

# The Stethoscope has Passed Away. Long Live Handheld Echocardiography!

*El estetoscopio ha muerto, ¡viva la ecocardiografía!*

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This year marks the bicentennial of the stethoscope's birth at the Necker Hospital in Paris, due to the brilliance of Rene Laennec, who 3 years later published the elegant treatise which laid the foundations of auscultation. (1) The stethoscope is the instrument that has been most identified with medical practice; it is our most representative icon, and probably the one that has revolutionized the immediate physical examination of patients.

Many physicians ignore that the introduction of the stethoscope was criticized among "pure clinicians", who blamed it for interfering with the patient-physician relationship and, surprisingly, most of the criticism made reference to the dehumanization of medicine and the loss of the old clinical sense as a consequence of "technological" advances, represented in this case by the stethoscope. (2)

Two hundred years after its birth, many of us consider that, with the development of pocket-sized echocardiography devices, the final death of the stethoscope is near, and, again, this posture draws criticism, which surprisingly brings us back to those taking place two centuries ago. The same intransigent voices, the same comments, and the same inconsistent arguments: "the introduction of handheld echocardiography means moving away from clinical practice; technology draws us away from the patient and dehumanizes us, breaking the basic patient-physician relationship."

This discussion often arises from the feelings that logically appear when we see that the instrument that helped us on many occasions and was a faithful partner in our clinical practice is attacked. Feelings do not count on science. As we know, the first step of the scientific method is the careful observation of the phenomenon under study and the description of facts, and, in my opinion, facts are very clear and stubborn.

## ARE AUSCULTATORY PROFICIENCY AND PHYSICAL EXAMINATION SKILLS POOR IN THE PATIENT WITH HEART DISEASE?

The fact that auscultatory proficiency is very poor is

indisputable and is supported by hundreds of scientific references. This is a universal issue. A recent publication performed among internal medicine residents in the United States, Canada and England (3) demonstrated that only 22%, 26% and 20% of patients, respectively, underwent appropriate cardiac auscultation. This deficiency is also significant among cardiologists. In a recent publication, (4) auscultation made a correct diagnosis of valvular heart disease in 31% of cases, of abnormal left ventricular function in 35% of patients and of right ventricular dysfunction in 11% of cases. Actually, these numbers are shocking and are explained by a series of reasons: lack of time during training, promotion of non-invasive techniques that are easier and more reliable, reduction in hospital stay length, and young insufficiently trained professors. But, in fact, there is an underlying problem: when, in the absence of other techniques the stethoscope was our king, we could assume its errors; nowadays, these errors cannot be justified. In addition, when we compare the findings of auscultation with those of echocardiography, we become aware of the many limitations auscultation has.

## DOES HAND-HELD ECHOCARDIOGRAPHY IMPROVE THE INFORMATION PROVIDED BY THE TRADITIONAL CARDIAC EXAMINATION?

The answer to this question is positive; there are many scientific publications supporting the superiority of pocket-sized echocardiography devices during the first physical examination. A study performed in American hospitals compared the use of handheld ultrasound devices versus traditional cardiac examination, (3) and concluded that handheld devices provided a correct diagnosis of valvular heart disease in 71% of cases compared with 31% using cardiac auscultation. If we focus on the important diagnosis of ventricular function, handheld echocardiography provided an adequate diagnosis in most cases, while traditional examination achieved accuracy in one third of patients. Finally, for the diagnosis of right ventricular dysfunction, handheld echocardiography made a proper diag-

nosis in 65% of cases, while physical examination provided a diagnosis in only one out of 10 patients (10%). The results are similar in a European setting. The well-known Naples study (5) demonstrated that the diagnosis of cardiac abnormalities was made in only 38% of cases by physical examination and in over 70% of cases by a portable ultrasound device.

