



Case Report

A novel in-plane technique for ultrasound-guided pericardiocentesis[☆]

Abstract

Ultrasound-guided procedures are becoming very common in emergency medicine and critical care. Ultrasound guidance for pericardiocentesis has been shown to reduce errors as compared with the landmark-based technique. A simplified in-plane ultrasound-guided pericardiocentesis allows the clinician an opportunity to visualize the needle and the guide wire during the procedure. In addition, post procedure ultrasound of the pericardial effusion, right ventricle and inferior vena cava allow the clinician confirmation of improvement of physiologic parameters that can lead to cardiovascular collapse from impending pericardial tamponade.

A focused evaluation for the presence of a pericardial effusion is within the scope of clinical practice for the emergency physician [1]. Detection of impending tamponade can also be performed with a bedside evaluation, allowing early intervention and prevention of clinical deterioration [2]. Unfortunately, pericardiocentesis is rarely performed in the emergency department (ED) by emergency physicians, making the procedure challenging. Case series of ultrasound-guided pericardiocentesis have been described in the literature, but descriptive method for this procedure has not been detailed in a manner that allows clinicians to incorporate the procedure into clinical practice [3–5]. We detail a novel in-plane visualized approach to ultrasound-guided pericardiocentesis that is simplified for the emergency medicine clinician.

A 36-year-old man with medical history of amyloidosis, end-stage renal disease, and injection drug user presented to the ED with complaint of shortness of breath. The patient had undergone hemodialysis the previous day and had experienced progressing dyspnea at rest. Physical examination on presentation to the ED revealed an uncomfortable diaphoretic appearing male in moderate distress. The patient's initial vital signs were heart rate of 81 beats per minute, blood pressure of 99/60 mm Hg, respiratory rate of 20 breaths per minute, temperature 34.3°C, and oxygen saturation of 99% on room air. His cardiovascular examination revealed a normal S1 and S2, with no audible murmurs. The patient's lung examination was significant for no crackles in any lung fields, mild end-expiratory wheezing, and moderate accessory muscle use. Ten centimeters of jugular venous distension was noted with no distal pitting edema.

The patient was placed on a cardiac monitor, and intravenous access was obtained. The standard parasternal long-axis view of the heart (probe marker to the patient's right with the screen marker on the left of the screen) (5–2 MHz curvilinear transducer SonoSite, Bothell, WA) noted a large circumferential pericardial effusion with

right ventricular (RV) collapse in diastole (Fig. 1). Using the opening of the mitral valve as the onset of diastole, it was clear in standard B-mode settings that the RV was collapsing while the heart was attempting to fill. Using M-mode to determine RV collapse is ideal but can be difficult for the novice sonographer and using the cine loop feature on most ultrasound systems to review images may be adequate for most sonographers. A subxiphoid view of the inferior vena cava (IVC) was noted to be plethoric with very minimal respirophasic variation (Fig. 2). The point-of-care ultrasound, in conjunction with the patient's clinical status, indicated the presence of impending cardiac tamponade.

Using a 10–5 MHz linear transducer, the internal mammary arteries were located just lateral to the sternum, verified with color flow, and mapped on the skin with a surgical marking pen (Fig. 3). The mammary arteries tend to be adjacent to the sternum and, in our experience, rarely in the path of the needle when performing the in-plane parasternal long technique for pericardiocentesis. We do believe that a simple survey scans to locate relevant vascular landmarks improves clinician confidence when performing uncommon procedures. The clinician repeated the parasternal long-axis evaluation of the heart, and at the site of planned needle puncture, 10 mL of lidocaine was infiltrated with 25-g, 1.5-in needle to reduce patient discomfort. The anesthetic needle was advanced deep to the skin surface and just above the rib (avoiding the neurovascular bundle).

The ultrasound system was positioned to the right of the patient with the operator on the left, allowing direct view of the ultrasound screen while performing the pericardiocentesis. The skin overlying the left chest was prepped and draped in a sterile manner, and the 5–2 MHz curvilinear ultrasound transducer covered with a sterile sheath (Fig. 4). The depth on the screen was adjusted so that only the effusion and RV were noted. An in-plane approach with a 45° angle of the needle was used to visualize the needle as it entered the pericardial space. Under direct needle visualization, fluid was then aspirated, and a guide wire was inserted into the pericardial space (Fig. 5). The wire was visualized in real time to ensure proper placement (Fig. 6). Standard Seldinger technique was used to dilate the subcutaneous space and place a single lumen catheter into the pericardial space.

