Review Article

Bedside cardiac auscultation in modern clinical practice: implications for non-cardiologists

Abstract

Cardiac auscultation remains a fundamental component of cardiovascular examination despite increasing reliance on advanced imaging techniques. For non-cardiologist physicians, proficiency in recognizing heart sounds and murmurs plays a critical role in early detection of structural heart disease, appropriate referral for echocardiography, and efficient use of healthcare resources. This narrative review summarizes the physiological basis of normal and abnormal heart sounds, the clinical interpretation of additional heart sounds, and a systematic approach to murmur evaluation. Key auscultatory features of common valvular disorders, including aortic stenosis, mitral regurgitation, and aortic regurgitation, are discussed with emphasis on practical bedside recognition. Extra-cardiac acoustic phenomena and their diagnostic relevance are also reviewed. The indications for further diagnostic testing are outlined to assist clinicians in distinguishing low-risk findings from those requiring advanced imaging. In addition, contemporary strategies for improving auscultation skills, including simulation-based education and digital technologies, are examined. Emerging applications of electronic stethoscopes and artificial intelligence in clinical practice are briefly addressed. Strengthening auscultation competence among non-cardiologists may enhance diagnostic accuracy, reduce unnecessary investigations, and improve patient outcomes. This review highlights the continued clinical value of cardiac auscultation as a rapid, cost-effective screening tool in modern medicine.

Keywords: cardiac auscultation, heart murmurs, valvular heart disease, physical examination, medical education

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Ahmed Şefik Begoğlu,[1] Abdullah Sarihan,[2] Macit Kalçik,[2] Mehmet Mustafa Yilmaz,[1] Osman Karaarslan,[1] Mucahit Yetim,[2] Muhammet Cihat Çelik,[1] Lütfü Bekar,[2] Yusuf Karavelioğlu[2]

[1]Department of Cardiology, Hitit University Erol Olçok Education and Research Hospital, Turkey

[2]Department of Cardiology, Faculty of Medicine, Hitit University, Turkey

Correspondence: Macit Kalcik, MD., Department of Cardiology, Faculty of Medicine, Hitit University, Çorum, Turkey

Address: Buharaevler Mah. Buhara 25. Sok. No:1 /A Daire:22 Çorum/ TURKEY, Tel (90)536 4921789, Fax (90)3645117889

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Introduction

Physical examination remains an essential component of clinical medicine, providing immediate diagnostic information at the point of care. Among physical examination techniques, cardiac auscultation has historically been a cornerstone for the initial assessment of cardiovascular disease.[1] The stethoscope, invented in the early 19th century, enabled clinicians to hear internal heart sounds and to correlate acoustic phenomena with underlying pathology. Despite advances in imaging technologies such as echocardiography, auscultation continues to be a valuable and cost-effective screening tool in general practice and emergency settings.[2,3]

Proficiency in cardiac auscultation involves the ability to accurately distinguish heart sounds, identify murmurs, and recognize abnormal acoustic patterns. Multiple studies have documented a decline in auscultation skills among medical trainees and practicing clinicians, often attributed to reduced emphasis in modern curricula and increasing reliance on diagnostic imaging.[4,5] For non-cardiologist physicians, these skills remain important for early clinical assessment and appropriate referral decisions.

Limited auscultation competency may contribute to delayed diagnosis or unnecessary diagnostic testing. Studies have shown that many trainees struggle to correctly identify clinically important heart sounds without structured training.[6] This deficit in clinical skill may lead to unnecessary testing, delayed diagnosis, or misclassification of disease severity. Conversely, structured educational interventions, including simulation-based and deliberate practice approaches, have been shown to improve auscultatory accuracy among learners.[7]

Although echocardiography provides detailed morphological and hemodynamic information, it is not universally available in all clinical settings, and over-use may contribute to increased healthcare costs. Therefore, reinforcing the value of cardiac auscultation and integrating efficient training strategies into non-cardiology education remains vital for improving quality of care and resource stewardship.[1-3]