Another study provided clarifying evidence (6) by comparing the accuracy of cardiovascular diagnoses made by board-certified cardiologists using standard physical examinations with that of medical students operating a handheld ultrasound device (student training...16 hours!). Solution: the ability of students to detect left ventricular dysfunction, cardiac enlargement, hypertrophy, valvular disease and other diseases was spectacularly superior to that of experienced cardiologists performing cardiac physical examinations. Several studies in the literature reach the same conclusion with minimal variations: handheld echocardiography overcomes the limitations of cardiac examination, even if performed by physicians with limited training. (7-10) The routine use of a pocket-sized ultrasound device for extended cardiac examination demands the method to be as cheap and widely spread as the use of the stethoscope. When the use of handheld echocardiography becomes as common as the use of the stethoscope (a matter of prices and just around the corner), the exclusive use of the stethoscope will indicate malpractice in our medical performance.

There are some dissenting voices against introducing handheld echocardiography into daily practice as part of the final examination of the patient, stating again that part of the relationship and interaction with our patient will be lost. (11) We agree that we must interact with our patients and listen to their history, problems of life and to his body. But I do not understand what strange magic the use of a pocket-sized ultrasound device exerts to make us unable and insensitive to feel, talk, and incorporate the patients' fears and problems in such an important first visit.

Those of us who use traditional cardiac examination complemented by a handheld echocardiography device in our daily practice are aware that what the literature states is true (I myself examine my patients before using the portable ultrasound device): the inability of the stethoscope to demonstrate our errors or to introduce us in a large percentage of confused diagnoses. The role of handheld echocardiography is even more significant in settings without technological support. Establishing an initial diagnosis is easier in large centers with the technological support of complementary tests, but this is not possible in poor areas, where technology is not easily available and experienced physicians are many kilometers away; how impressive is to increase diagnostic accuracy based on the use of a pocket-sized ultrasound device as a complement to physical examination. As an example: a recent publication conducted in Cambodia and Mozambique, (12) reported the prevalence of valvular heart disease in children. Clinical examination detected a prevalence

of valvular heart disease of 3 cases per 1000 compared to a prevalence 10 times greater detected with echocardiographic screening...No comments.

#### **EXTENDED CARDIAC EXAMINATION WITH PORTABLE ECHOCARDIOGRAPHY CHANGES MY DAILY PRACTICE**

I would like to present 6 clinical situations in which handheld echocardiography as extended cardiac examination surpasses routine examination in my daily practice:

1. A 78 year-old patient with systolic murmur: The patient complains of dizziness over the past months. History taking is difficult. A grade 2/4 systolic murmur is heard over the aortic valve area with a single second heart sound. The amplitude of the carotid pulse is apparently decreased, no thrills are found and the apex beat is normal. Using my handheld ultrasound device, I detect an aortic valve with significant calcification; a scheduled echocardiographic screening confirms the presence of severe aortic stenosis with a peak gradient of 72 mm Hg.

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Then I recall: The traditional signs of aortic stenosis found at physical examination, as decreased amplitude and upstroke velocity of the carotid pulse, may be absent in elderly patients due to concomitant atherosclerotic vascular disease. Murmur intensity is not a reliable indicator of the severity of the disease, and although a clearly splitting second heart sound rules out severe aortic stenosis, a single second heart sound may be present in different degrees of severity... What is your opinion: stethoscope or extended cardiac examination?

2. A 52-year-old patient referred by a primary care physician: The patient had an influenza-like illness 2 months ago and, since then, feels "much more tired". Cardiac auscultation shows a probable third heart sound and a grade I early- and mid-systolic murmur is heard over Erb's point. I perform an extended cardiac examination with my pocket-sized device and find mild left ventricular dilation and an ejection fraction of 40%.

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fraction of 76% and tricuspid annular plane systolic excursion of 25 mm.

Then I recall: The diagnosis of heart failure is difficult. There are no difficulties in the moderate or severe forms. The situation is more complex when patients with mild forms of the disease are evaluated, particularly women or elderly patients, obese or with comorbidities. Approximately 50% of the diagnoses of heart failure in primary care are false; 43% of the clinical diagnoses of heart failure in patients complaining of dyspnea are inconclusive... What is your opinion: stethoscope or extended cardiac examination?