One liter of serosanguinous fluid was removed from the pericardial space with immediate improvement of the patient's blood pressure and reduction in dyspnea. Repeat ultrasound examination showed a notable reduction in the pericardial effusion and the absence of RV diastolic collapse (Fig. 7A). Post procedural evaluation of the IVC demonstrated complete collapse during inspiration in a subxiphoid view, reassuring the providers that tamponade physiology had been alleviated (Fig. 7B). The patient was admitted to the intensive care unit and eventually underwent a pericardial window.

Point-of-care ultrasound has become integrated into emergency medicine training, with evaluation of the pericardial space becoming a

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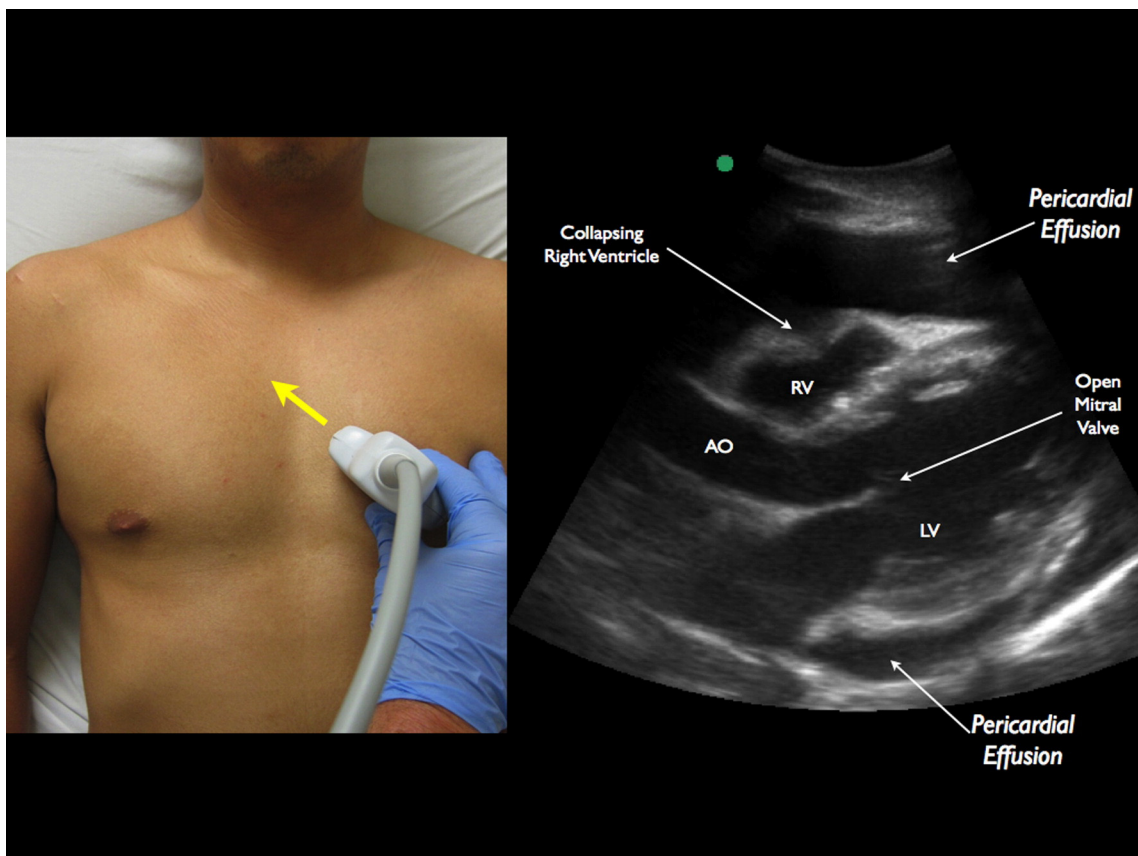


Fig. 1. Curvilinear probe placed in the parasternal long axis with identification of the circumferential pericardial effusion. Note the RV free collapse during diastole (open mitral valve). LV, left ventricle; AO, aortic outflow.

