The first long-lasting, widely used application of diagnostic cardiac ultrasound was the detection of pericardial effusion. Although cardiac ultrasound already had been around for at least 10 years, one can make a strong case that this use of cardiac ultrasound was the real origin of today’s practice of echocardiography (echo). This particular application all came about because of an erroneous advertisement.

In 1963, I was in charge of our cardiac catheterization laboratory. From an investigational point of view, I was interested in left ventricular function. I was specifically interested in the status of the left ventricle in patients with mitral stenosis (1). Although the left ventricle was thought to be totally normal with mitral stenosis, we had data indicating that the diastolic function was abnormal. As a result, we were studying the left ventricular pressure volume relationship during diastole at rest and with exercise. There were definite limitations to the techniques we were using. I then saw an advertisement claiming that non-invasive cardiac volumes could be obtained with cardiac ultrasound. I called the company making the claim and was told that the instrument would be displayed at the upcoming American Heart Association meeting in Los Angeles. I already was planning to attend the meeting so I arranged to go to their booth. When I arrived at the booth, the representative did not have the vaguest idea how to measure cardiac volumes with this instrument. In retrospect, I suppose the person who created the ad may have been aware that in 1950 a German investigator named Keidel used through-transmission ultrasound to obtain an acoustic shadow that was related to cardiac volume. In any case, the instrument in the booth was an ultrasonic reflectoscope and did not provide through-transmission ultrasound. Instead of walking away in disgust, I asked the salesperson what in fact this instrument did. He actually did not know of any cardiac applications, and he and I both had no idea why the instrument was at a cardiology meeting. The instrument was an A-mode reflectoscope, and the only known clinical use at that time was echoencephalography, which was the detection of the midline of the brain looking for intracranial masses.

I took the transducer, placed it on my chest and pointed it toward my heart. I almost immediately saw a moving A-mode echo spike that very likely was coming from the back wall of my left ventricle. I asked the person in the booth how that signal was being generated. He then gave me a little information about acoustic impedance. I asked him what would happen if there was fluid behind the heart. He told me that fluid should be echo-free. I then asked if this instrument could detect pericardial effusion. He did not know what pericardial effusion
was. I asked if there was any way I could use the instrument in Indiana on a trial basis. He said yes, but the company, Biosonar, went bankrupt shortly after the meeting and was never heard from again.

When I returned to Indiana, I told several people of my curiosity of possibly finding an instrument that could detect pericardial effusion. Someone told me that the Neurology Department had an instrument for echoencephalography. I found the instrument, and it was rarely being used. I borrowed it and began examining patients’ hearts and could detect the singular echo from the back wall of the left ventricle in virtually every patient. I then put out a search for patients with pericardial effusion. Such a patient became available and, much to my delight, the predicted echo-free space between a moving and a nonmoving echo appeared. I then immediately contacted John Waldhausen, who was one of our cardiovascular surgeons who had access to a dog lab. I told him that I wanted to perform this ultrasound examination on a dog before and after injecting saline in the pericardial sac to see if we could reproduce the echo-free space that I saw in the patient with pericardial effusion. He did and we did. He introduced fluid into the pericardial sac, and we saw an echo-free space that disappeared when the fluid was withdrawn. We successfully repeated the experiment in a small series of dogs and published our findings in JAMA in March 1965 (2).

Figure 1 shows the original instrument that was used. Figure 2A is an A-mode display of pericardial effusion. The thin echo labeled PW is a moving signal from the posterior wall of the left ventricle. The thicker nonmoving echo is from the pericardium and lung. The echo-free space between the two echoes is the pericardial effusion. Shortly after the original paper was published, we were able to obtain a “slow sweep” module from Smith Kline Instruments. Figure 2B demonstrates a “slow sweep” or M-mode recording of a patient with
pericardial effusion (3). The sweep is from bottom to top. The next advance in instrumentation is shown in Figure 3 (4). The echo display is now horizontal with the sweep being from left to right. An ECG is added for timing. There still was no grayscale quality in the echocardiogram, so we had to vary the gain to see the detail in the recording.

It would be nice to say, “And the rest is history,” suggesting that all went well thereafter. Unfortunately there still were plenty of skeptics because cardiac ultrasound followed a failed diagnostic technique called ballistocardiography and because Edler et al.’s (5) and Joyner et al.’s (6) ultrasonic mitral valve diastolic E-to-F slope turned out to be non-specific for mitral stenosis and was a major disappointment. Another major problem was that not all echographs were the same. I was very fortunate that our neurologists happened to have a Smith Kline Instrument echograph (Philadelphia, Pennsylvania). As can be seen in Figure 2, the echo PW from the posterior wall was thin. Smith Kline differentiated the returning echoes and displayed them as thin signals. The other instruments that were available did not differentiate the echoes, and they were up to a centimeter thick. If the PW echo in Figure 2 was a centimeter thick, the echo-free pericardial space would not be visible. Thus not everyone was able to duplicate our findings until this difference was recognized and resolved. Eventually all echographs differentiated their echoes, and the skeptics began to disappear. As a result, echocardiography has been the procedure of choice for the detection of pericardial effusion for over 40 years, and the application represents the true beginning of clinical echocardiography. It might never have happened without a false advertisement.

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REFERENCES

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