مستشفى القلب
Heart Hospital
عضو في مؤسسة حمد الطبية
A Member of Hamad Medical Corporation

EACVI
European Association of Cardiovascular Imaging

Critical Care Echocardiography

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Nothing to disclose

- The original description of M-mode echocardiography in 1953, by Inge Edler (1911–2001) and his physicist friend Hellmuth Hertz, marked the beginning of a new diagnostic noninvasive technique.
- Edler used this technique primarily for the preoperative study of mitral stenosis and diagnosis of mitral regurgitation

Father of Echocardiography
Inge Edler (1911–2001)

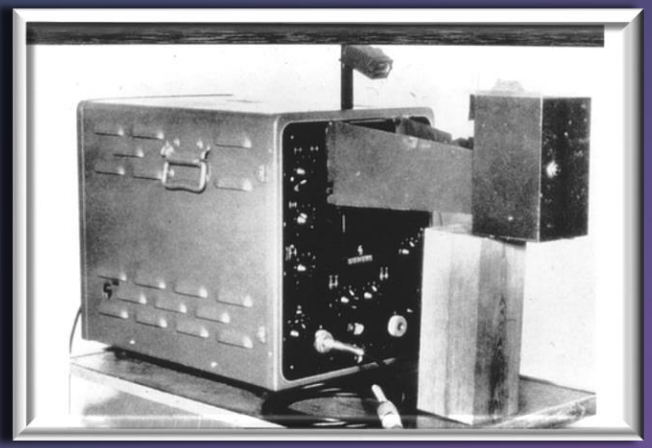
Dr. Inge Edler

Carl Hertz

Inge Edler and Hellmuth Hertz happily flanking the poster on the 1977 symposium on Echocardiography in the University Hospital in Lund.

Origin of ‘Echocardiography

- Edler called it ultrasound cardiography > UCG.
- First diagnostic US in medicine was by **Neurologist** , to detect midline shift of the brain by an intracranial space–occupying mass !!. echoencephalography.
- So the ultrasonic examination of the brain was echoencephalography, then the examination of the heart should be echocardiography.
- ECG abbreviation was already being used for electrocardiography.
- Abbreviation “echo” > at that time cant be used because it did not differentiate between echocardiography and echoencephalography.
- Now, the abbreviation (echo) is only used for echocardiography as the echoencephalography disappeared.



Early echocardiographic equipment used by Edler and Hertz to record M-mode echograms

multielement transducer that provides

an electronic linear scan and represents the first real-time, two-dimensional, echographic system

