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REVIEW ARTICLE

# Point-of-care echocardiography for aortic dissection, pulmonary embolism and acute coronary syndrome in patients with killer chest pain: EASY screening focused on the assessment of effusion, aorta, ventricular size and shape and ventricular asynergy

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**Abstract** Focus assessed transthoracic echocardiography and focused cardiac ultrasound are point-of-care echo protocols for the evaluation of cardiac disease in the emergency room; however, these protocols may not adequately assess aortic dissection, pulmonary embolism, and acute coronary syndrome in patients with killer chest pain. Here, I present an echocardiography protocol focused on screening for these critical cardiovascular diseases. This protocol (termed EASY screening) consists of the assessment of effusion in the pericardial space, aortic abnormalities, the size and shape of the ventricles and asynergy of the left ventricle. Aortic dissection is suggested by positive findings for effusion and/or abnormal aortic findings. Pulmonary embolism is suggested by a dilated right ventricle and a D-shaped left ventricle in the short-axis view. Acute coronary syndrome is suggested by asynergy of left ventricular wall motion. EASY screening may facilitate the assessment of aortic dissection, pulmonary embolism and acute coronary syndrome in patients presenting to the emergency room with killer chest pain.

**Keywords** Point-of-care echocardiography · Chest pain · Aortic dissection · Pulmonary embolism · Acute coronary syndrome

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## Introduction

Chest pain in the emergency room is very common and may be due to serious cardiovascular diseases including aortic dissection, pulmonary embolism and acute coronary syndrome. Clinicians focus on the immediate recognition and exclusion of these life-threatening causes of chest pain. Echocardiography is widely available and useful for the assessment of most chest pain associated with cardiovascular diseases. Focus assessed transthoracic echocardiography (FATE) [1] and focused cardiac ultrasound (FoCUS) [2, 3] are simplified protocols that use point-of-care echocardiography to quickly identify the underlying causes of cardiovascular symptoms in the emergency room and/or intensive care unit. Although FATE and FoCUS can evaluate most cardiac diseases using point-of-care echocardiography, these protocols may not adequately assess aortic dissection, pulmonary embolism and acute coronary syndrome in patients presenting with chest pain in the general clinical setting. Here, I present a protocol focusing on the assessment of aortic dissection, pulmonary embolism and acute coronary syndrome in patients with cardiovascular killer chest pain, since it is easy to overlook these cardiovascular diseases in the emergency room.

## FATE

The FATE concept provides the trainee with essential practical knowledge of transthoracic echocardiography, including a description of the basic measurements, and guidance in interpretation of echocardiographic images in a clinical context. Basic FATE views include the subcostal 4-chamber, apical 4-chamber, parasternal long-axis, parasternal left ventricular (LV) short-axis, and pleural scanning. M-Mode is covered to assess wall thickness, chamber dimensions, and

bi-ventricular function. Advanced FATE includes an assessment of the severity of valve diseases and an estimation of chamber pressure, cardiac output, and diastolic function using Doppler echocardiography.

## FoCUS

FoCUS provides an algorithm of focused echocardiography for the evaluation of resuscitation management. For the assessment of acute severe dyspnea, undifferentiated hypotension, shock of unknown origin, and atypical/typical chest pain, wall motion is examined to diagnose myocardial insufficiency. The proposed integration of brief echocardiography into advanced life support to identify reversible causes allows the assessment of pulseless electrical activity. Time-dependent use of focused echocardiography during cardiopulmonary resuscitation can establish the presence of tamponade, cardiac standstill, pulmonary embolism, etc.