Literature search approach

In order to provide a comprehensive overview of the topic, a narrative literature review was conducted using major medical databases including PubMed and Google Scholar. Searches were performed using combinations of keywords such as “cardiac auscultation,” “heart sounds,” “heart murmurs,” “valvular heart disease,” “digital stethoscope,” and “artificial intelligence in auscultation.” Relevant original studies, clinical reviews, and guideline documents published primarily between 1990 and 2025 were considered. Additional articles were identified through manual screening of reference lists of key publications. Studies were selected based on their relevance to the clinical interpretation, diagnostic value, and educational aspects of cardiac auscultation, particularly in the context of non-cardiologist clinical practice.

Physiological basis of heart sounds

Heart sounds arise from the mechanical events of the cardiac cycle, generated by closure of valves and the resulting vibrations of blood and surrounding structures.[8] These vibrations become audible through a stethoscope when turbulence and rapid pressure changes occur at specific points in the cycle.

The first heart sound (S1) is produced by the closure of the mitral and tricuspid valves, marking the onset of ventricular systole.[8] The mitral component typically precedes the tricuspid component by milliseconds due to left ventricular contraction occurring slightly before right ventricular contraction.[9] This sound identifies the transition from diastole to systole and is best heard at the cardiac apex. The quality of S1 is influenced by valve pliability, ventricular contractility, and timing within the cardiac cycle.

The second heart sound (S2) reflects the closure of the aortic and pulmonic semilunar valves at the end of systole and the beginning of diastole. It consists of two components, aortic (A2) and pulmonic (P2), which can be heard separately when conditions allow differentiation of valve closure timings.[10] Physiological splitting of S2 occurs during inspiration, when variations in intrathoracic pressure and right ventricular ejection delay pulmonic valve closure relative to aortic valve closure.[11] The pattern and degree of S2 splitting have diagnostic implications and can vary with age and cardiac function.

The acoustic characteristics of S1 and S2, including intensity, frequency, and timing, are determined by the dynamics of valve closure and the resulting vibrations in blood and cardiac structures. Hemodynamic models affirm that abrupt cessation of retrograde blood flow and the mechanical interactions of valves and surrounding tissues are key to sound generation.[8] Understanding these mechanisms provides the foundation for recognizing normal and pathological auscultatory findings. The main characteristics of normal and additional heart sounds, including their timing within the cardiac cycle, underlying mechanisms, and common clinical associations, are summarized in Table 1.

Table 1 Heart sounds and their clinical significance

Heart sound	Timing in cardiac cycle	Mechanism	Common clinical associations	Clinical implication
S1	Onset of systole	Closure of mitral and tricuspid valves	Normal finding; reduced in calcified valves; loud in hyperdynamic states	Identifies beginning of systole
S2	End of systole	Closure of aortic and pulmonic valves	Physiologic splitting with inspiration; fixed splitting in atrial septal defect	Marker of ventricular relaxation
S3	Early diastole	Rapid ventricular filling into compliant ventricle	Heart failure, volume overload, dilated cardiomyopathy	Indicates elevated filling pressures
S4	Late diastole	Atrial contraction into stiff ventricle	Hypertension, ischemia, hypertrophic cardiomyopathy	Suggests diastolic dysfunction
Opening snap	Early diastole	Sudden tensing of stenotic mitral valve	Mitral stenosis	Severity correlates with left atrial pressure
Pericardial rub	Systole and diastole	Inflamed pericardial layers rubbing	Acute pericarditis	Highly specific diagnostic sign

Abbreviations: S1, first heart sound; S2, second heart sound; S3, third heart sound; S4, fourth heart sound

Additional heart sounds and their clinical meaning

Beyond the normal first and second heart sounds, additional low-frequency sounds may be detected during diastole, most commonly the third (S3) and fourth (S4) heart sounds. These sounds reflect alterations in ventricular filling dynamics and myocardial compliance and often provide important clues regarding underlying cardiac pathology.[12]