Currently , small , portable , high quality probes &3 Ds

Pioneer of modern nursing

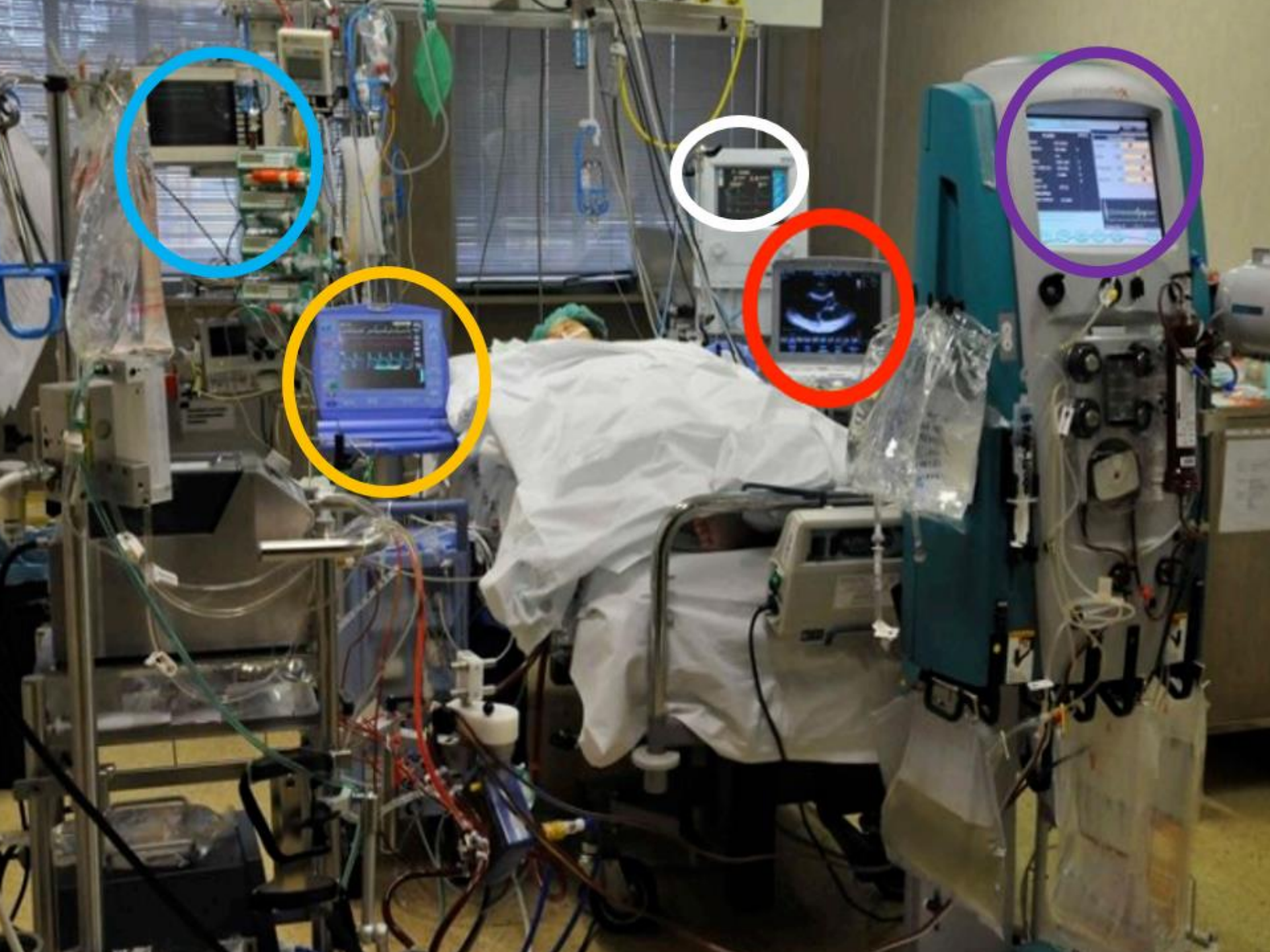
"The lady with the lamp"

History of intensive care December 1953 (65 yrs) old

- In 1952 Bjorn Ibsen , a Danish anesthetist was involved in a Polio epidemic of 2722 cases in 6 months
- Supply of the traditional iron lung ventilators became overwhelmed
- Ibsen used PPV after intubating patients and enlisting a rota of 1500 medical students, nurses and volunteer retired staff to manfully ventilate them
- Dedicated ward, where each patient could have their own nurse. Thus, in **December 1953**, the specialty of intensive care was born.
- Reduction in mortality from 90% to 15 % .
- Ibsen is considered the founding father of intensive care

Well equipped , monitoring , therapeutic devices , availability , tailored to patient need

- Competency
- Holistic approach
- Evaluate , integrate and develop set of priorities
- Objective care for the patients
- Multidisciplinary team
- Dedicated nurse and physicians
- High nurse/patient & physician/patient ratio



INTRODUCTION

- Critical care ultrasonography (CCUS) refers to the use of ultrasonography in patients who are critically ill/Unstable.
- Multiple terms are used to describe various elements of CCUS.
  - point-of-care ultrasonography [POCUS],
  - thoracic ultrasonography (TUS; lung, pleural, and/or heart), lung ultrasonography (LUS),
  - abdominopelvic ultrasonography,
  - vascular ultrasonography,
  - cardiac ultrasonography (basic and advanced critical care echocardiography [CCE]

