# Diagnostic and Therapeutic Value of Echocardiography in Critically Ill Patients

*Essay*

Submitted for Partial Fulfillment of Master Degree in General Intensive Care

*By*


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# Abstract

**Background:** Echocardiography is one of the best diagnostic tools that the intensivist has, because it can be performed at the bedside, avoiding patients' displacements, and can provide transcendental information on real time for making vital decisions in a noninvasive or semi-invasive form, such as fluid therapy continuity, early vasoactive or inotropic treatment.

Echocardiography is not only a routine diagnostic tool in critically ill patient but also has an important role in assessment of patient with unstable cardiovascular diseases, which is known as emergency echocardiography. In this situation there are 3 scopes of emergency echoc-ardiography: diagnostic, symptom or sign- based and resuscitative.

We also have to distinguish between emergency echo, which is a comprehensive study, from Focused cardiovascular ultrasound or examination performed with pocket size imaging devices.

**Aims:** The aim of this essay is to discuss the importance of usage of echocardiography in critically ill patients and in emergency settings either as a diagnostic or a therapeutic tool.

**Conclusion:** Echocardiography has become the primary imaging tool for bedside diagnosis and monitoring of patients in acute cardiovascular conditions. It is non-invasive, provides rapid and accurate assessment of cardiac morphology and haemodynamics under stressful situations and is very useful in assisting therapeutic procedures.



**Keywords:** Echocardiography, Diagnostic, Therapeutic, Critically Ill Patients

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# List of Abbreviations

| | |
|---|---|
| **AAA** | Acute Aortic Aneurysm |
| **ACSs** | Acute Coronary syndrome |
| **AI** | Acoustic impedence |
| **ARDS** | Acute respiratory Distress syndrome |
| **AR** | Aortic regurge |
| **AS** | Aortic stenosis |
| **ASD** | Atrial septal defect |
| **AMI** | Acute myocardial infarction |
| **AoVTI** | Aortic velocity time integral |
| **BAV** | Ballon aortic valvuloplasty |
| **CFD** | Colour floow doppler |
| **CWD** | Continous wave doppler |
| **DCM** | Dilated cardiomyopathy |
| **DT** | Deceleration time |
| **EDV** | End diastolic volume |
| **EF** | Ejection fraction |
| **ERO** | Effective regurgitant orifice |
| **ESV** | End systolic volume |
| **GLS** | Global longitudinal strain |
| **HF** | Heart failure |
| **HFnEF** | Heart Failure with normal ejection fraction |
| **ICM** | Ischemic cardiomyopathy |
| **HCM** | Hypertrophic cardiomyopathy |
| **ICD** | Implantable cardioverter defibrillator |
| **IDCM** | Idiopathic cardiomyopathy |
| **IMH** | Intra mural hematoma |
| **IVC** | Inferior vena cava |

| | |
|---|---|
| **IVRT** | Isovolumic relaxation period |
| **LA** | Left atrium |
| **LAA** | Left atrial appendage |
| **LV** | Left ventricle |
| **LVIDD** | Left ventricular internal diameter at end-diastole |
| **LVOT** | Left ventricular outflow tract |
| **LVEDV** | Left ventricular end diastolic volume |
| **MR** | Mitral regurge |
| **MS** | Mitral stenosis |
| **PA** | Pulmonary artery |
| **PAsP** | Pulmonary artery systolic pressure |
| **PE** | Pulmonary embolism |
| **PEEP** | Positive end expiratory pressure |
| **PFO** | Patent foramen ovale |
| **PISA** | Proximal isovelocity surface area |
| **PLAX** | Parasternal longitudinal axis |
| **PMC** | Percutaneous mitral commissurotomy |
| **PRF** | Pulse repetition frequency |
| **PSAX** | Parasternal short axis |
| **PTX** | pneumothorax |
| **PV** | Pulmonary vein |
| **PVR** | Pulmonary vascular resistance |
| **PWD** | Pulsed wave doppler |
| **RV** | Right ventricle |
| **RAP** | Right atrial pressure |
| **RCM** | Restrictive cardiomyopathy |
| **RVIDD** | Right ventricular internal diameter in diastole |
| **SAM** | Systolic anterior motion |
| **STE** | Speckel tracking echocardiography |

| | |
|---|---|
| **SV** | Stroke volume |
| **SVC** | Superior vena cava |
| **TAPSE** | Tricuspid annular plane systolic excursion |
| **TAVI** | Transcatheter aortic valve implantation |
| **TDE** | Tissue Doppler echocardiography |
| **TEE** | Transesophageal echocardiography |
| **TR** | Tricuspid regurge |
| **TTE** | Transthoracic echocardiography |
| **VSD** | Ventricular septal defect |
| **VTI** | Velocity-time integral |
| **2D** | Two-dimensional |

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# Introduction

Echocardiography is one of the best diagnostic tools that the intensivist has, because it can be performed at the bedside, avoiding patients' displacements, and can provide transcendental information on real time for making vital decisions in a noninvasive or semi-invasive form, such as fluid therapy continuity, early vasoactive or inotropic treatment, realization of a pericardiocentesis in a cardiac tamponade, systemic fibrinolysis in severe pulmonary embolism, or the indication of cardiac surgery for the existence of mechanical complications in context of acute coronary syndrome. In spite of this, it continues to be an underused diagnostic method, even in the coronary units **(Romero-Bermejo *et al*., 2011).**

Echocardiography is not only a routine diagnostic tool in critically ill patient but also has an important role in assessment of patient with unstable cardiovascular diseases, which is known as emergency echocardiography. In this situation there are 3 scopes of emergency echocardiography: diagnostic, symptom or sign- based and resuscitative **(Neskovic *et al*., 2013).**

Emergency echocardiography is directly related to acute resuscitation such as detection of pericardial effusion and tamponade, regional left ventricular function, right ventricular size, checking central venous volume status and condition of great vessels, which may be crucial for acute decision-making **(Neskovic *et al*., 2013).**

Transthoracic echocardiography is the main source of information in the emergency setting but when its results are non-diagnostic, transesophgeal echocardiography should reasonably be the first choice **(Neskovic *et al*., 2013).**

We also have to distinguish between emergency echo, which is a comprehensive study, from Focused cardiovascular ultrasound or examination performed with pocket size imaging devices **(Neskovic *et al*., 2013).**

# Aim of the Work

The aim of this essay is to discuss the importance of usage of echocardiography in critically ill patients and in emergency settings either as a diagnostic or a therapeutic tool.

# Chapter 1

# Physical Aspects, Types and Different Modes of Echocardiography

## I. Physics of ultrasound:

Sound is an example of a longitudinal wave oscillating back and forth through a transmitting medium at a fixed velocity, resulting in zones of compression and rarefaction. Ultrasound includes that proportion of the sound spectrum above 20kHz. Echo machines use frequencies of 2–10MHz. The wavelength ($\lambda$) is inversely related to the frequency ($f$) by the sound velocity ($c$) so that $c = \lambda f$. Sound velocity in a given material is constant but varies in different materials. Ultrasound propagates poorly in air. c in blood is 1570 m/s, soft tissue 1540 m/s and air 330 m/s (Figure 1) **(Otto, 2004).**