The third heart sound (S3) occurs early in diastole, shortly after S2, during the phase of rapid passive ventricular filling. It is generated by sudden deceleration of blood flow as it encounters a compliant or volume-overloaded ventricle, producing vibrations within the ventricular walls and surrounding structures.[13] In children, adolescents, and young adults, an S3 may be a normal physiological finding related to highly compliant ventricles and brisk filling. However, in patients over 40 years of age, the presence of S3 is strongly associated with pathological states such as heart failure, dilated cardiomyopathy, and significant valvular regurgitation.[14] Numerous clinical studies have demonstrated that S3 correlates with elevated left ventricular filling pressures and worse prognostic outcomes in heart failure populations.[15]

The fourth heart sound (S4) occurs late in diastole, immediately before S1, and is produced by atrial contraction forcing blood into a stiff or noncompliant ventricle.[16] This sound reflects impaired ventricular relaxation and increased myocardial stiffness, commonly seen in conditions such as hypertensive heart disease, ischemic cardiomyopathy, aortic stenosis, and hypertrophic cardiomyopathy. Unlike S3, S4 is almost always pathological in adults and disappears in the presence of atrial fibrillation, since coordinated atrial contraction is required for its generation.[17]

Gallop rhythms occur when S3 or S4 combine with the normal heart sounds to create a cadence resembling a horse's gallop. A ventricular gallop (S3) typically suggests volume overload and systolic dysfunction, whereas an atrial gallop (S4) reflects diastolic dysfunction and increased ventricular stiffness.[15,16] Recognition of these rhythms is clinically valuable for non-cardiologists, as they often indicate advanced cardiac disease and warrant further diagnostic evaluation.

Overall, S3 and S4 provide acoustic markers of ventricular hemodynamics and myocardial properties. Their detection can guide early identification of heart failure and diastolic dysfunction, particularly in settings where immediate imaging is not available.

Systematic approach to cardiac murmurs

Cardiac murmurs result from turbulent blood flow within the heart or great vessels and represent one of the most clinically informative components of auscultation. A structured and reproducible assessment allows non-cardiologists to differentiate benign flow phenomena from murmurs suggestive of significant structural disease.[18]

The first step in murmur evaluation is determining its timing within the cardiac cycle. Systolic murmurs occur between S1 and S2 and may be classified as early, mid-systolic, late systolic, or holosystolic. Early

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systolic murmurs are often related to acute regurgitant lesions or high flow states, while mid-systolic murmurs commonly reflect outflow obstruction such as aortic or pulmonic stenosis. Holosystolic murmurs typically indicate regurgitant flow across incompetent atrioventricular valves, most frequently mitral or tricuspid regurgitation.[6] In contrast, diastolic murmurs, which occur between S2 and the subsequent S1, are almost always pathological and suggest conditions such as aortic regurgitation or mitral stenosis. Continuous murmurs span both systole and diastole and are classically associated with abnormal vascular connections, including patent ductus arteriosus.

Murmur intensity is conventionally graded using the Levine scale, ranging from grade I (barely audible) to grade VI (audible without a stethoscope touching the chest wall). Although loudness does not directly correlate with disease severity, high-grade murmurs (grade III or higher) are more likely to reflect significant hemodynamic lesions.[18] The quality of the murmur, described as harsh, blowing, rumbling, or musical, further aids diagnostic interpretation.

Radiation of murmurs provides important anatomical clues. For example, murmurs originating from the aortic valve frequently radiate toward the carotid arteries, whereas mitral regurgitation often radiates toward the left axilla. Careful attention to the point of maximal intensity and direction of sound propagation improves localization of the underlying lesion.[6]

Bedside maneuvers modify venous return, systemic vascular resistance, and ventricular loading conditions, thereby altering murmur intensity. Squatting increases preload and afterload, typically intensifying murmurs of aortic stenosis while diminishing hypertrophic cardiomyopathy murmurs. The Valsalva maneuver reduces venous return and accentuates murmurs associated with dynamic outflow obstruction. Handgrip increases systemic resistance, enhancing regurgitant murmurs such as mitral regurgitation while reducing flow-dependent ejection murmurs.[19] These dynamic responses are particularly useful for non-cardiologists in resource-limited or acute care settings.