Critical care echocardiography CCE

- CCE uses portable equipment that is compact and relatively inexpensive.
- Image acquisition and interpretation are performed by the intensivist at the bedside, so results can be immediately integrated into a comprehensive management plan.
- CCE is typically best suited for patients with imminently life threatening processes, to categorize shock and respiratory failure, to check for coexisting diagnoses and complications of therapy, and to track the evolution of the critical illness by serial examinations.
- **Several studies showed use of CCE result in immediate change in management in up of 50%**

Echo By Non-Cardiologist

~ One study of pocket-sized ultrasound devices in an ICU The investigators found good correlation with conventional echocardiography in assessment of global left ventricular systolic function (87%), severe right ventricle dilation (87%), inferior vena cava dilation (90%), respiratory variation of inferior vena cava diameter 84%, as well as pericardial effusion (75%) and compressive pericardial effusion (100%).

~ ICU physicians were given a short course limited to interpretation of LV size and function, RV dilation, pericardial effusion, and pleural effusion. They were able to get 93% of clinical questions with close agreement with the interpretation of expert operators.

Vignon, P. et al. Intensive Care Medicine, 33, 1795- 1799

~In a similar study, intensivists were given a 10 hour course in echo after which they performed hand-held bedside examinations. Their interpretations correlated well with those of experienced echocardiographers in 84% of the examinations and led to immediate treatment adjustments in 40% of the subjects .

Manasia, A.R. et al. Journal of Cardio-thoracic and Vascular Anesthesia, 19, 155-159.

Questions need to be answered by Focus Echo

- What is the LV function ?
- What is the RV function ?
- Is there any evidence of pericardial effusion & cardiac tamponade ? Pulmonary embolism ? Aortic dissection ?
- What is filling pressure ?
- Fluid responsiveness ?
- Acute ischemia/mechanical complications
- Intracardiac source of infection

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The use of echocardiography in acute cardiovascular care: Recommendations of the European Association of Cardiovascular Imaging and the Acute Cardiovascular Care Association

Patrizio Lancellotti[1]*, Susanna Price[2]*, Thor Edvardsen[3], Bernard Cosyns[4], Aleksandar N. Neskovic[5], Raluca Dulgheru[1], Frank A. Flachskampf[6], Christian Hassager[7], Agnes Pasquet[8], Luna Gargani[9], Maurizio Galderisi[10], Nuno Cardim[11], Kristina H. Haugaa[3], Arnaud Ancion[1], Jose-Luis Zamorano[12], Erwan Donal[13], Héctor Bueno[14], and Gilbert Habib[15]

Evaluation of shock

- in patients with undifferentiated shock, multiorgan CCUS that includes basic CCE is useful for the following:
  - Classification of shock
  - Identification of life-threatening cardiac causes of shock
  - Guides the intensivist in establishing initial management strategy with volume /intropes/vassopresors/MCS
  - Tracking evolution of disease and response to therapy using serial CCE examinations
- CCE study often yields immediate results allowing for the initiation of therapy, while a follow-up advanced study brings the advantage of further refining the diagnosis and providing an in-depth hemodynamic assessment

Rapid Ultrasound for Shock and Hypotension – the RUSH Exam

- The components of the RUSH exam are: **H**eart, **I**nferior vena cava (IVC), **M**orrison's/FAST abdominal views, **A**orta, and **P**neumothorax (**HI-MAP**).
- A more simple method is to think of:
  - **Pump** (Heart): Tamponade, LVEF, and RV size
  - **Tank** (Intravascular): IVC, thoracic and abdominal compartments
  - **Pipes** (Large Arteries/Veins): Aorta and femoral/popliteal veins

Sepsis
why ECHO ?

- It represent complex situation where early hemodynamic assessment and support is the key of success
- Sepsis and SS are common causes of cardiovascular failure in critical care > Heart is the victim
- Heart may the source of sepsis
- Evidence showed that the use Echo in SS leads to change in therapy in large number of patients , majority of which concern volume status and intropes .
- Using Echo in ED in patient with undifferentiated shock had specificity of 94% for identifying sepsis .