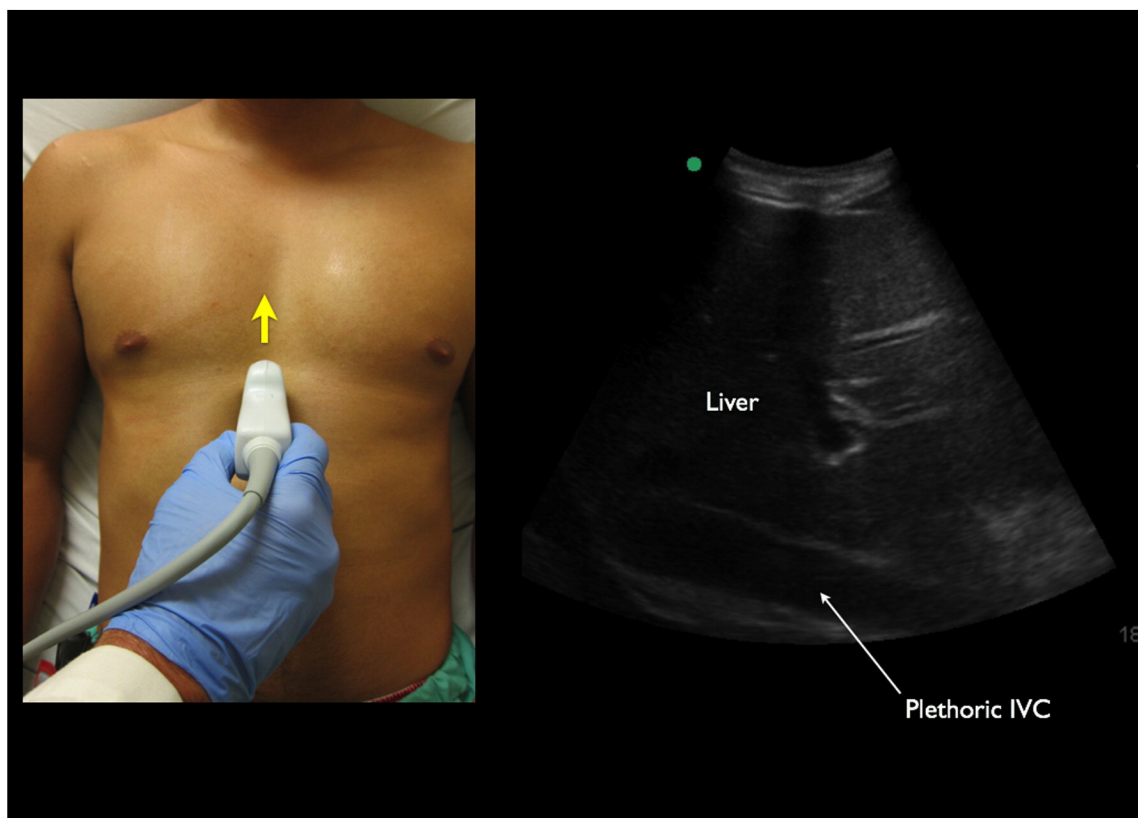


Fig. 2. Subxiphoid evaluation of the IVC. Place the probe just right lateral to the midline with the probe marker facing cephalad. Note, the plethoric IVC.