A systematic approach integrating timing, intensity, radiation, and maneuver response enables clinicians to narrow diagnostic possibilities efficiently and identify patients requiring further investigation. Typical auscultatory characteristics of common valvular lesions, including timing, location, radiation, and distinctive acoustic features, are summarized in Table 2 to facilitate practical bedside recognition. This structured bedside evaluation is particularly valuable for non-cardiologist clinicians in primary care and emergency departments, where rapid initial risk stratification is required to determine whether immediate echocardiographic evaluation or specialist referral is necessary.

Table 2 Murmur characteristics by valve lesion

Valve lesion	Timing	Typical location	Radiation	Key auscultatory features
Aortic stenosis	Systolic (crescendo–decrescendo)	Right upper sternal border	Carotid arteries	Harsh quality, diminished S2
Mitral regurgitation	Holosystolic	Apex	Left axilla	Blowing quality, increased with handgrip
Aortic regurgitation	Early diastolic	Left sternal border	Toward apex	High-pitched decrescendo murmur
Mitral stenosis	Diastolic rumble	Apex	Minimal	Opening snap, presystolic accentuation
Tricuspid regurgitation	Holosystolic	Lower left sternal border	Right sternal border	Increases with inspiration
Hypertrophic cardiomyopathy	Systolic	Left sternal border	Minimal	Increases with Valsalva

Abbreviations: AS, aortic stenosis; AR, aortic regurgitation; MR, mitral regurgitation; TR, tricuspid regurgitation; HCM, hypertrophic cardiomyopathy

Clinically important murmurs non-cardiologists must recognize

Certain cardiac murmurs are strongly associated with clinically significant structural heart disease and require prompt recognition by non-cardiologists. Early identification through auscultation facilitates timely referral for echocardiography and prevents delayed diagnosis of potentially progressive conditions.[20]

Aortic stenosis is characterized by a harsh, crescendo–decrescendo systolic murmur best heard at the right upper sternal border with frequent radiation to the carotid arteries. The murmur typically intensifies with increased stroke volume and diminishes as ventricular function deteriorates in advanced disease. Clinical features such as diminished carotid upstroke, exertional dyspnea, syncope, or angina increase the likelihood of severe obstruction.[21] Auscultatory detection of this murmur remains an effective screening method in elderly populations where degenerative calcific disease is prevalent.

Mitral regurgitation commonly presents as a holosystolic blowing murmur heard best at the cardiac apex and radiating toward the left axilla. Acute regurgitation may produce a softer murmur despite significant hemodynamic compromise, whereas chronic regurgitation often generates a prominent murmur due to increased flow across the incompetent valve.[22] Recognition is essential because progressive ventricular dilation and systolic dysfunction may develop before overt symptoms appear.

Aortic regurgitation produces an early diastolic, high-frequency decrescendo murmur best auscultated along the left sternal border with the patient leaning forward. This murmur reflects rapid backflow of blood from the aorta into the left ventricle during diastole. Peripheral signs of widened pulse pressure may accompany advanced disease. Early auscultatory detection can prompt evaluation before irreversible ventricular remodeling occurs.[23]

Innocent or functional murmurs are frequently encountered in children and young adults and are typically soft, mid-systolic, position-dependent, and not associated with symptoms or abnormal physical findings. These murmurs do not radiate widely and often decrease with standing or Valsalva maneuver. Differentiating benign murmurs from pathological ones prevents unnecessary testing while ensuring significant disease is not overlooked.[20]

Overall, recognizing hallmark features of major valvular murmurs allows non-cardiologists to make informed decisions regarding further investigation and referral.