Cardiac abnormalities in severe sepsis

Left ventricular dilatation
Left ventricular contraction impairment
Global
Segmental
Left ventricular diastolic dysfunction
Right ventricle systolic/diastolic dysfunction
Ventricular outflow obstruction
Valvular lesions
Functional
Endocarditis

Sepsis

DOCUMENT REASSESSMENT OF VOLUME STATUS AND TISSUE PERFUSION WITH:

EITHER

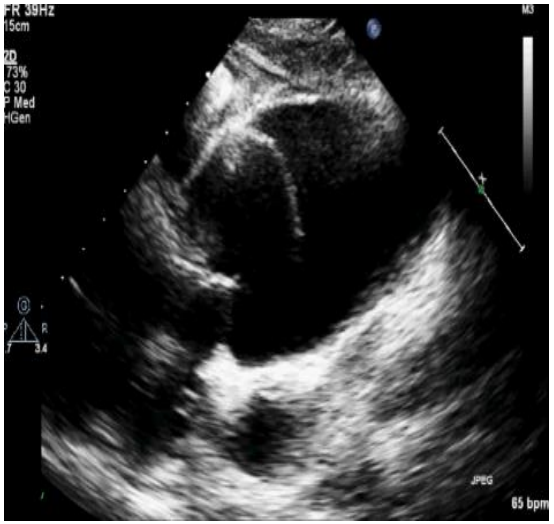
- Repeat focused exam (after initial fluid resuscitation) including vital signs, cardiopulmonary, capillary refill, pulse, and skin findings.

OR TWO OF THE FOLLOWING:

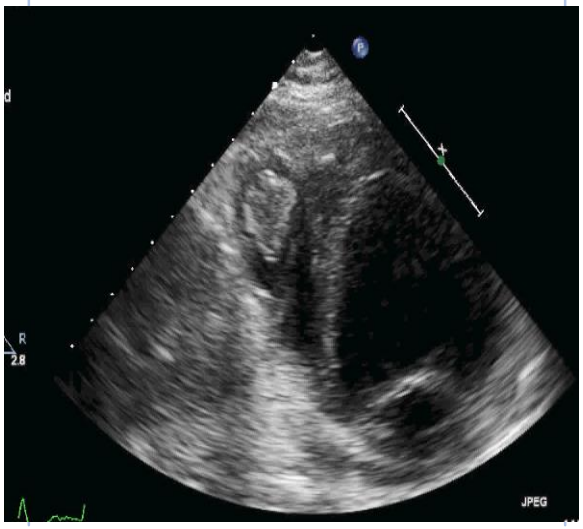
- Measure CVP
- Measure ScvO2
- Bedside cardiovascular ultrasound
- Dynamic assessment of fluid responsiveness with passive leg raise or fluid challenge