3. A 72 year-old patient is referred by the primary care physician due to uncontrolled hypertension. Cardiac examination reveals normal palpation of the chest, the apical beat is not significant, but seems to be sustained in the left lateral decubitus position. Cardiac auscultation shows a probable third heart sound and a grade I early- and mid-systolic murmur is heard over Erb's point. I perform an extended cardiac examination and find dilation of the aortic root at the level of the ascending aorta which measures 5.4 cm. The interventricular septum measures 13.5 mm, corresponding to mild left ventricular hypertrophy and the left atrium is dilated, so I presume diastolic dysfunction.

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Then I recall: left ventricular hypertrophy is an indicator of complications in hypertensive patients and 40% of the patients with significant dilation of the aorta are free of symptoms. Then, I realize that the introduction of extended cardiac examination basically and easily changes the outcome, diagnosis and treatment of my patient... What is your opinion: stethoscope or extended cardiac examination?

#### **HANDHELD ECHOCARDIOGRAPHY IS NOT ECHOCARDIOGRAPHY, BUT EXTENDED CARDIAC EXAMINATION**

There is considerable apprehension, which I share, about the use of ultrasound techniques by non-cardiologists. The different scientific societies have set the limits between handheld ultrasound devices and echocardiography, which should be performed by cardiologists. Thus, the Spanish Society of Cardiology clearly establishes the limitations of handheld echocardiography. (13, 14) Of importance, this technique has its own characteristics (Table 1 and 2) and the scientific societies should regulate and control specific training

**Table 1.** Description of a study with a pocket-sized ultrasound device performed by non-cardiologists (13, 14)

-	A standard report is not provided, only a note in the medical history
-	Standardized recording may not be possible
-	Should only be used for a non-standard study to answer specific questions
-	There are no additional costs to the patient (similar to not charging for auscultation)
-	The doctor who performs it does not receive financial benefit (similar to not charging for auscultation)

and use of these devices. When a pocket-sized echocardiography device costs a bit more than a stethoscope (something in which electromedical manufacturers are working on due to high business expectations) nobody will stem the tide, and we should be prepared to regulate its use.

Pocket-sized ultrasound devices are here to stay and those who have participated in the dissemination of this technique have the moral obligation of regulating the training of those who use them. It is important to be able to convey, in practical terms, the limitations and benefits of this technique when these simple devices are used by physicians without specialized training.

It is almost 15 years since we carried out one of the first studies comparing handheld echocardiography with standard echocardiography. (15) J. R. Roelandt, one of the fathers of echocardiography, dedicated an editorial in *Heart* entitled "Ultrasound stethoscopy: a renaissance of the physical examination?" (16) With the advent of "ultra-portable" devices, in price and size, this editorial comment has become a reality. The incorporation of handheld echocardiography to the patient examination (extended cardiac examination) means its real renaissance and the death of the stethoscope that is relegated to a very secondary place. It is difficult to understand the resistance of many physicians to incorporate an easy tool to our daily practice, allowing a more accurate bedside diagnosis of the patient.

The School of Medicine of the Universidad Complutense de Madrid incorporated a new subject called "Clinical examination of the heart with ultrasound" 4

**Table 2.** Information that can be obtained using a portable echocardiographic device (13, 14)

-	Qualitative ejection fraction
-	Myocardial thickness
-	Left atrial size
-	Pericardial effusion
-	Valvular calcification
-	Approximate degree of mitral regurgitation
-	Right ventricular dilation

years ago. It is exciting to watch how quickly students manage this technique with the help of echocardiography simulators. They are walking towards a future that will be very different, at least regarding physical examination. Undoubtedly, the patient, who is the main purpose of our existence, will be grateful to us for avoiding diagnostic errors with important clinical and prognostic repercussions thanks to the use of an easy method.

