CRITICAL CARE MEDICINE

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OUTLINE

- Introduction
- What is critical care?
- ICU multidisciplinary team
- Hemodynamic monitoring
- Ventilation
- ICU assessment and documentation
- Who gets ICU admission
- Common ICU scenarios

CRITICAL CARE

- Historically, we recognized that the needs of patients with acute, life-threatening illness or injury could be better treated if they were grouped into specific areas of the hospital.

- Intensive care began in the United States in 1920's, when W.E. Dandy established the first 3-bed neurosurgical ICU at Johns Hopkins Hospital in Baltimore.

CRITICAL ILLNESS

- Acute life threatening conditions that require close and frequent assessment and multi-disciplinary care.
    - Trauma
    - Sepsis
    - Respiratory failure
    - ACE
    - ETC.

CRITICAL CARE UNIT

- A section in the hospital that is equipped to deal with critically ill patients.
    - General ICU
    - Surgical ICU
    - Medical ICU
    - Neuro ICU
    - ETC.

ADVANTAGES/DISADVANTAGES OF CRITICAL CARE UNIT

- The chief advantage is that it provides better and more organized care

- The main disadvantage is of a hostile environment contributing to anxiety, emotional stress, loneliness, fear and a greater risk of developing nosocomial infections.

ICU MULTIDISCIPLINARY TEAM

- ICU medical team, (consultant, assistants, residents, etc.)
- Nursing, (specialized in critical care, 1:1 ratio ideally)
- Respiratory therapy.
- Dieticians
- Clinical pharmacists
- Physiotherapy
- Occupational therapy.
- Social worker
- Consultation services, (Radiology, ENT, Surgery, Nephrology, etc.)

ICU MULTIDISCIPLINARY TEAM

- Provide advanced care to ICU patients

  -Multi-disciplinary management plan.

  -Advanced and tight monitoring of vital signs.

  -Resuscitation and maintaining vital functions during critical illness.

  -Provision of life-saving treatment modalities.

HEMODYNAMIC MONITORING

- Monitoring provides an early warning of adverse changes or trends before irreversible damage occurs.
- Monitoring
  - reflects physiologic homeostasis
  - allows prompt recognition of responses to therapeutic interventions
  - allows prompt recognition of adverse changes.
- What is the most important monitor?
  - Vigilance!

MONITORING MODALITIES

- Vigilant Physicians (Subjective data)
  - Monitors
  - (Visual, Tactile, Auditory, Olfactory)
- Standard Monitoring Equipment (Objective Data)
  - -Pulse Oximetry
  - -Capnography
  - -Body Temperature
  - -ECG
  - -Systemic Blood Pressure

MONITORING THAT REQUIRES NO INSTRUMENTATION

- Inspection
  - – Skin (Is there normal capillary refill? Delayed return suggests abnormality in regional or systemic circulation)
- Palpation
  - – Skin (Is the patient warm or cold and clammy)
  - – Pulse (Presence/Absence of pulse)
  - – Skeletal muscle (Are muscles fasciculating)
- Auscultation
  - – Chest (Listen for breath sounds over both lung field, is there paradoxical breathing)
  - – Heart (Are sounds muffled, or murmurs present)

NON-INVASIVE HEMODYNAMIC MONITORING

- Noninvasive BP
- Heart Rate, pulses
- Mental Status
- Skin Temperature
- Capillary Refill
- Urine Output

MINIMAL MONITORING STANDARDS

- Oxygenation (inspired gas and saturation of arterial blood (SpO2))
- Ventilation (capnography and clinical assessment)
- Circulation (ECG, arterial blood pressure)
- Temperature
- Neuro-vitals (GCS, mental status)

PULSE OXIMETRY

- Assess the oxygenation of blood
  - Reduced (or deoxygenated) hemoglobin (Bluish)
  - Oxygenated hemoglobin (Red)
- How it works?
  - A probe send light impulses into a finger and collects the light that pass through it.
  - The units estimates the proportion of oxyhemoglobin to reduced hemoglobin
- SpO2 – the saturation based on pulse oximetry
- SaO2 – the saturation obtained from direct arterial blood sample

PULSE OXIMETRY

- Acceptable readings depend on the clinical condition, and trends must be considered.
- Limitations:

  -Cannot differentiate between different forms of hemoglobin.