Chest Pain with hemodynamic instability

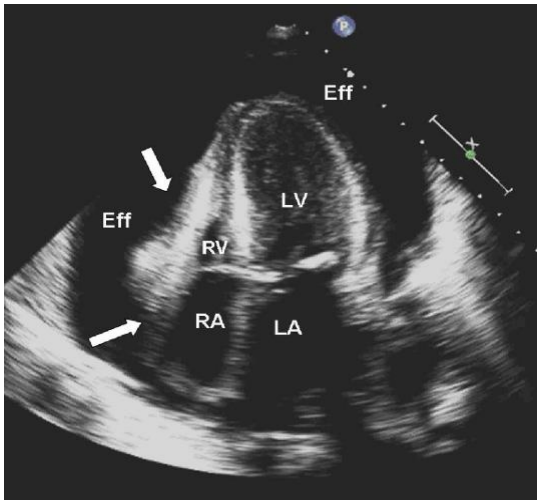
Acute aortic dissection



PuI embolism with RV thrombus



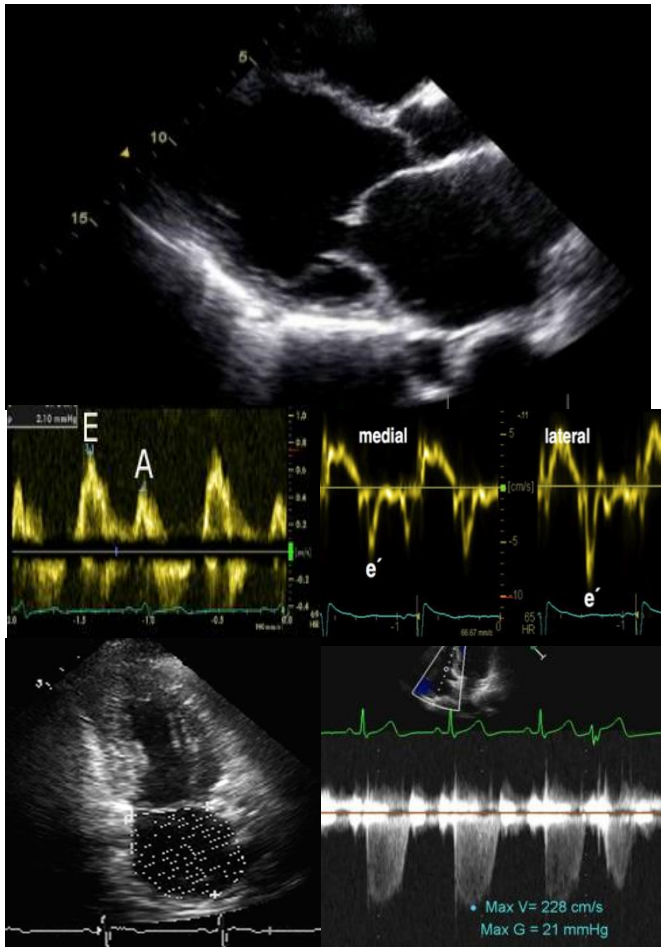
Pericarditis with tamponade



Recommendations for echocardiography in patients with acute dyspnoea

Assessment of LV size and function in patients with suspected clinical diagnosis of HF

Assessment of Diastolic function
A/E ratio
E/e
LA volume
RVSP



Lung US

- Differentiate cardiac edema from primary lung disease
- Pleural effusion diagnosis and aspiration
- Pneumothorax

Respiratory Failure

Critical Care Ultrasonography Differentiates ARDS, Pulmonary Edema, and Other Causes in the Early Course of Acute Hypoxemic Respiratory Failure

Hiroshi Sekiguchi, MD; Louis A. Schenck, MS; Ryohei Horie, MD; Jun Suzuki, MD; Edwin H. Lee, MD; Brendan P. McMenomy, MD; Tien-En Chen, MD; Alexander Lekah, MD; Sunil V. Mankad, MD, FCCP; and Ognjen Gajic, MD, FCCP

use of bedside-focused cardiac and thoracic CCUS in AHRF result in early identification of underline etiology
(acute ARDS, CPE, p.effusion and other)

- A meta-analysis of seven prospective cohort studies reported that bedside CCE had a sensitivity and specificity of 94 % and 92 %, respectively.

- In a prospective study of 136 patients with acute respiratory failure, adding CCE to thoracic ultrasonography improved diagnostic accuracy for cardiogenic pulmonary edema, pulmonary embolism, and pneumonia, when compared with thoracic US alone .

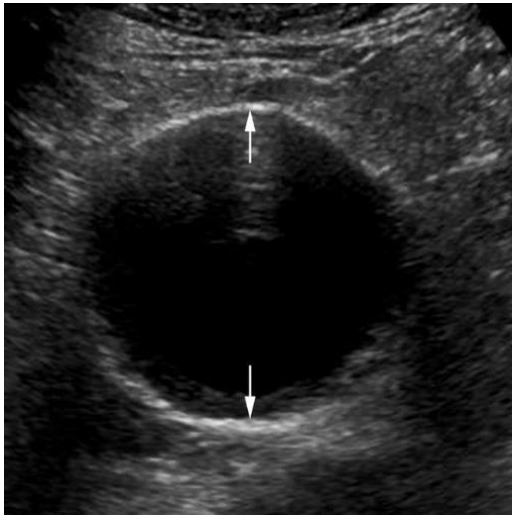
Cardiopulmonary resuscitation

- Bedside Echo has been used during pulse checks :
  - pericardial tamponade,
  - profound hypovolemia,
  - thrombus in transit with
  - acute cor pulmonale

