Common Errors in Critical Care Set-Up

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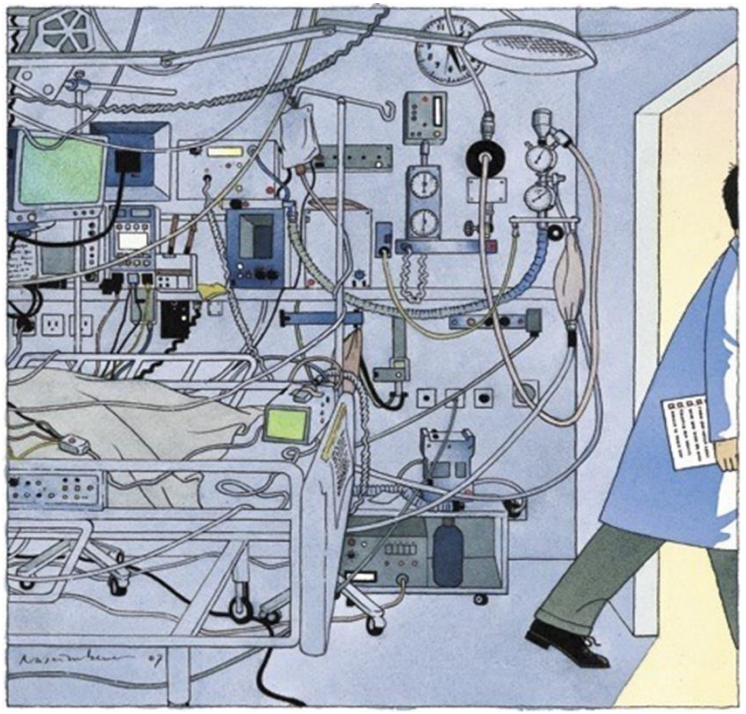
Spectrum of common errors