  -Environmental interference: vibration at 0.5-3.5 Hz, excessive movement and perhaps high level of ambient light, including infrared heat lamps.

  -Cold hands

  -Poor perfusion.

  -Nail polish.

  -Intravascular dyes

ELECTROCARDIOGRAM (ECG)

- Provides information on
  - cardiac arrhythmias
  - myocardial ischemia/infarction
  - electrolyte changes, particularly potassium
- ECG is not a measure of heart function
- ECG reflects only the electrical activities occurring in the heart

ECG

- Lead V5 is the most sensitive lead for detecting ischemia
- Lead II is the most sensitive lead for detecting arrhythmias
- P waves are best seen on Lead II
  - best to observe the cardiac rhythm.

BLOOD PRESSURE (BP) MONITORING

- BP monitoring is commonly performed either:
    - Indirectly – noninvasive cuff around extremity
    - Directly – inserting catheter into artery

BLOOD PRESSURE (BP) MONITORING

- Systolic Blood Pressure (SBP)
  - Pressure which ejected blood will overcome to perfuse vessels distally
- Diastolic Blood Pressure (DBP)
  - Pressure under which the blood flow will be laminar
- Pulse Pressure = SBP – DBP
- Mean Arterial Blood Pressure (MAP)
  - Time weighted average of arterial pressures during a pulse cycle
  - MAP = [SBP + (2 x DBP)] / 3

NON-INVASIVE BP MONITORING

- Mechanical deformation from the blood pressure cuff of an artery leads to the creation of Korotkoff sounds result from turbulent flow
- The appearance of the first Korotkoff sound is the systolic blood pressure
- The disappearance of the Korotkoff sound signals the diastolic blood pressure.

NON-INVASIVE BP MONITORING

- American Heart Association recommends
  - Bladder width: approximately 40% of the circumference of the extremity
  - Bladder Length: sufficient to circle at least 60% of the extremity
- Falsely low estimates occur:
  - after quick deflation
  - when the extremity is above the heart
  - when cuffs are too large
- Falsely high estimates occur when:
  - cuffs are applied too loosely
  - when the extremity is below heart level
  - when cuffs are too small

NON-INVASIVE BP MONITORING PROBLEMS

- Hematomas results due to increase venous pressure after failure to deflate the cuff
- Delayed cuff deflation can result from shivering and tremors
- Ulnar neuropathy can occur due to compression of the ulnar nerve

INVASIVE BP MONITORING

- Provide beat to beat blood pressure reading (real time)
- Reliable access for analysis of arterial blood gases, pH, and/or electrolytes
- New technologies enable cardiac output estimation from invasive BP monitoring