- Absent cardiac contractility following a reasonable period of cardiopulmonary resuscitation (CPR) indicates limited probability for return of spontaneous circulation

VASCULAR ULTRASONOGRAPHY

- Central and peripheral vein catheter placement (studies have shown reduced complications).
- Arterial access for catheter placement
- ECMO cannulation

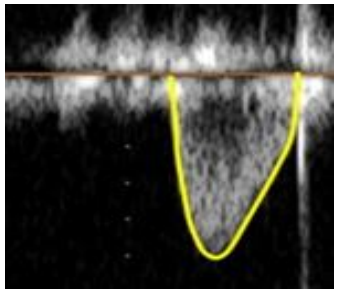


- Abdominal aortic syndromes

Volume status Assessment

~Rt & LV side filling pressure
~IVC collapsibility
~Dispensability index
~Aortic blood velocity variation
~Systolic pressure variations

Hemodynamic assessment



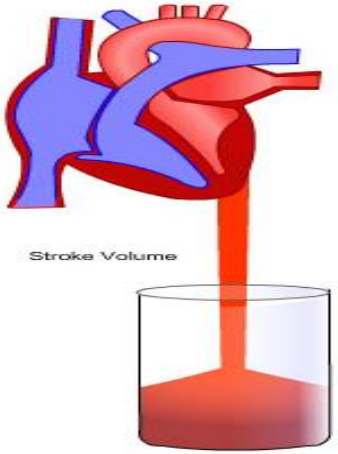
- LV and RV size and function
- Diastolic function
- Cardiac out put ,CI & CPO

  Stroke Volume

  LVOT diameter

  VTI

  CO= SV *HR



- Dynamic LVOT obstruction
- Tamponade physiology

ECMO

Echo is very essential in pre ECMO evaluation
During cannulation Echo is used for proper poisoning of cannula