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Pericardial and extra-cardiac sounds

Not all abnormal sounds heard during cardiac auscultation originate from intracardiac blood flow. Several important acoustic phenomena arise from the pericardium or valvular structural changes and may provide critical diagnostic clues when properly recognized.[24]

The pericardial friction rub is a characteristic, high-pitched, scratching sound produced by inflamed pericardial layers sliding against one another. It is classically triphasic, with components occurring during atrial systole, ventricular systole, and early diastole, although biphasic or monophasic forms may also be present. The rub is typically best heard along the left sternal border with the patient leaning forward and may vary with respiration and body position. Its presence is highly specific for acute pericarditis and often precedes electrocardiographic changes or effusion development.[25]

Opening snaps are brief, high-frequency sounds occurring shortly after S2 and are associated with abrupt tensing of stenotic but mobile mitral valve leaflets, most commonly in rheumatic mitral stenosis. The shorter the interval between S2 and the opening snap, the higher the left atrial pressure and the more severe the stenosis tends to be. Recognition of this sound helps distinguish mitral stenosis from other causes of diastolic murmurs.[26]

Prosthetic valve sounds are frequently audible and vary depending on valve type and position. Mechanical valves produce distinct high-frequency closing clicks, whereas bioprosthetic valves generate softer sounds resembling native valve closure. Absence or alteration of expected prosthetic sounds may signal valve dysfunction, thrombosis, or structural failure and should prompt immediate further evaluation.[27]

Extra-cardiac sounds such as pleural friction rubs, respiratory wheezes, or gastrointestinal noises may mimic cardiac murmurs but can usually be differentiated by their variation with respiration or disappearance when breath is held. Careful correlation with respiratory maneuvers reduces diagnostic error. Understanding these non-murmur acoustic findings enhances the diagnostic accuracy of auscultation and prevents misinterpretation of potentially serious conditions.

When auscultation is not enough: indications for further testing

While cardiac auscultation remains a valuable bedside tool, it has inherent limitations in sensitivity and specificity, particularly in distinguishing lesion severity and identifying subclinical disease. Certain auscultatory findings should prompt timely use of echocardiography to confirm diagnosis, assess hemodynamic significance, and guide management.[28]

Diastolic murmurs are universally considered pathological and warrant echocardiographic evaluation regardless of symptom status. These murmurs often reflect valvular stenosis or regurgitation and may be associated with progressive ventricular remodeling if left untreated.[29] Similarly, loud systolic murmurs (grade III or higher), murmurs associated with symptoms such as dyspnea, chest pain, or syncope, and murmurs accompanied by abnormal physical signs (e.g., displaced apex beat, heart failure signs) indicate a high probability of significant structural heart disease.[18]

New-onset murmurs in the context of acute illness require particular attention. Acute mitral regurgitation following myocardial infarction, papillary muscle dysfunction, or infective endocarditis may produce subtle or soft murmurs despite severe hemodynamic compromise. Reliance solely on auscultation in such scenarios may underestimate disease severity, making echocardiography essential for rapid diagnosis.[30]

In asymptomatic individuals, echocardiography is recommended when murmurs demonstrate classical features of aortic stenosis, hypertrophic cardiomyopathy, or significant regurgitant lesions. Screening through auscultation followed by targeted imaging allows efficient use of diagnostic resources while avoiding unnecessary testing in patients with clearly innocent murmurs.[31]

Point-of-care ultrasound is increasingly used by non-cardiologists as an adjunct to auscultation, enabling rapid bedside assessment of ventricular function, valve motion, and volume status. Although not a replacement for comprehensive echocardiography, this approach enhances diagnostic confidence in acute and resource-limited settings.[32]

Overall, auscultation should be viewed as a triage tool that guides further investigation rather than a definitive diagnostic modality. Recognition of high-risk acoustic patterns remains essential for timely referral and optimal patient outcomes. Key auscultatory red flags that should prompt echocardiographic evaluation and their associated clinical implications are summarized in Table 3. For non-cardiologist physicians, these auscultatory red flags provide a practical framework for deciding which patients require urgent imaging and which can be safely monitored without immediate echocardiography.