INVASIVE BP MONITORING

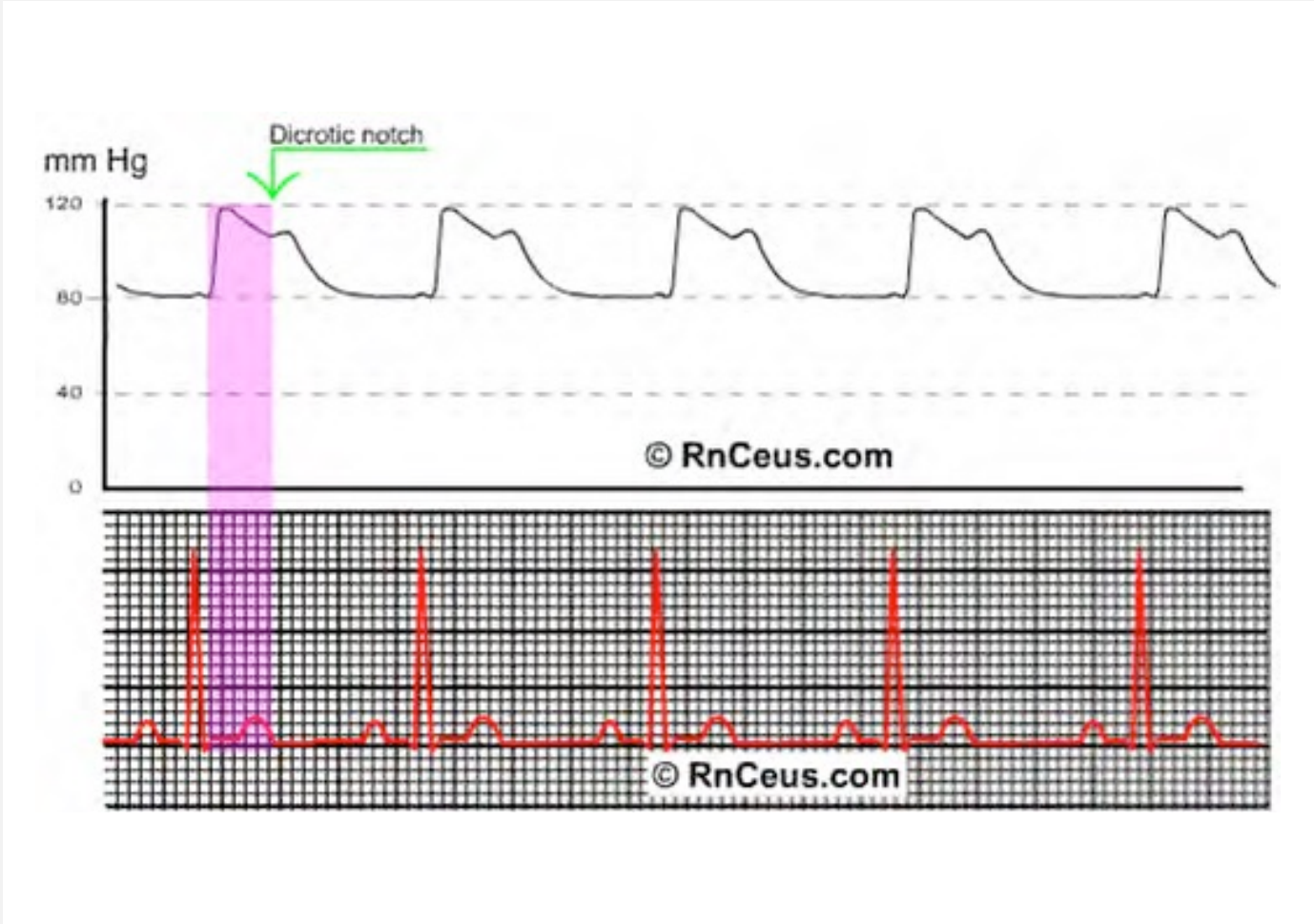
- Expected rapid changes in hemodynamic stability (shock)
- Induced hypotension, acute hypotension
- Inability to achieve noninvasive monitoring
- Use of Vasoactive drugs
- Frequent blood gas monitoring.

INVASIVE BP MONITORING

- Radial artery is the most frequent site
- Can be at femoral artery or brachial artery
- Dorsalis pedis rarely.

INVASIVE BP MONITORING

- Rate of upstroke indicates contractility
- Rate of the downstroke indicates peripheral vascular resistance
- Dicrotic notch reflects the closure of the aortic valve
- The farther out the dicrotic notch the lower the SVR or peripheral vascular resistance



INVASIVE BP MONITORING: COMPLICATIONS

- Hematoma
- Bleeding
- Vasospasm
- Arterial Thrombosis
- Distal Emboli
- Infection and Necrosis
- Air embolism
- Unintentional intraarterial drug injection
- Pseudoaneurysm
- Damage to adjacent nerves

CENTRAL VENOUS ACCESS

- **Monitoring central venous pressure (CVP)**
- Rapid administration of fluid to treat hypovolemia and shock (i.e. acute hemorrhaging)
- Infusions of drugs
- Long-term IV Feeding (i.e. Hyperalimentation)
- Insertion of Transcutaneous pacing leads
- Venous Access in patients with poor peripheral veins

CENTRAL VENOUS PRESSURE

- Central venous pressure parallels right atrial pressure.
- Normal pressures might range from -2 to 12 mmHg in a spontaneously breathing patient.
- Pressures of 6 to 15 mmHg (or more with high peak inspiratory pressures) can be expected on mechanical ventilation.
- The shape of the central venous waveform corresponds to the events of the cardiac contractions.

CENTRAL VENOUS PRESSURE

Three peak (a,c, and v waves) and two descents (x,y) can be seen in a normal CVP waveform.