## Life-threatening conditions as a cause of chest pain

Diseases of the heart, aorta, lungs, esophagus, stomach, mediastinum, plural, and abdominal viscera can cause chest discomfort. Cardiovascular causes of chest pain that pose an immediate threat to life include acute coronary syndrome, aortic dissection, and pulmonary embolism. A tension pneumothorax is a non-cardiovascular cause of chest pain that can also be life-threatening. Primarily, a patient's medical history and physical examination are essential to identify these causes of killer chest pain. Chest pain radiating to the arms, neck, jaw or teeth may suggest acute coronary syndrome. Discrepancy in pulses or blood pressure can be indicative of aortic dissection. Tachypnea and a history of deep vein thrombosis suggest possible pulmonary embolism. Dyspnea and decreased breath sounds can be suggestive of pneumothorax. Point-of-care ultrasonography can be obtained secondarily or simultaneously. Here, I focus on the diagnosis of cardiovascular killer chest pain diseases using point-of-care echocardiography. Pneumothorax as a non-cardiovascular cause of killer chest pain can basically be diagnosed with chest radiography, although the lung echo may show the disappearance of a seashore sign and/or lung sliding (Movie 1).

## Point-of-care echocardiography protocol for aortic dissection, pulmonary embolism and acute coronary syndrome in patients presenting with chest pain

The present point-of-care echocardiography protocol focused on effusion in the pericardial space, aortic abnormalities, size of right ventricle (RV), shape of LV and asynergy of LV wall motion. Figure 1 shows a flow chart of this protocol.

## Effusion in the pericardial space

Cardiac tamponade is a frequent complication of type A aortic dissection, occurring in 19 percent of patients in an international registry and may induce shock or hypotension [4]. Pericardial effusion could also be caused by pericariditis, ventricular rupture due to myocardial infarction or perforation of the myocardial wall by a cardiac device (pacemaker lead, etc.). Effusion in the pericardial space can be one of the most important echocardiographic findings that suggest aortic dissection (Fig. 2, Movie 2).

## Aortic abnormalities

Although aortic echo might not yet be established, the aorta should be easy to visualize during routine transthoracic echocardiography with multiple views [5]. The parasternal long-axis echocardiographic view can show the aortic root and the descending aorta below the left atrium in a small-scale view (Fig. 3, Movie 3). The superior parasternal approach may allow visualization of the proximal portion of the ascending aorta (Fig. 4, Movie 4). A flap in the aorta or a crescent shape of the aortic wall suggests aortic dissection (Movie 5). Dilation of the aorta can be a helpful finding suggesting acute aortic disease including the impending rupture of an aortic aneurysm.

## The size of the right ventricle and shape of the left ventricle

Pulmonary embolism is one of the emergent critical cardiovascular diseases, and this disorder might be missed in the emergency room. Echocardiography is a major modality to assess pulmonary embolism on the basis of an increase in size of the RV (Fig. 5, Movie 6). An RV-to-LV end-diastolic diameter ratio $\geq 0.9$ was reported to indicate critical pulmonary embolism [6]. In pulmonary embolism, RV overload can cause displacement of the interventricular septum towards the left ventricle, resulting in septal flattening and a D-shaped configuration of the LV cavity (Movie 7).

## Asynergy of LV wall motion

Acute coronary syndrome is one of the most common causes of chest pain in the emergency room. Although electrocardiogram is the most reliable tool to diagnose