1. Structural errors
2. IPC Related errors
3. Treatment related errors



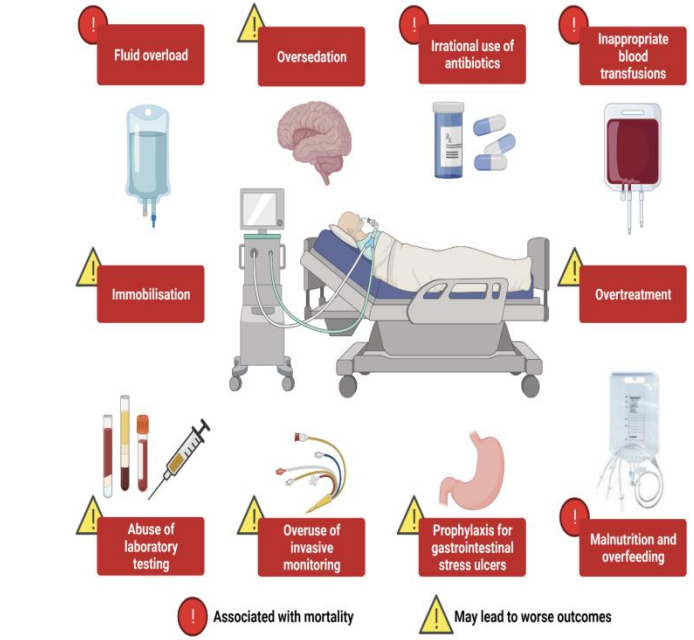
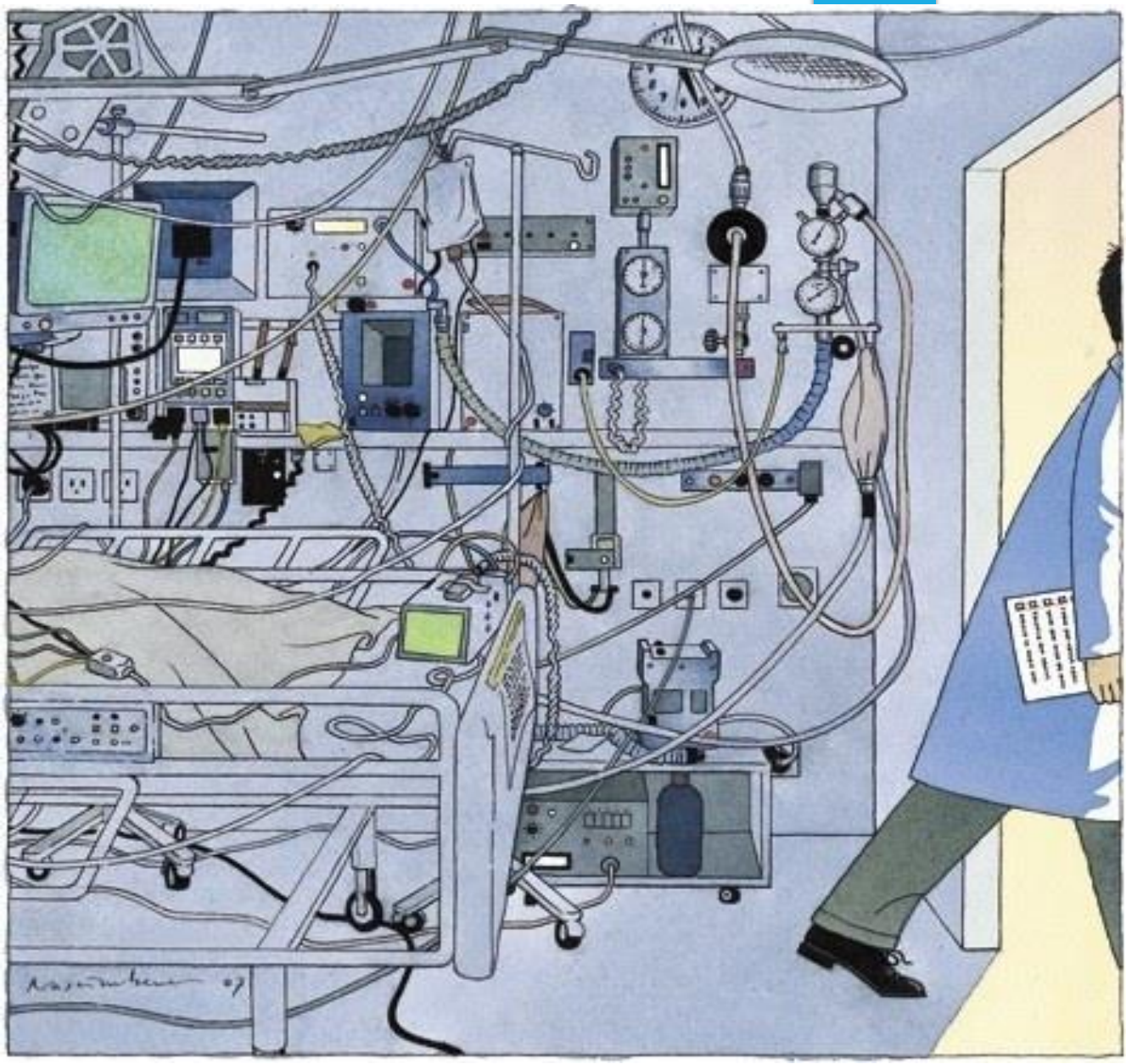


Figure 1. 10 common pitfalls in the management of critically ill patients

Structural Errors



Structural errors…

- Location
- Total strength
- Lay out
- Floor space
- Free space around bed
- Window set up

- Position of monitoring systems
- HVAC system in ICU
- Floor wall and ceiling coverings
- Noise level
- Lighting

Ideal Structure of Intensive Care Unit

Location of ICU :

- **Safe, easy, fast transport of a critically sick patient**
- **Ground floor should be avoided for ICU location.**
- **First floor is the ideal location in close proximity of ED and OT.**
- **Higher floors are suitable if elevators are available close to ICU.**
- **Corridors, lifts and ramps should be spacious enough to provide easy movement of bed/trolley**

- **There should be single entry/exit point to ICU and should be manned.**
- **However, it is required to have an emergency exit point.**

Floor space:

- Space per bed has been recommended from 150 to 200 sq ft in the patient care area. Some recommendations have placed it even higher up to 250 sq ft per bed.
- In addition, there should be 100 to 150% extra space to accommodate nursing station, storage, patient/doctors/staff movement area, equipment area, doctor's and nurse's rooms, teaching area, relative's area and toilets.