RA/CVP WAVEFORM INTERPRETATION

'a' wave (end diastole)
right atrial (RA) contraction

Lost in atrial fibrillation/flutter

↑ 'a' wave in tricuspid/pulmonic stenosis and RV failure due to ↑ resistance to forward flow

"Cannon" 'a' waves in junctional rhythm, V-tach, 3° block from RA contraction against closed tricuspid valve (TV) generating large reflection wave back into RA

'c' wave (early systole)
TV cusps bulging into RA

Tricuspid regurgitation (TR) causes fusion of 'c' and 'v' waves with blunting of 'x' descent

'v' wave (late systole)
rapid filling of RA

↑ 'v' wave in TR (reaches RVSP) from regurgitant jet ↑ RA pressure

'x' descent (mid systole)
RA relaxation

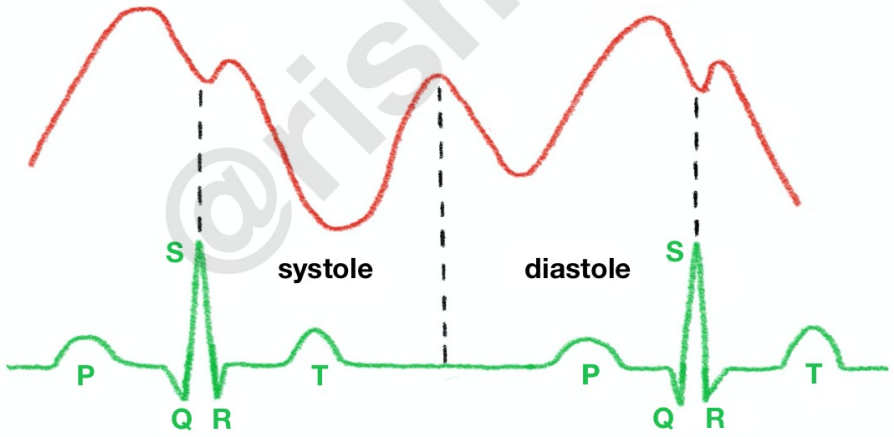
↑ 'x' descent in constrictive pericarditis

↓ 'x' descent with TR as this jet ↑ RA pressure. Suggests RV dysfunction due to ↓ apical motion

'y' descent (early diastole)
early ventricular filling

↑ 'y' descent in constrictive pericarditis

↓ 'y' descent in tamponade due to pericardial fluid pressure impairing caval inflow to RA and RV filling

