CLINICAL COLUMN

Heart Sounds: Are You Listening? Part 1

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Abstract

All nurses should have an understanding of heart sounds and be proficient in cardiac auscultation. Unfortunately, this skill is not part of many nursing school curricula, nor is it necessarily a required skill for employment. Yet, being able to listen and accurately describe heart sounds has tangible benefits to the patient, as it is an integral part of a complete cardiac assessment. In this two-part article, I will review the fundamentals of cardiac auscultation, how cardiac anatomy and physiology relate to heart sounds, and describe the various heart sounds. Whether you are a beginner or a seasoned nurse, it is never too early or too late to add this important diagnostic skill to your assessment tool kit.

Key words: cardiac cycle, cardiac auscultation, S1, S2, S3, S4

A complete cardiac examination is a multisensory experience that requires the integration of inspection, palpation, and auscultation. When auscultation is performed correctly, most cardiac abnormalities can be accurately detected. Yet, did you know that cardiac examination skills are declining and often inaccurately performed? Researchers have found disturbingly low identification rates of commonly encountered heart sounds by both internal medicine and family practice trainees; and that heart sound proficiency did not improve after the third year as a medical student (Mangione & Nieman, 1997; Vukanovic-Criley et al., 2006).

How would nurses have fared if they were study participants? Nurses tend to lack confidence when it comes to stating their findings related to cardiac auscultation. Mastering this skill requires an understanding of cardiac anatomy and physiology, especially as it relates to the cardiac cycle, and being able to differentiate the first heart sound (S1) from the second heart sound (S2) and any other heart sounds before, between and after.

Cardiac auscultation is a fundamental, yet exceedingly difficult-to-master clinical skill. Often high-tech, high-cost medical imaging takes the place of listening to heart sounds (Chizner, 2008; Mangione & Nieman, 1997; RuDusky, 2005). This is deemed to be linked to the fact that, traditionally, heart sounds have been taught as an intellectual skill with didactic lectures followed by brief demonstrations. The results of this teaching method have been disappointing. The psychoacoustic learning principle, which is based on developing an auditory template that comes from repeated and attentive listening, has yielded better results. One needs to hear a sound between 400 and 600 times for the brain to recall and recognize the sound. Once the sound has been mastered it is reinforced each time the skill is applied in the clinical setting (Barrett, Lacey, Sekara, Linden, & Gracely, 2004).

To accurately identify heart sounds will require the right stethoscope, as not all are equal in their ability to transmit sound. If your stethoscope is less than ideal, you may know heart sounds, but you may not hear them. Prior to the early 1800s the unaided ear was used to listen to a patient. Dr. Rene Laennec is credited with the first stethoscope in 1819, which was no more than a cylindrical tube. He is also credited with being the first to distinguish S1 and S2 (Roguin, 2006).

The modern stethoscope consists of two earpieces connected via tubing to a chest piece consisting of a diaphragm and bell. The diaphragm is used to pick up high-frequency sounds such as systolic murmurs, S1, and S2. The bell is used to pick up low-pitched sounds such as diastolic murmurs, the third heart sound (S3), and the fourth heart sound (S4). If pressure is applied to the bell, it behaves like a diaphragm.

Techniques for Listening to Heart Sounds

To help practitioners improve their ability to hear heart sounds, several techniques can be applied, such as a quiet room, adequate exposure to the precordium without interference from clothing and body hair, standing on the right-hand side of the patient, and patient positioning that help amplify heart sounds (Walker, Hall, & Hurst, 1990).

For most of the exam the patient (if possible) should be supine with the head-of-the-bed at 30 degrees. To bring out an easily missed mitral stenosis murmur, or a soft S3 or S4 have the patient roll onto his or her left side and place the bell of your stethoscope lightly at the apex. This manoeuvre brings the heart closer to the chest wall. To bring out an easily missed soft aortic regurgitation murmur have the patient sit up, lean forward, exhale completely and stop breathing after he or she has exhaled, and place the diaphragm of the stethoscope firmly against the chest wall along the left sternal border. Remember to pause during the examination to let the patient take a breath. This manoeuvre brings the left ventricular outflow track closer to the chest wall.

Auscultation sites closely correlate to the location of the valves. It is best to have a sequence when listening to heart sounds. You can start at the base of the heart and move down towards the apex in the following manner: second right intercostal space (RICS), also known as the aortic area, across to the second left intercostal space (LICS), also known as the pulmonic area, inch along the left sternal border to the fifth LISC, also known as the tricuspid area, and end as you move across to the midclavicular line or apex, also known as the mitral area. If you start at the apex, you would retrace these steps in the opposite direction (Huebner, 2010; Walker et al., 1990).

Heart Sounds in Relation to the Opening and Closing of the Cardiac Valves

There are four valves in the heart—the tricuspid valve (TV) and mitral valve (MV), also known as atrioventricular valves, and the pulmonic valve (PV) and aortic valve (AV), also known as semilunar valves. Heart sounds come from the valves closing and vibrations that emanate from the valve leaflets, adjacent cardiac structures, and blood flow.