- **Patient care area should be 200 to 250 sq ft. It may be prudent to make one or two bigger rooms or areas, depending upon needs like for bariatric patients and bedside procedures e.g. ECMO, RRT etc.**
- **It is recommended to have 10% (one to two) isolation rooms where immunocompromised/infected patients may be treated. Need for laminar flow in isolation room in ICU has not found favor.**

- It is recommended that there should be a partition between rooms for patient's privacy.
- Standard curtains soften the look and are placed commonly between two patients in most ICUs, however, curtains may become unclean or get displaced and breach the privacy.
- Two rooms may be separated by unbreakable fixed or removable partition which may be of aluminum, wood or fiber. However permanent partitions may take away the flexibility of increasing floor space temporarily when required.

- **The ideal floor should be easy to clean, non-slippery, able to withstand abuse and absorb sound while enhancing the overall look and feel of the environment, carts and beds equipped with large wheels should roll easily over it.**

Floor of ICU

Floor of ICU

Heating,ventilation and air conditioning (HVAC) System:

- The ICU should be fully air-conditioned which allows control of temperature, humidity and air change. If this may not be possible, then one should have windows which can be opened (‘Tilt and turn’ windows are a useful design). Suitable and safe air quality must be maintained at all times.

Sound and Noise level:

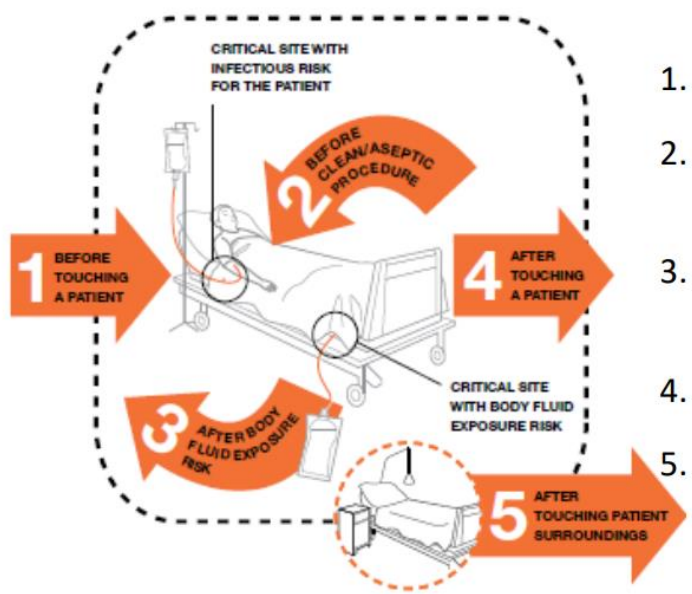
- The International Noise Council recommends that the noise level in an ICU be under 45 dB in the daytime, 40 dB in the evening and 20 dB at night. For example, 16 A watch ticks at about 20 dB, normal conversation is at about 55 dB, vacuum cleaner produces about 70 dB.

IPC related errors

IPC…

IPC…

- IPC is one of important steps to prevent Health care associated infection (HCAI) and hospital associated infection (HAI)
- Hand wash, PPE, Sterile technique, decontamination, waste disposal are the effective measures.
- Only effective hand wash can prevent 80% of HCAI.