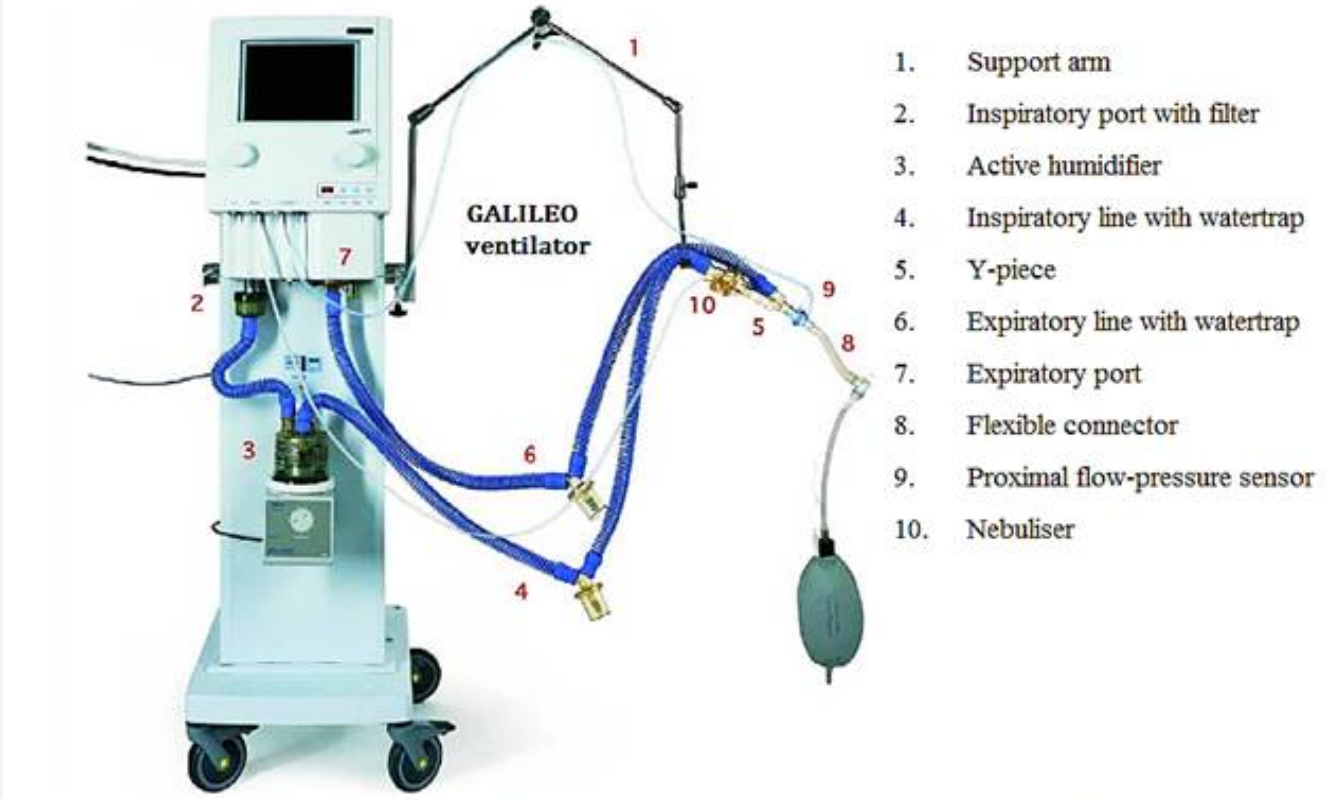


ELEVATED CENTRAL VENOUS PRESSURE

- Tricuspid Stenosis
- Tricuspid Regurgitation
- Pulmonary Hypertension
- Mitral Stenosis
- Mitral Regurgitation
- LV Failure
- Volume Overload
- Cardiac Tamponade
- Arrhythmias
- Increased PVR (Anxiety, Pain)

MECHANICAL VENTILATION

- Delivery of ventilation and supplemental Oxygen with a mechanical ventilator to support a patient experiencing Respiratory Failure.



1. Support arm
2. Inspiratory port with filter
3. Active humidifier
4. Inspiratory line with watertrap
5. Y-piece
6. Expiratory line with watertrap
7. Expiratory port
8. Flexible connector
9. Proximal flow-pressure sensor
10. Nebuliser

Fig - A mechanical ventilator for intensive care, with the external circuit

MECHANICAL VENTILATION: INDICATIONS

Respiratory Failure:

Hypoxemic Failure:

V/Q Mismatch vs. Shunt vs. Hypoventilation

$PaO_2 < 60mmHg$ on 100% NRB

Pneumonia
ARDS
Congestive Heart Failure
Pulmonary Embolism

Ventilatory Failure:

Altered Respiratory Mechanics

Acute ↑ pCO_2 with Resp. Acidosis

COPD/Asthma
Acute Intoxication
Neuromuscular Disease
Sepsis
Obesity Hypoventilation

RESPIRATORY FAILURE

- Arterial Blood Gas Abnormalities:
  - Hypoxemia:
    - $PaO_2 < 60$mmHg or O_2 sat < 90% on 100% NRB
  - Hypercapnea:
    - Acute: pH Δ 0.08 for pCO_2 Δ 10mmHg
    - Chronic: pH Δ 0.03 for pCO_2 Δ 10mmHg

- Clinical Impression:
  - -Use of Accessory Muscles
  - -Inability to Speak in Full Sentences
  - -Paradoxical Respirations
  - -Altered Mentation
  - -Cardiopulmonary Arrest: When Respirations and Pulse Cease

STARTING MECHANICAL VENTILATION

- 1. Need a Conduit:
  - Endotracheal Tube: Invasive Mechanical Ventilation
  - Face Mask: Noninvasive Mechanical Ventilation (NPPV)
- 2. Deliver Cyclical Positive-Pressure 'Breaths'.
- 3. Provide Supplemental Oxygen.
- 4. Minimize Complications.