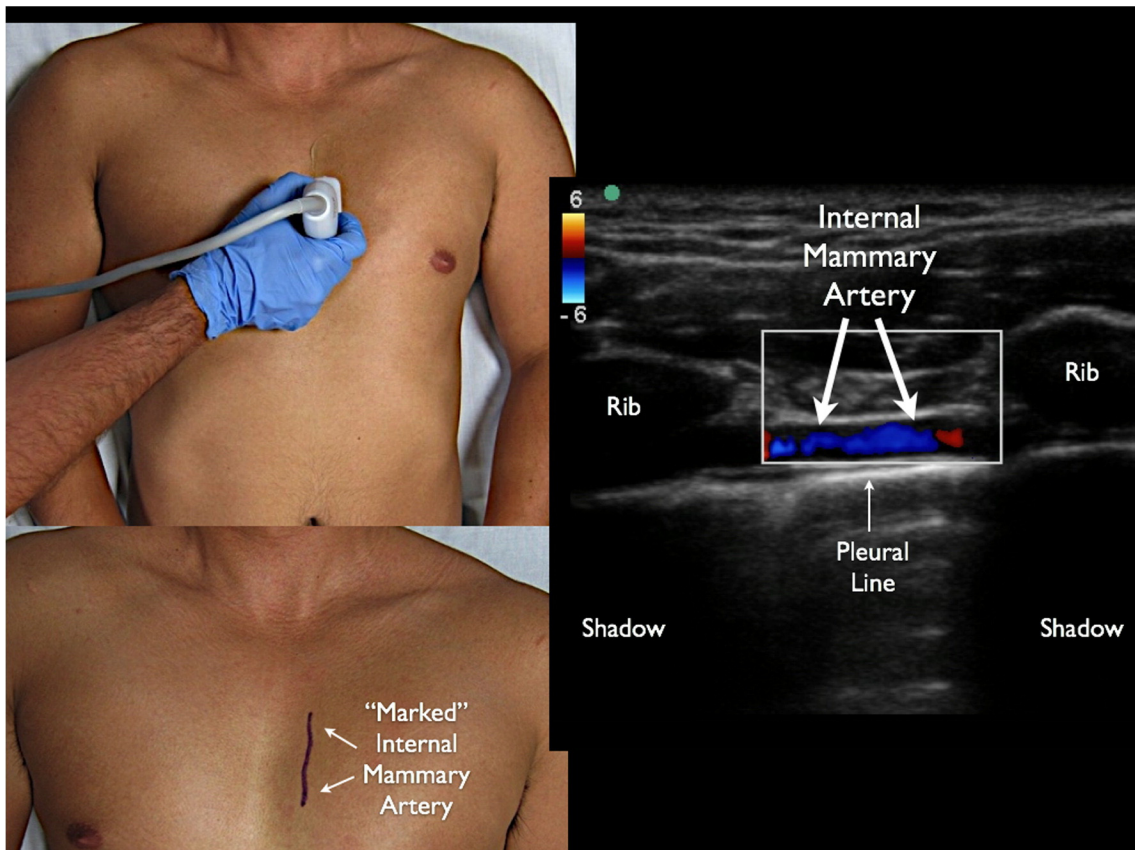


Fig. 3. Locate the mammary arteries with a linear probe just lateral to the sternum. Color flow can be used to confirm the presence of the artery.