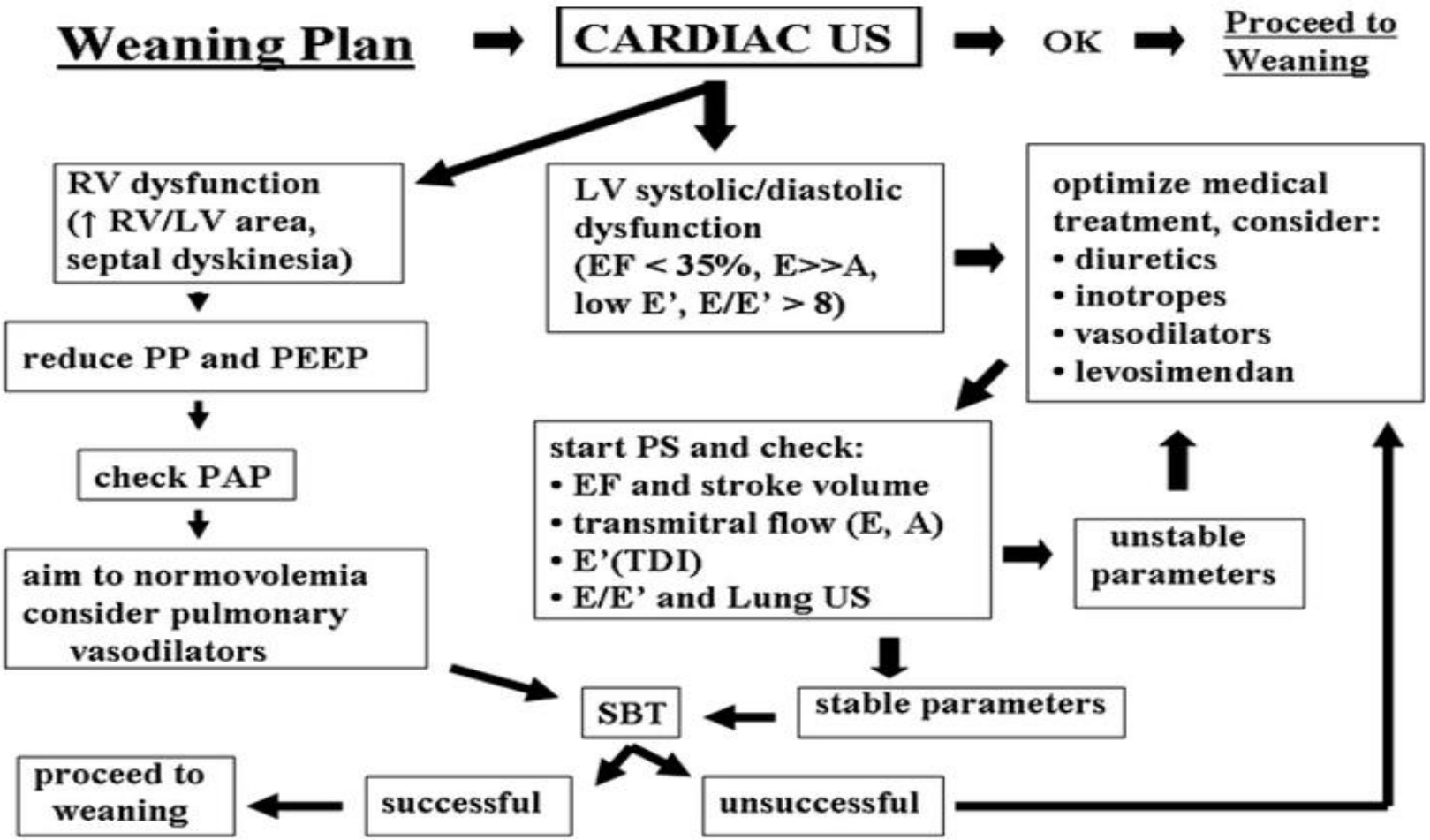
- Biventricular size and function
- Biatrial size and volume
- Follow up of any pre-existing pathology
- Volume status
- Presence of thrombus ,pericardial effusion
- Valvular regurgitation

Assessment for weaning

VV
- LVEF, TR and RVSP
- RV size and function (TAPSE, FAC, S at tricuspid annulus)
- Paradoxical septum

VA
- LVEF , TR and RVSP
- LVOT VTI
- S wave at lateral annulus
- RV size and function