ASSESSMENT OF A PATIENT IN THE ICU

- The Flow Sheet: Recording round the clock information of different organ systems.

  -Vital signs

  -Neurological Status

  -Haemodynamic Parameters

  -Ventilation settings

  -Respiratory parameters

  -Input/output

  -Laboratory Data

  -Medications

ASSESSMENT OF A PATIENT IN THE ICU

- Systematic daily oriented team rounds with accurate transmission and discussion of all clinical information from head to toe.

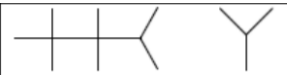
  -Identification/problem list

  -Major events during the last 24 hrs

  -By system approach; CNS, Cardiovascular, Respiratory, GI, Renal/metabolic, Heme/ID, tubes, etc.

- Documented note containing problem list and plan for all of the above.

Name & Room No: Hospital Day # ICU Day #		Things to do/ Plan
Vitals:	Temp P R BP Pulse Ox:	
Neuro	EVD @ 24 h output ICP (last 24h) Imaging (last 24h) TCD EEG	
Resp	Vent settings ABG Secretions: scant/copious; thin/thick; white/putrid CXR: ETT - Lung parenchyma -	
CVS	I/O Balance Wt: Fluids Labs Echo	
GI/ Endo	TF: Goal - ml/h; Type - Residuals (vol – 24h) - BM (last 24h) Y/N GI Ppx – Y/N Labs: LFT AST ALT BG - SSI – q h Prealbumin	

Renal	 1:1 fluid matching Y/N	
Inf.	Lines – Foley – T_{max} – Micro – Abx (with day) – Antipyretics – Tylenol/Ibuprofen	
Heme/ Skin	 Coags – TEDs/SCD – Y/N Heparin/Lovenox – Y/N Ulcers – Y/N	

ICU NOTE

WHO GET ICU ADMISSION

- Acute life-threatening illnesses which are potentially reversible
- Acute illnesses with potential and likely to occur life-threatening complications
- Monitoring of vital parameters of patients with symptoms/signs that suggest the possibility of an evolving life-threatening illness.

COMMON SCENARIOS IN ICU

- A 73 year old lady with a history of ischemic heard disease, HTN, DM II presents to the ED with altered mental status. She is febrile to 39.4, hypotensive (BP 80/40) with a widened pulse pressure, tachycardic (HR 121), with warm extremities and decreased urine output.

- How would you manage this patient?

SEPTIC SHOCK

- ICU admission
- Hemodynamic monitoring.
- Resuscitation with fluids, vasopressors.
- Pan cultures, looking for source of sepsis
- Treatment and reversal of condition. (antibiotics, drainage, etc.)
- Monitoring and prevention of complications. (respiratory failure, ARDS, multiorgan failure, etc.)

COMMON SCENARIOS IN ICU

- A 71 year old gentleman with a history of ischemic heard disease, HTN, DM II presents to the ED with altered mental status and slurred speech since morning. His BP is 190/90, HR 111/min. On exam he has right facial drop, slurred speech and left sided arm weakness.

- How would you manage this patient?

STROKE

- ICU admission
- Hemodynamic and neurovitals monitoring.
- Blood pressure control.
- Workup of possible stroke, type, risk factors etc.
- Monitoring and prevention of complications. (hemorrhage, re stroke, seizures, respiratory failure, etc)

COMMON SCENARIOS IN ICU

- A 63 year old lady with a history of DM, IHD and previous stroke with no deficit has just had a Whipple procedure for pancreatic carcinoma. The surgery lasted for 6 hours and was complicated with major bleeding requiring multiple transfusions.

- How would you manage this patient?

BLEEDING

- ICU admission
- Hemodynamic monitoring.
- Resuscitation with fluids, blood products, and vasopressors.
- Monitoring and prevention of complications.
    - recurrent bleeding.
    - leak
    - compartment syndrome
    - fluid overload
    - Post op acute coronary syndrome.

SEVEN ‘C’S OF CRITICAL CARE

- **C**ompassion
- **C**ommunication (with patient and family).
- **C**onsideration (to patients, relatives and colleagues) and avoidance of Conflict.
- **C**omfort : prevention of suffering
- **C**arefulness (avoidance of injury)
- **C**onsistency
- **C**losure (ethics and withdrawal of care).

END