ductal murmur is low-pitched and decrescendo.[7] Patent ductus arteriosus is frequently associated with bounding pulses and a hyperdynamic left cardiac impulse.

Innocent peripheral pulmonary stenosis
Features. In newborns, particularly in premature infants, the relatively dilated

main pulmonary artery branches to smaller lateral vessels at sharp angles, creating turbulence and thus an audible sound, the murmur of peripheral pulmonary stenosis (*Figure 5*), in some babies. It is a short midsystolic ejection murmur of medium pitch and intensity. It is heard in the pulmonic area in systole but is equally loud when auscultated in the axillae. The sound frequency of the murmur is similar to that of a neonate's breath sounds and could be missed, particularly if the axillae are not auscultated.

Differential diagnosis. The murmur of innocent peripheral stenosis should radiate widely and disappear within a few months. If it does not, then one is probably dealing with another process associated with a pulmonic murmur, eg, pulmonary stenosis (valvular, supravalvular, or subvalvular), ASD, patent ductus arteriosus, or anomalous pulmonary venous return. True pulmonary branch stenosis, as opposed to the innocent transient infantile peripheral pulmonary stenosis, frequently is accompanied by a history of maternal rubella exposure. Valvular stenosis often has an associated click. Wide and fixed splitting of the second heart sound should accompany an ASD, and ductal murmurs tend to be harsh and continuous.

Investigations

Newburger et al[8] found little likelihood that ECG, chest x-ray, or M-mode echocardiogram results would alter the diagnosis of innocent heart murmur made on the basis of a proper history and physical examination. Smythe et al[9] reported that the clinical examination by a pediatric cardiologist, used to identify the origin of childhood murmurs, had a sensitivity of 96%, specificity of 95%, positive predictive value of 88%, and negative predictive value of 98%. In this study, the ECG changed no diagnosis from innocent to pathological. Generally, the chest x-ray, ECG, and even the echocardiogram serve more to identify the specific nature of already suspected disorders than to screen murmurs thought to be innocent based upon clinical examination.

Management

Primary care physicians can effectively screen for heart murmurs in children. Congenital heart disease will be identified in 46% of cases by the first week, in 88% of children by 1 year, and in 98% by 4 years of age.[10] Furthermore, although less than 1% of children have congenital heart disease, the incidence at initial assessment by a pediatric cardiologist is approximately 30% to 35%.[8,9,11]

When a careful history and physical examination clearly support the diagnosis of innocent heart murmur, neither further investigation nor referral is indicated. It is sufficient to inform the parents and the child, when appropriate, of the presence of the murmur in as reassuring a manner as possible. Thereafter, the murmur can be monitored at routine periodic checkups.

In some situations, one cannot be certain of a murmur's innocence. If the child has historical risk factors for congenital heart disease, if the examination is suboptimal due to noncompliance, or if the findings are equivocal, a chest x-ray and ECG are indicated. Afterward, if the physician remains uncertain about the murmur or suspects an organic lesion, referral to a pediatric cardiologist is advised. A referral could also be required if parental anxiety remains excessive.

In general, the younger the patient, the more prompt should be the referral.[12] Neonates with suspected congenital heart disease should be referred as soon as possible, whereas older asymptomatic children can safely wait weeks for assessment by a cardiologist with little likelihood of adverse effect. ■

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cilazapril
`INHIBACE`™

Therapeutic Classification
Angiotensin Converting Enzyme Inhibitor

Indications And Clinical Use
Mild to moderate essential hypertension. May use alone or in combination with thiazide diuretics. Use not recommended in congestive heart failure or renovascular hypertension as safety and efficacy not established. Safety and efficacy of concomitant use with antihypertensive agents other than thiazide diuretics not established. When used in pregnancy during the second and third trimesters, ACE inhibitors can cause injury or even death of the developing fetus. When pregnancy is detected 'Inhibace' should be discontinued as soon as possible.

Contraindications
Hypersensitivity to this product and history of angioedema related to previous treatment with an angiotensin converting enzyme inhibitor.

Warnings
Angioedema: Angioedema has been reported. Discontinue, institute appropriate therapy without delay, and follow carefully until the swelling subsides. When tongue, glottis or larynx involved, administer subcutaneous adrenaline (0.5 mL 1:1000) promptly when indicated. Patients with history of angioedema unrelated to ACE inhibitor may be at increased risk.
Hypotension: Symptomatic hypotension has been reported, after first dose or when dose increased. More likely with sodium or volume depletion. Patients with congestive heart failure may experience excessive hypotension and should start therapy under close medical supervision and be followed for the first two weeks of treatment and when increasing the dose of 'Inhibace' and/or diuretic.
Neutropenia/Agranulocytosis: Leucopenia and neutropenia have been reported. Monitor white blood cell counts periodically.
Use in Pregnancy: ACE inhibitors can cause fetal and neonatal morbidity and mortality when administered to pregnant women. Discontinue as soon as possible when pregnancy detected. Consult product monograph for situations in which no alternative treatment can be found, and for infants with a history of in utero exposure.