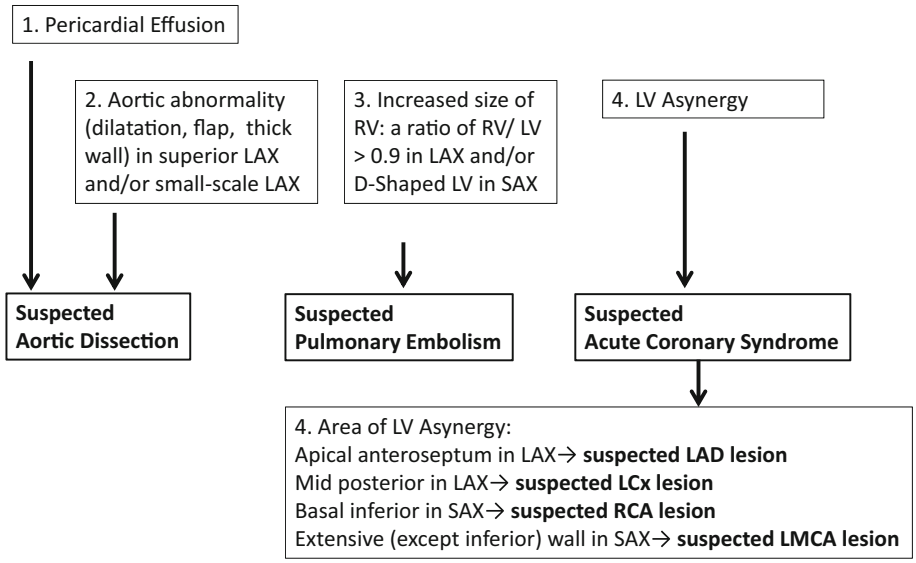


**Fig. 1** Flow chart of the EASY screening protocol. *LAX* long-axis view, *SAX* short-axis view, *RV* right ventricle, *LV* left ventricle, *LAD* left anterior descending coronary artery, *LCx* left circumflex coronary artery, *RCA* right coronary artery, *LMCA* left main coronary artery

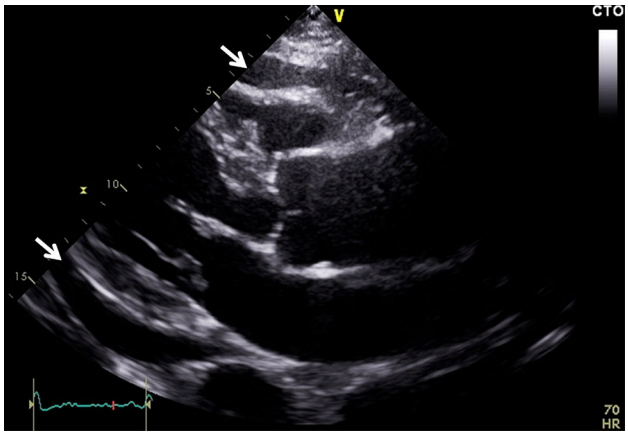

**Fig. 2** Left parasternal long-axis view showing effusion (*arrow*) in the pericardial space

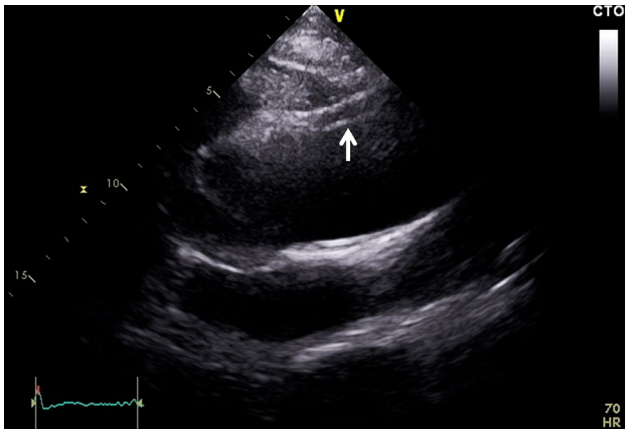

**Fig. 4** Left parasternal cardiovascular view from the superior intercostal showing the ascending aorta along with wall thickening (*arrow*)

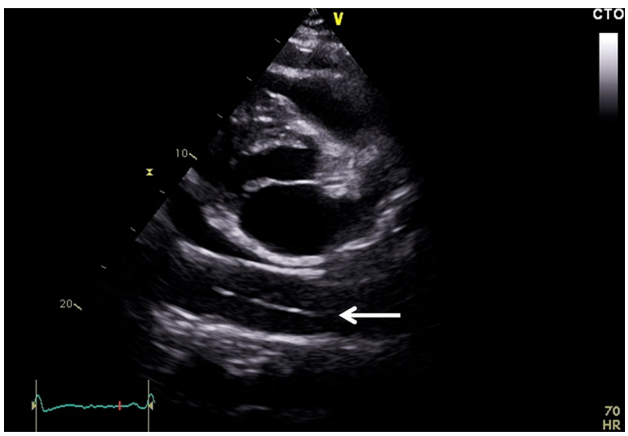

**Fig. 3** Left parasternal cardiovascular view on a small scale showing the long-axis view of the descending aorta and a flap (*arrow*)