Table 3 Red flags requiring echocardiographic evaluation

Auscultatory finding	Associated risk	Recommended action
Any diastolic murmur	Structural heart disease	Immediate echocardiography
Grade ≥ III systolic murmur	Significant hemodynamic lesion	Echocardiography
Murmur with dyspnea, syncope, chest pain	Severe valve disease or cardiomyopathy	Urgent imaging
New murmur after myocardial infarction	Acute regurgitation or rupture	Emergency echocardiography
Murmur with heart failure signs	Elevated filling pressures	Echocardiography
Abnormal prosthetic valve sounds	Thrombosis or dysfunction	Immediate evaluation

Abbreviations: MI, myocardial infarction; LV, left ventricle

Teaching and improving auscultation skills

Effective cardiac auscultation requires structured training and repeated deliberate practice. Traditional bedside teaching alone has proven insufficient for achieving long-term proficiency, particularly among non-cardiologists who encounter a wide variety of cardiac sounds less frequently than specialists.[33]

Several studies have demonstrated that medical trainees often fail to correctly identify fundamental heart sounds and murmurs after conventional clinical exposure. This skill decay is attributed to limited supervised practice, variable patient availability, and increasing reliance on imaging technologies for diagnosis.[7] As a result, targeted educational interventions have been developed to address these deficiencies.

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Simulation-based training has emerged as one of the most effective methods for improving auscultatory competence. High-fidelity mannequins and digital heart sound simulators allow learners to repeatedly practice recognition of normal and pathological sounds in a controlled environment. Randomized studies show significant improvements in diagnostic accuracy following structured simulation curricula compared with traditional teaching alone.[34]

Digital auscultation platforms and mobile applications further enhance learning by providing extensive libraries of annotated heart sounds linked to specific pathologies. These tools enable self-directed practice and facilitate skill retention over time. When combined with clinical correlation and feedback, digital resources substantially improve long-term performance.[35]

Deliberate practice models emphasizing focused repetition, immediate feedback, and progressive difficulty have been particularly successful in transforming auscultation from a passive observational skill into an actively trained competency. Such approaches align with modern medical education frameworks that prioritize mastery over exposure.[34]

Incorporating structured auscultation training into undergraduate and postgraduate curricula is essential for maintaining clinical competence. For non-cardiologists, proficiency in heart sound interpretation directly enhances diagnostic efficiency and reduces unnecessary imaging while ensuring early detection of serious pathology.

Clinical algorithms for non-cardiologists

For non-cardiologist clinicians, transforming auscultatory findings into appropriate clinical decisions is essential. A structured diagnostic pathway allows rapid differentiation between low-risk murmurs and those requiring further investigation, optimizing patient safety while minimizing unnecessary imaging.[36]

The initial step involves identifying murmur timing. Diastolic and continuous murmurs should be considered high risk and prompt immediate echocardiographic evaluation. Systolic murmurs are then assessed for intensity, radiation, and associated symptoms. Systolic murmurs of grade III or higher (Levine scale), murmurs radiating to the neck or axilla, and those accompanied by exertional dyspnea, syncope, chest pain, or signs of heart failure warrant advanced imaging regardless of patient age.[37]

In contrast, soft mid-systolic murmurs in asymptomatic individuals without abnormal physical findings often represent innocent flow murmurs and may be safely monitored without immediate imaging. Positional changes and physiologic maneuvers further aid risk stratification; murmurs that diminish with standing or Valsalva maneuver are more likely benign, whereas those that intensify may indicate structural pathology.

Integration of patient history, physical examination, and focused bedside maneuvers creates a reliable triage system. In recent years, simplified clinical algorithms combining auscultation with point-of-care ultrasound have demonstrated improved diagnostic accuracy compared with auscultation alone, particularly in acute care settings.[38]

These stepwise approaches empower non-cardiologists to utilize auscultation as an effective screening tool while ensuring timely referral for echocardiographic confirmation when necessary. Such structured algorithms are particularly useful in primary care clinics and emergency departments, where clinicians must rapidly distinguish benign murmurs from findings suggestive of significant structural heart disease.