Precautions
Impaired Renal Function: Use with caution. Monitor patients closely assessing renal function before and during therapy. Dosage reduction and/or discontinuation of concomitant diuretic and/or cilazapril may be required. In patients with severe heart disease, treatment with ACE inhibitors may result in oliguria and/or azotemia and acute renal failure and/or death. Increases in blood urea nitrogen and/or serum creatinine observed in patients with renal artery stenosis. Increase in blood urea nitrogen and creatinine observed with concomitant use of diuretic.
Anaphylactoid Reactions during Membrane Exposure: Anaphylactoid reactions have been reported in patients dialysed with high-flux (polyacrylonitrile) membranes. Dialysis should be stopped immediately.
Anaphylactoid Reactions during Desensitization: There have been isolated reports of patients experiencing sustained life-threatening anaphylactoid reactions while receiving ACE inhibitors during desensitizing treatment with hymenoptera (bees and wasps) venom.
Hyperkalemia: Elevated serum potassium observed. Consider additional risk factors.
Valvular Stenosis: Patients with aortic stenosis might be at risk of decreased coronary perfusion.
Surgery/Anesthesia: Arterial hypotension may result.
Impaired Liver Function: Hepatitis, jaundice, elevations in liver enzymes and/or serum bilirubin reported during therapy with ACE inhibitors. Liver function tests, other necessary investigations and/or discontinuation of therapy should be considered. No studies in patients with cirrhosis and/or liver dysfunction. Therefore, use with caution.
Cough: Consider possible drug involvement as part of differential diagnosis.
Nursing Mothers: Not known if excreted in breast milk. Use with caution.
Pediatric Use: Safety and efficacy not established. Not recommended.
Elderly: Greater sensitivity cannot be ruled out.

Drug Interactions
Diuretic Therapy: Occurrence of hypotension. Minimize by discontinuing diuretic or increasing salt intake, prior to initiation of treatment with 'Inhibace' and/or reducing initial dose of 'Inhibace'.
Agents Increasing Serum Potassium: Elevation of serum potassium has been reported. Use potassium sparing diuretics with caution and monitor frequently.
Agents Causing Renin Release: Antihypertensive effect is augmented.
Agents Affecting Sympathetic Activity: Use with caution.
Inhibitors of Endogenous Prostaglandin Synthesis: Indomethacin may reduce the antihypertensive effect of cilazapril but there is no evidence of attenuation of blood pressure lowering effects of cilazapril when its administration precedes the administration of the NSAID.
Digoxin: No pharmacodynamic or pharmacokinetic interaction.
Lithium Salts: Lithium elimination may be reduced. Therefore, monitor serum lithium levels.

Adverse Reactions
The most frequent adverse reactions (2,586 hypertensive participants) reported in controlled clinical trials were: headache (5.1%), dizziness (3.0%), fatigue (2.1%), cough (1.8%) and nausea (1.3%). 2.4% discontinued. The most severe adverse reactions reported in 5,450 hypertensive patients were angioedema/face edema (0.1%), postural hypotension (0.3%), orthostatic hypotension (2.1%), myocardial infarction (0.1%), cerebrovascular disorder (0.04%), renal failure (0.09%), and thrombocytopenic purpura (0.02%). For adverse reactions occurring in <1% of the patients consult product monograph.
Abnormal Laboratory Findings: Leucopenia 0.2%, neutropenia 0.4%, changes in liver function enzymes 0.1% - 1.1%, changes in renal function tests 0.6% or less, hyperkalemia (>5.5 mEq/L) 0.7%, serum creatinine >2 mg/dL 1.3%, proteinuria 0.5%.

Dosage And Administration
Individualize dosage. Initial dose 2.5 mg per day. Usual dose range 2.5 mg to 5 mg per day in a single daily dose. If satisfactory control is not maintained for 24 hours, consider twice daily administration with the same total daily dose or an increased dose, maximum dose of 10 mg daily.
If blood pressure is not adequately controlled with 'Inhibace' alone, a non-potassium-sparing diuretic may be administered concomitantly.
Diuretic-Treated Patients: Discontinue diuretic two to three days before 'Inhibace'. Start at 0.5 mg (half of a 1 mg tablet) once daily and monitor the patient after the first dose until stabilized. Thereafter, adjust the dose according to individual response.
Dosage in Elderly Patients (Over 65 Years): Initiate treatment with 1.25 mg (half of a 2.5 mg tablet) once daily or less and adjust with caution.

Dosage Adjustment in Renal Impairment (including patients on dialysis):

Creatinine Clearance	Initial Dose of 'Inhibace'	Maximal Dose of 'Inhibace'
>40 mL/min	1 mg once daily	5 mg once daily
10 - 40 mL/min	0.5 mg once daily	2.5 mg once daily
<10 mL/min	0.25 - 0.5 mg once or twice a week according to blood pressure response	

Dosage Adjustment in Hepatic Impairment: Initiate treatment with caution at a dose of 0.5 mg once daily.

Availability
'Inhibace' (cilazapril) is available in film-coated tablets containing:

1 mg cilazapril	yellow, oval shaped, single scored biconvex tablets, imprinted CIL 1.
2.5 mg cilazapril	pinkish-brown, oval shaped, single scored biconvex tablets, imprinted CIL 2.5.
5 mg cilazapril	reddish-brown, oval shaped, single scored biconvex tablets, imprinted ROCHE 5.

Bottles of 100 tablets.
Schedule F Drug.

Product Monograph available upon request.

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8. Based on 1994 Price Lists and Ontario Drug Benefit Formulary with January 15, 1995 Supplement and 1995 Quebec Formulary.

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