Figure 1 shows cardiac diastole and systole. Diastole is a long phase that occurs when the atrioventricular valves (TV and MV) are open (atria contracting and emptying) and the semilunar valves (PV and AV) are closed (ventricles relaxed and filling). Diastole lengthens with bradycardia and shortens with tachycardia. At a heart rate of 120 beats per minute or greater diastole may be indistinguishable from systole.

Systole is a short phase that occurs when the atrioventricular valves (TV and MV) are closed (atria relaxed and filling) and the semilunar valves (PV and AV) are open (ventricles contracting and emptying). Timing and identifying what is systole and what is diastole are essential to being able to decipher various heart sounds.

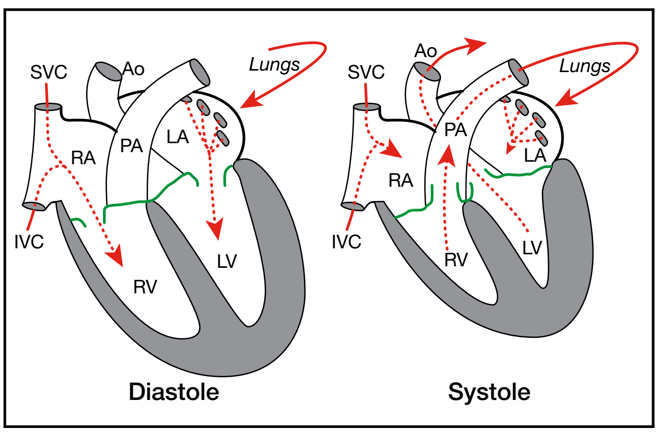

Figure 1: Heart in diastole and systole
Klabunde, R.E. (2011). http://cvphysiology.com/Heart%20 Disease/HD002.htm
Image used with permission

Heart Sounds in Relation to the Cardiac Cycle

Heart sounds relate to the events within the cardiac cycle, as well as those displayed on an electrocardiogram (ECG) tracing (see Figure 2) (Klabunde, 2011). It is important to note that the heart sound will lag behind the electrical events recorded by the ECG (Malarvili, Kamarulafizam, Hussain, & Helmi, 2003). The description that follows only refers to the left heart and the activity of the MV and AV.

Late diastole

Number 1 at the top of Figure 2 correlates with the heart in late diastole. The left ventricle is relaxed with the AV already closed and the MV already open and the left ventricle being filled with left atrial blood. This is the phase during which an S4 would be heard (Walker et al., 1990).

Fourth heart sound—S4

S4 occurs immediately before S1 and after the P wave on the ECG (Malarvili et al., 2003). It is best heard at the apex of the heart with the bell of the stethoscope and the patient lying supine or left-side lying. This late diastolic sound is made during atrial contraction when blood from the left atrium enters a stiff non-compliant left ventricle. S4 can sound like “belub dup” S4-S1-S2 or a cadence similar to the words “a-stiff-wall” (a=S4, stiff=S1, wall=S2), “Tennessee” (Ten=S4, nes=S1, see=S2), or “Toronto” (Tor=S4, on=S1, to=S2) (Warnica, 2007).

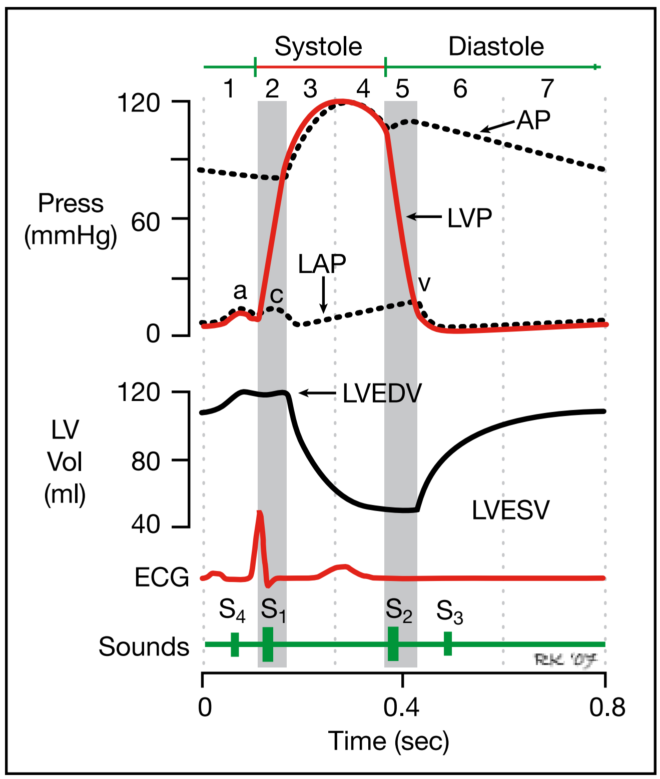

Figure 2: Heart sounds in relation to the cardiac cycle
Klabunde, R.E. (2011). http://cvphysiology.com/Heart%20 Disease/HD002.htm
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Isovolumetric contraction

Number 2 at the top of Figure 2 correlates with the period of systole called isovolumetric contraction when the AV remains closed and the MV closes as soon as left ventricular pressure exceeds left atrial pressure. During a brief period of time both the AV and MV are closed and left ventricular pressure continues to rise sharply to overcome aortic pressure. This is the phase during which an S1 would be heard (Walker et al., 1990).