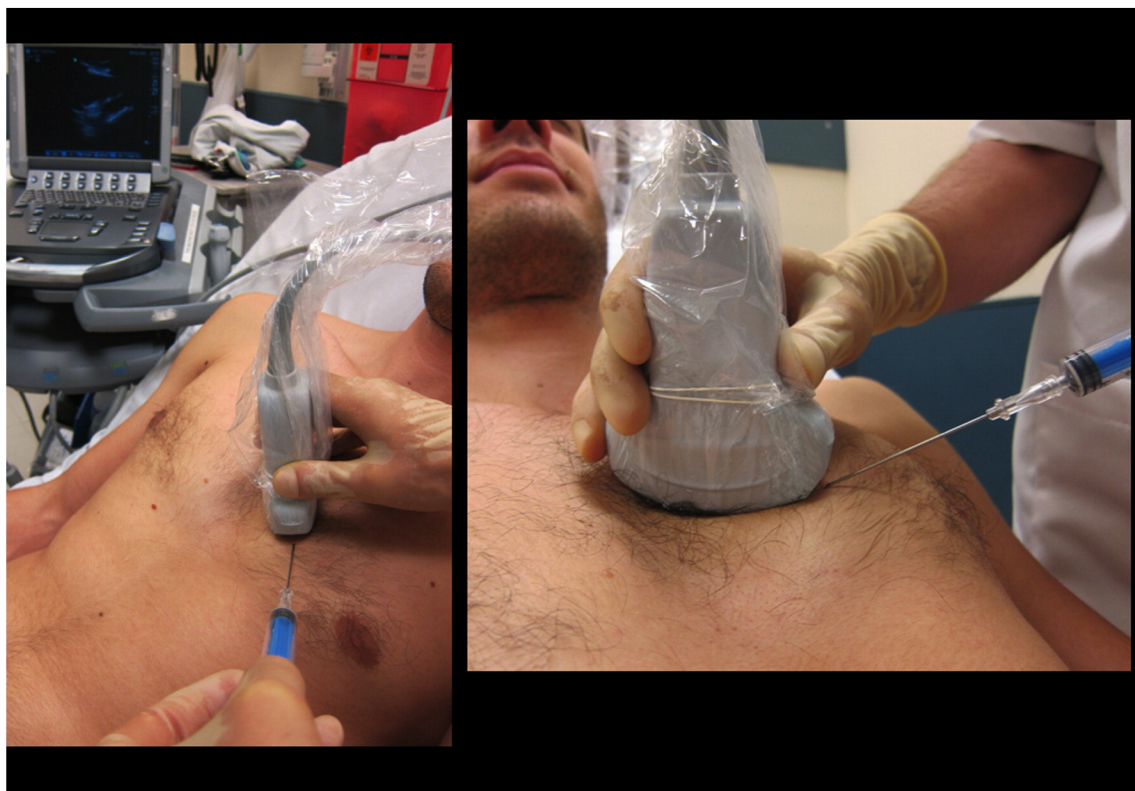


Fig. 4. The ultrasound system should be in the direct line of sight of the provider. Place the needle under the ultrasound probe to allow for direct visualization. Standard sterile procedure not shown.



Fig. 5. Visualize the needle as it enters the pericardial effusion.

basic skill for the most novice sonographer [1]. Signs of impending pericardial tamponade can also be detected during the point-of-care examination (RV collapse in diastole and a plethoric IVC), alerting the clinician to obtain the needed tools to perform a pericardiocentesis [2]. Although numerous case series have demonstrated the utility

of ultrasound-guided pericardiocentesis, a clear technique for the emergency provider has never been detailed. The classically taught blind subxiphoid procedure forces the needle to traverse the abdomen, diaphragm, and liver before entering the pericardial space. In addition, needle visualization is not possible from this

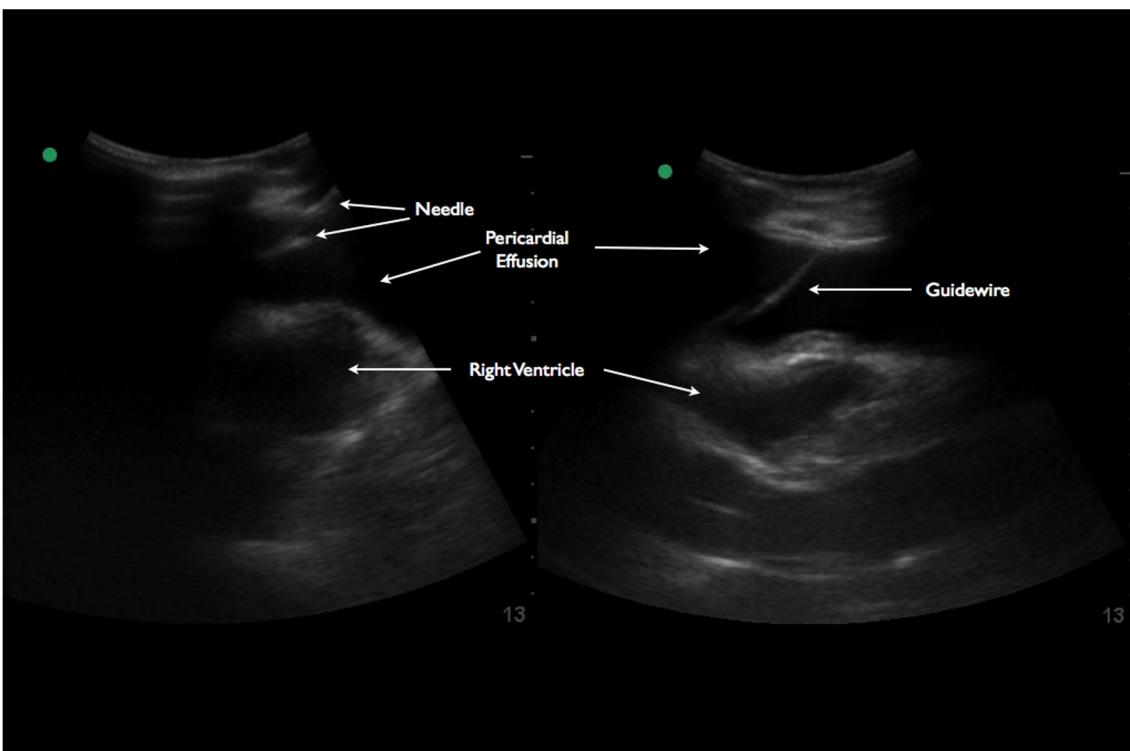


Fig. 6. To confirm needle placement, visualize the guide wire in the pericardial effusion.