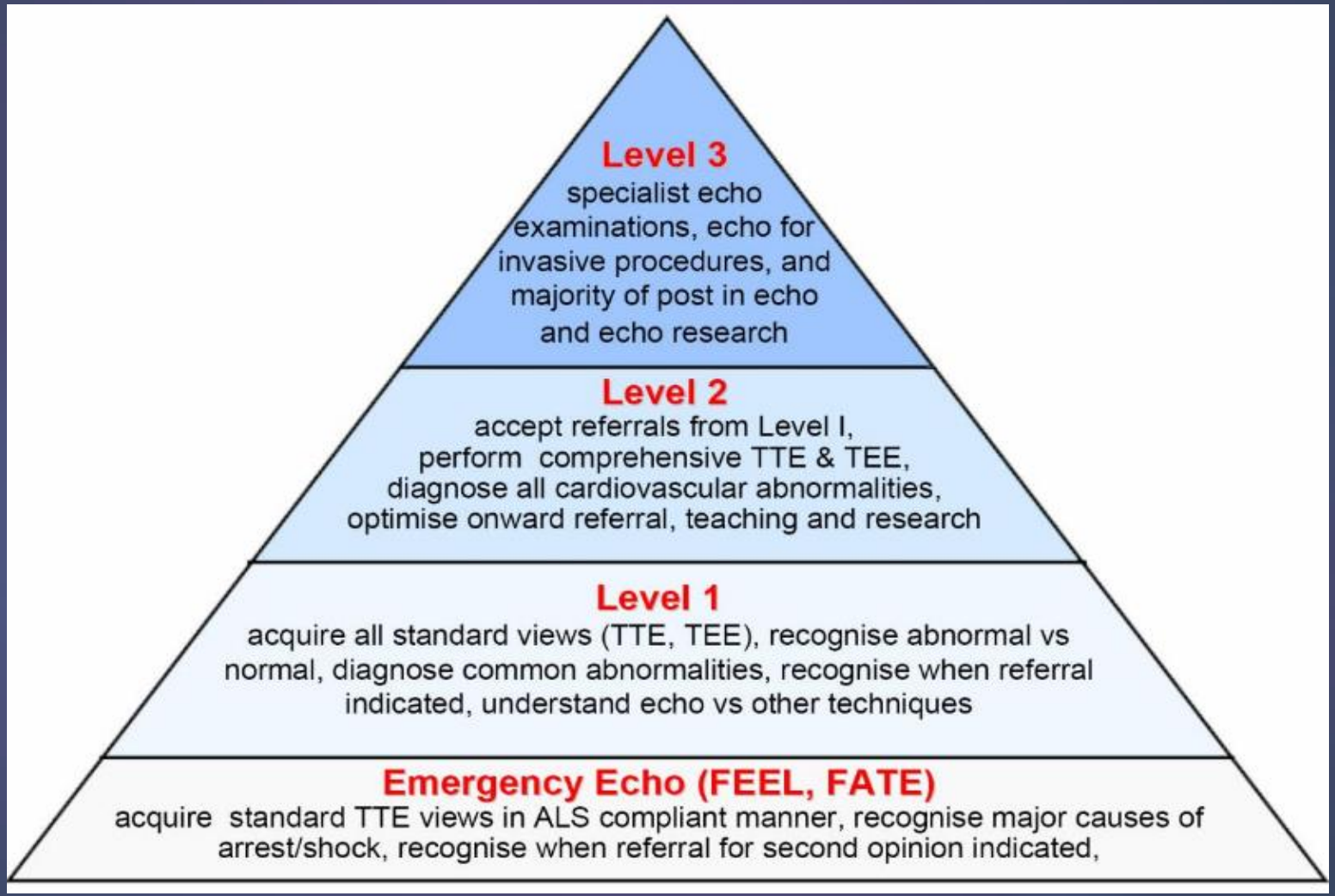
Weaning From Mechanical Ventilation



Competency

- **Competency in basic critical care echocardiography is now regarded as a mandatory part of critical care training with clear guidelines available. The majority of pathologies found in shocked patients are readily identified using basic level 2D and M-mode echocardiography.**

Competency


Level 3
specialist echo examinations, echo for invasive procedures, and majority of post in echo and echo research
Level 2
accept referrals from Level I, perform comprehensive TTE & TEE, diagnose all cardiovascular abnormalities, optimise onward referral, teaching and research
Level 1
acquire all standard views (TTE, TEE), recognise abnormal vs normal, diagnose common abnormalities, recognise when referral indicated, understand echo vs other techniques
Emergency Echo (FEEL, FATE)
acquire standard TTE views in ALS compliant manner, recognise major causes of arrest/shock, recognise when referral for second opinion indicated,

Summary

Basic Critical care echocardiography is useful in the evaluation of patients with undifferentiated shock or acute respiratory failure as well

CCE offers a wide range of hemodynamic parameters to help the intensivist in adjusting therapy in patients with cardiopulmonary compromise

CCE scan in critical care patients can be challenging due to equipment that surrounds the patient , mechanical ventilations ,tubes & drains

Integrated approach is the key to proper management

Formal training is important for safe application of focused CCE in clinical practice

- The good physician treats the disease; the great physician treats the patient who has the disease.

William Osler


Thank You