First heart sound—S1

The onset of systole is marked with the closure of the MV producing S1 or "lup". Best heard at the apex of the heart with the diaphragm of the stethoscope, this low-pitched sound is of longer duration than S2. It can be distinguished using the ECG as S1 is heard right after the QRS complex (Malarvili et al., 2003).

S1 can also be distinguished using the carotid pulse, as it occurs just before or coincident with the upstroke of the carotid pulse (Walker et al., 1990). The carotid pulse is preferred over peripheral pulses, as there is a palpable delay between ventricular contraction and more distal peripheral pulses.

S1 can also be split as the MV normally closes just before the TV. A split S1 sounds like "lu-lub". A normal split S1 is very brief and often not detected. An abnormal split S1 is prolonged and caused by a right bundle branch block (RBBB) (Walker et al., 1990).

Systole (ejection phase)

Numbers 3 and 4 at the top of Figure 2 correlate with the ejection phase of systole. The left ventricle is contracting and when left ventricular pressure exceeds aortic pressure the AV is pushed open. The MV remains closed, which allows the left ventricle to forcefully empty its blood into the aorta. As soon as the volume within the left ventricle decreases, left ventricular pressure immediately falls.

Isovolumetric relaxation

Number 5 at the top of Figure 2 correlates with the period of systole called isovolumetric relaxation when the MV remains closed and the AV closes as soon as left ventricular pressure has fallen below aortic pressure. During a brief period of time both the AV and MV are closed as left ventricular pressure continues to fall sharply until it is below LA pressure. This is the phase during which an S2 would be heard (Walker et al., 1990).

Second heart sound—S2

The end of systole is marked with the closure of the AV producing S2 or "dub" (Huebner, 2010). Best heard at the base of the heart with the bell of the stethoscope this high-pitched sound is of shorter duration than S1. S2 occurs after the peak or with the downslope of the carotid pulse. If using the ECG to help with timing, S2 occurs at the end of the T wave.

Normally, at the very end of systole, the AV closes just before the PV causing a split S2, which sounds like "du-dub". Physiological splitting is normal and it will fluctuate with the respiratory cycle. During inspiration, PV closure is delayed due to increased venous return to the right side of the heart. The split will widen and become more discernible on inspiration and disappear on expiration. Pathological splitting can be fixed, narrowed, or reversed (paradoxical). Fixed splitting can be caused by an RBBB or an atrial septal defect. Narrowed splitting during inspiration occurs when left ventricular ejection time is increased. Causes include severe aortic stenosis, left ventricular outflow obstruction, left ventricular volume overload, patent ductus arteriosus, left bundle branch block (LBBB), and Wolf Parkinson White Syndrome. Paradoxical or reversed splitting occurs when the AV closes after the PV. Most commonly caused by LBBB, it can also be heard in patients with hypertrophic cardiomyopathy, in the immediate few days after an acute myocardial infarction, or secondary to severe left ventricular dysfunction (Walker et al., 1990).

Early diastole

Number 6 and 7 at the top of Figure 2 correlate with the heart in early diastole. The left ventricle is relaxing with the AV closed and the MV open and the left ventricle is beginning to fill with left atrial blood. This is the phase during which an S3 would be heard (Walker et al., 1990).

Third heart sound—S3

S3 is best heard at the apex of the heart with the bell of the stethoscope and with the patient lying supine or left side-lying. Although common and innocent in children and young adults it is pathological in older adults often due to left ventricular dysfunction. This early diastolic sound is made when blood from the left atrium slams into an already full left ventricle. S3 can sound like "lub du bub" S1-S2-S3 or a cadence similar to the words "sloshing-in" (slosh=S1, ing=S2, in=S3), "Kentucky" (Ken=S1, tuc=S2, ky=S3), or "Montréal" (Mon=S1, tré=S2, al=S3) (Warnica, 2007).

Conclusion

This concludes part 1 with the overview of the fundamentals of cardiac auscultation, how cardiac anatomy and physiology relate to heart sounds and the basic heart sounds of S1, S2, S3, and S4. Appreciating these sounds is an essential prerequisite to learning advanced heart sounds, which will be covered in part 2. Remember it takes time, patience, and dedication to create an auditory template in your brain. To help you with this, visit websites like: http://medicine.osu.edu/exam/; http://www.med.ucla.edu/wilkes/intro.html; http://depts.washington.edu/physdx/heart/demo.html; or http://www.cardiosource.com/heartsounds/index.asp. The end result will be worth it, as you will have an important skill to add to your assessment tool kit. ♥

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