myocardial ischemia, asynergy of LV wall motion occurs earlier than electrocardiographic changes during acute ischemia. Several reports suggested that echocardiography could be used to reduce the number of cases with a missed diagnosis of acute coronary syndrome [7]. It has been reported that focal asynergy of LV wall motion suggests a specific coronary arterial lesion. Asynergy of the apical to mid-anteroseptal wall could indicate a left anterior descending arterial lesion (Movie 8), asynergy of the basal inferior wall could indicate a right coronary arterial lesion (Movie 9), asynergy of the mid posterior wall could indicate a left circumflex arterial lesion (Movie 10), and asynergy of the entire left ventricle except for the inferior wall could indicate a left main coronary arterial lesion (Movie 11). The parasternal long-axis view can assess mid anteroseptal and mid posterior wall motion, whereas the

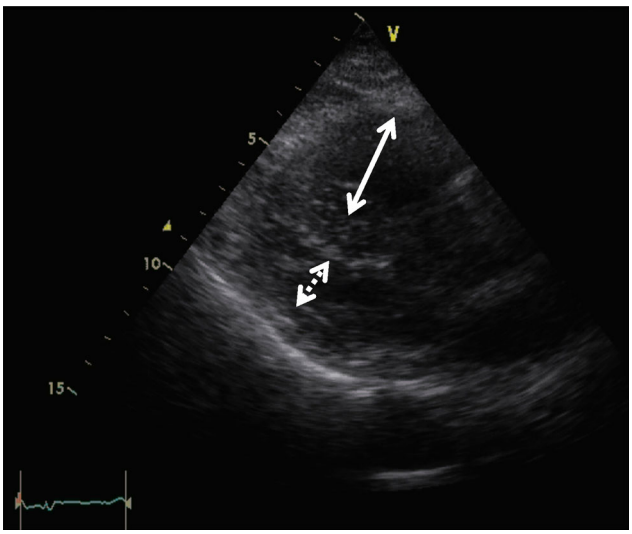


**Fig. 5** Parasternal long-axis view showing a dilated right ventricle. The diameter of the right ventricle (*solid arrow*) is longer than that of the left ventricle (*dashed arrow*)

parasternal short-axis view can assess basal inferior wall motion. The ventricular area fed by peripheral coronary arteries can be dominantly injured and show a wall motion abnormality.

## Clinical implications

Although echocardiography is a user-dependent technology, point-of-care echocardiography can provide important immediate information in the emergency room and can be performed repeatedly if the patient's condition changes. Chest pain is one of the most common complaints in patients visiting the emergency room and can reflect the presence of critical cardiovascular diseases. The present point-of-care echocardiography protocol focuses on the assessment of effusion in the pericardial space, aortic abnormalities, the size and shape of the ventricles and asynergy of LV wall motion for the screening of aortic dissection, pulmonary embolism and acute coronary syndrome. This protocol is called EASY screening based on the beginning of the assessment items. Although it might not be easy to perform this application in all patients presenting with killer chest pain, routine EASY screening of these patients could play an important role in reducing the number of cases with a missed diagnosis of aortic dissection, pulmonary embolism or acute coronary syndrome.

**Compliance with ethical standards**

**Conflict of interest** Kazuhiro Nishigami has received honoraria of $1,000 or less as a lecture fee from Astellas Pharma Inc., AstraZeneca K.K., Bayer Yakuhin Ltd., Boehringer Ingelheim Japan Inc., Kowa Pharmaceutical Co., Ltd., MSD K.K., Shionogi & Co., Ltd., Novartis Pharma K.K., Tanabemitsubishi Pharmaceutical Co., Ltd. and Takeda Pharmaceutical Co., Ltd.

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