#### Conflicts of interest

None declared.

(See authors' conflicts of interest forms in the website/Supplementary material).

#### REFERENCES

1. Laennec RT. *De l'Auscultation Médiante ou Traité du Diagnostic des Maladies des Poumons et du Coeur*. Paris: Brosson & Chaudé; 1819.
2. Duffin J. *To See with a Better Eye: A Life of R. T. H. Laennec*. Princeton New Jersey: Princeton University Press; 1998.
3. Mehta M, Jacobson T, Peters D, Le E, Chadderdon S, Allen AJ, et al. Handheld ultrasound versus physical examination in patients referred for transthoracic echocardiography for a suspected cardiac condition. *J Am Coll Cardiol Img* 2014;7:983-90.
4. Mangione S. Cardiac auscultatory skills of physicians-in-training: a comparison of three English-speaking countries. *Am J Med* 2001;110:210-6. <http://doi.org/cb68z3>
5. Galderisi M, Santoro A, Versiero M, Lomoriello VS, Esposito R, Raia R, et al. Improved cardiovascular diagnostic accuracy by pocket size imaging device in non-cardiologic outpatients: the NaUSiCa (Naples Ultrasound Stethoscope in Cardiology) study. *Cardiovasc Ultrasound* 2010;8:51. <http://doi.org/b6n2d6>
6. Kobal SL, Trento L, Baharami S, Tolstrup K, Naqvi TZ, Cercek B, et al. Comparison of effectiveness of hand-carried ultrasound to bedside cardiovascular physical examination. *Am J Cardiol* 2005;96:1002-6. <http://doi.org/bfkhv5>
7. Kimura BJ, Amundson SA, Willis CL, Gilpin EA, DeMaria AN. Usefulness of a hand-held ultrasound device for bedside examination of left ventricular function. *Am J Cardiol* 2002;90:1038-9. <http://doi.org/d8zndw>
8. Alexander JH, Peterson ED, Chen AY, Harding TM, Adams DB, Kisslo JA Jr. Feasibility of point-of-care echocardiography by internal medicine house staff. *Am Heart J* 2004;147:476-81. <http://doi.org/bxx7sx>
9. Borges AC, Knebel F, Walde T, Sanad W, Baumann G. Diagnostic accuracy of new handheld echocardiography with Doppler and harmonic imaging properties. *J Am Soc Echocardiogr* 2004;17:234-8. <http://doi.org/fr6xk3>
10. Hellmann DB, Whiting-O'Keefe Q, Shapiro EF, Martin LD, Martire C, Ziegelstein RC. The rate at which residents learn to use handheld echocardiography at the bedside. *Am J Med* 2005;118:1010-8. <http://doi.org/fvhzbg>
11. Fuster V. The stethoscope's prognosis: very much alive and very necessary. *J Am Coll Cardiol* 2016;67:1118-9. <http://doi.org/bjkt>
12. Marijon E, Ou P, Celermajer D, Ferreira B, Mocumbi AO, Jani D, et al. Prevalence of rheumatic heart disease detected by echocardiographic screening. *N Engl J Med* 2007;357:470-6.
13. García Fernández MA. ¿Es posible entrenar a no cardiólogos para realizar ecocardiografía? *Rev Esp Cardiol* 2014;67:168-70. <http://doi.org/f2np9g>
14. <http://secardiologia.es/publicaciones/catalogo/protocolos/5919-recomendaciones-sec-para-el-uso-de-equipos-de-ecocardiografia-de-bolsillo>
15. Quiles J, García-Fernández MA, Almeida PB, Pérez-David E, Bermejo J, Moreno M, et al. Portable spectral Doppler echocardiographic device: overcoming limitations. *Heart* 2003;89:1014-8.
16. Roelandt JR. Ultrasound stethoscopy: a renaissance of the physical examination? *Heart* 2003;89:971-4. <http://doi.org/bcdzwt>