Future perspectives

Advances in digital health technologies are reshaping the role of cardiac auscultation in modern clinical practice. Electronic stethoscopes capable of sound amplification, filtering, and waveform visualization have improved the detection of subtle heart sounds and murmurs, particularly in noisy clinical environments. These devices also enable sound storage and remote transmission, facilitating telemedicine consultations and longitudinal patient monitoring.[39]

Artificial intelligence (AI) based algorithms are increasingly being integrated into digital auscultation platforms. Machine learning models trained on large phonocardiographic datasets have demonstrated high accuracy in detecting valvular heart disease, heart failure–related acoustic signatures, and abnormal rhythm patterns. Such tools may assist non-cardiologists by providing real-time diagnostic support and standardized interpretation, reducing interobserver variability.[40]

Recent studies evaluating AI-assisted auscultation systems have reported promising diagnostic performance for the detection of pathological heart murmurs. Deep learning–based algorithms trained on large phonocardiographic datasets have demonstrated sensitivities and specificities exceeding 85–90% for identifying clinically significant valvular heart disease in controlled validation settings.[40] However, several limitations remain. Many algorithms are developed using curated datasets obtained under standardized recording conditions, which may limit their generalizability to real-world clinical environments where background noise, variable recording techniques, and heterogeneous patient populations are common. In addition, dataset bias and insufficient representation of certain age groups or rare cardiac conditions may influence algorithm performance. From a regulatory perspective, several digital stethoscope platforms incorporating AI-based analysis have begun to receive regulatory clearance for clinical use, although widespread implementation remains limited and further large-scale prospective validation studies are needed before routine adoption in everyday clinical practice.[41,42]

In real-world clinical settings, particularly in primary care and emergency departments, improved auscultation proficiency may function as a practical screening tool for structural heart disease. Early identification of clinically significant murmurs can facilitate timely referral for echocardiography while reducing unnecessary imaging in patients with clearly benign findings. This targeted diagnostic approach may improve workflow efficiency, shorten time to diagnosis, and contribute to more rational use of healthcare resources. From a health economics perspective, strengthening bedside diagnostic skills, especially when augmented by digital auscultation technologies, offers a cost-effective strategy to balance high-quality cardiovascular care with rising demands on imaging services.[43]

Despite these technological developments, the foundational skill of bedside auscultation remains essential. Digital tools should be viewed as adjuncts rather than replacements, reinforcing clinical reasoning while preserving physician–patient interaction. Structured training programs that combine traditional bedside teaching with simulation and digital augmentation are likely to produce the most durable skill acquisition.

Conclusion

Cardiac auscultation remains a fundamental clinical skill that continues to offer meaningful diagnostic value despite rapid advances in cardiovascular imaging. For non-cardiologists, the ability to systematically interpret heart sounds and murmurs enables early recognition of structural heart disease, guides appropriate referral for

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echocardiography, and supports efficient use of healthcare resources. When applied thoughtfully, auscultation functions as an effective first-line screening tool in both outpatient and acute care settings.

This narrative review highlights the physiological basis of heart sounds, the clinical interpretation of additional heart sounds, and a structured approach to murmur assessment. Recognition of hallmark acoustic features associated with common valvular lesions allows clinicians to distinguish benign findings from potentially serious pathology. Furthermore, awareness of extra-cardiac sounds and high-risk auscultatory patterns enhances diagnostic accuracy and prevents misclassification.

Equally important is the role of structured education in maintaining and improving auscultation proficiency. Simulation-based learning, digital sound libraries, and deliberate practice models provide effective strategies for skill acquisition and long-term retention, particularly for clinicians who encounter cardiac pathology less frequently. Integrating these methods into medical training can help reverse the documented decline in bedside examination skills.

In summary, strengthening cardiac auscultation competence among non-cardiologists has direct clinical impact. A systematic listening approach, combined with modern educational tools and clinical judgment, supports timely diagnosis, reduces unnecessary investigations, and ultimately improves patient care.

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All of the authors contributed planning, conduct, and reporting of the work. All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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