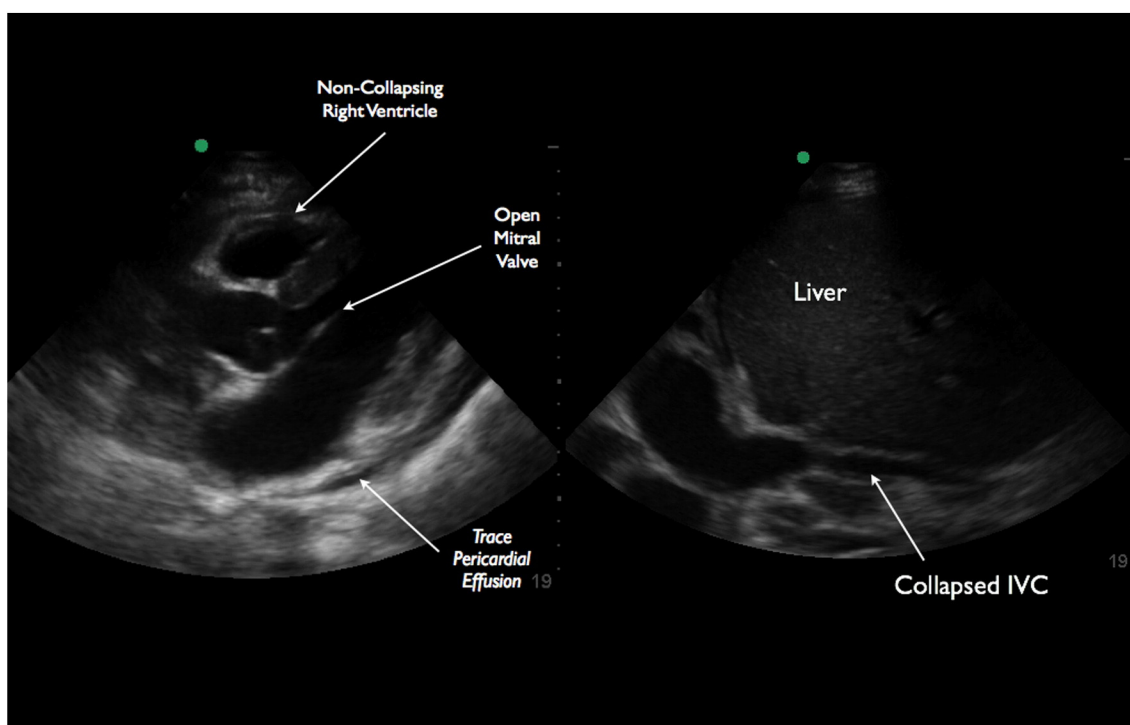


Fig. 7. After pericardial catheter placement, ensure reduction in effusion, lack of RV free wall collapse, and normal respirophasic IVC.

technique, making this uncommon procedure more difficult. The in-plane ultrasound guidance allows for needle visualization and confirmation of catheter placement in the pericardial space. In addition, post procedure ultrasound can confirm improvement of physiologic parameters in the critically ill patient.

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References

- [1] Mandavia DP, Hoffner RJ, Mahaney K, Henderson SO. Bedside echocardiography by emergency physicians. *Ann Emerg Med* 2001 Oct;38(4):377–82.
- [2] Nagdev A, Stone MB. Point-of-care ultrasound evaluation of pericardial effusions: does this patient have cardiac tamponade? *Resuscitation* 2011 Jun; 82(6):671–3.
- [3] Tsang TSM, Enriquez-Sarano M, Freeman WK, Barnes ME, Sinak LJ, Gersh BJ, et al. Consecutive 1127 therapeutic echocardiographically guided pericardiocenteses: clinical profile, practice patterns, and outcomes spanning 21 years. *Mayo Clin Proc* 2002 May;77(5):429–36.
- [4] Lindenberg M, Kjellberg M, Karlsson E, Wranne B. Pericardiocentesis guided by 2-D echocardiography: the method of choice for treatment of pericardial effusion. *J Intern Med* 2003 Apr;253(4):411–7.
- [5] Osranek M, Bursi F, O'Leary PW, Bruce CJ, Sinak LJ, Chandrasekaran K, et al. Hand-carried ultrasound-guided pericardiocentesis and thoracentesis. *J Am Soc Echocardiogr* 2003 May;16(5):480–4.