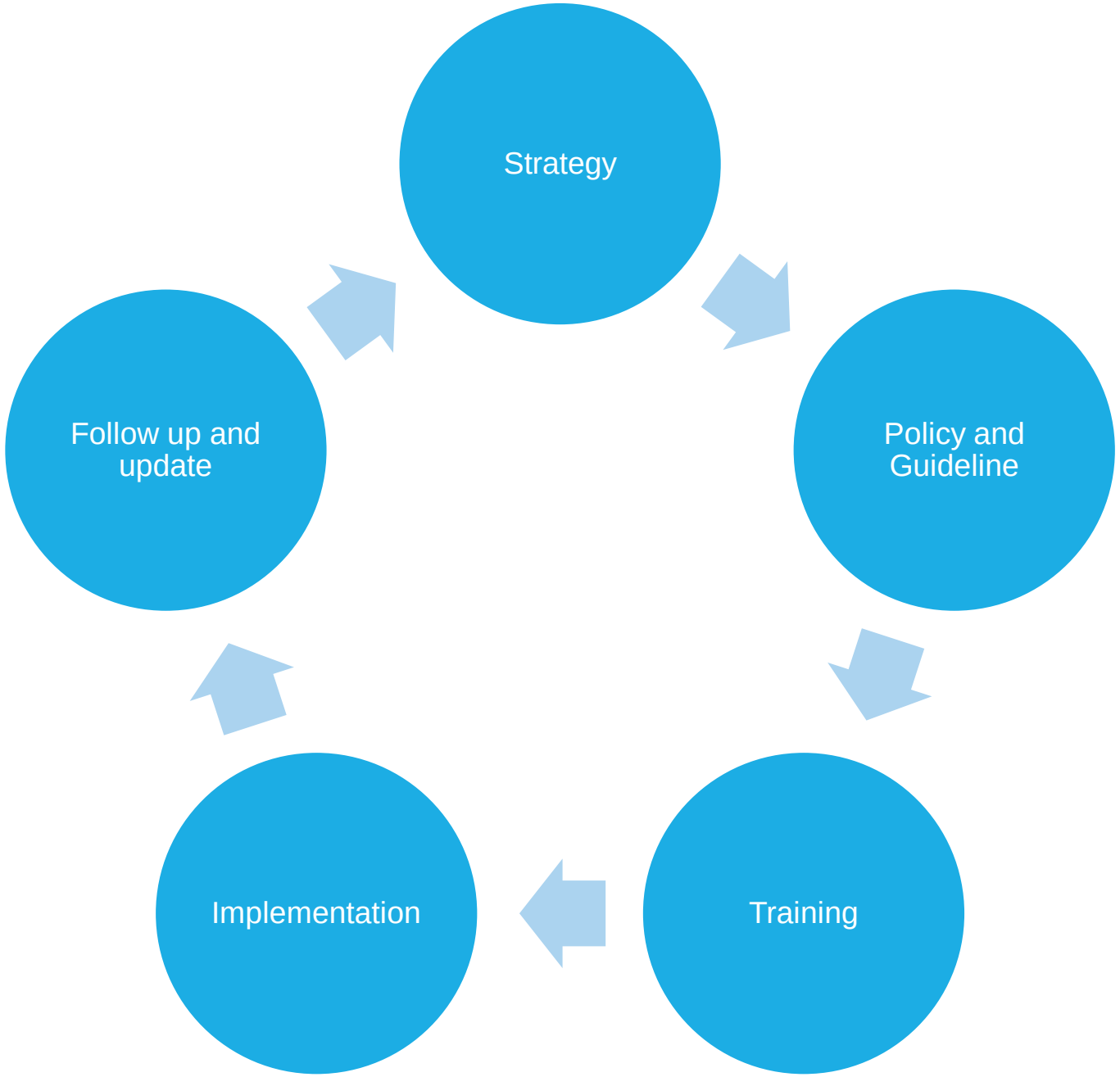
1. Before touching a patient
2. Before providing a clean/aseptic procedure
3. After direct contact with body fluid
4. After touching a patient
5. After touching surfaces around a patient

CDC

(Boyce JM, Am J Infect Control, 2002; WHO Guidelines on Hand Hygiene in Health Care, WHO, 2009)

IPC…

- Education and training for ICU stuff about prevention of nosocomial infection
- ICU protocol for prevention of nosocomial infection
- Audit and Surveilance of infections and infection control practices
- Infection control team (multidisciplinary approach)
- Vaccination of health care personnel


Strategy
Policy and Guideline
Training
Implementation
Follow up and update

Treatment related errors

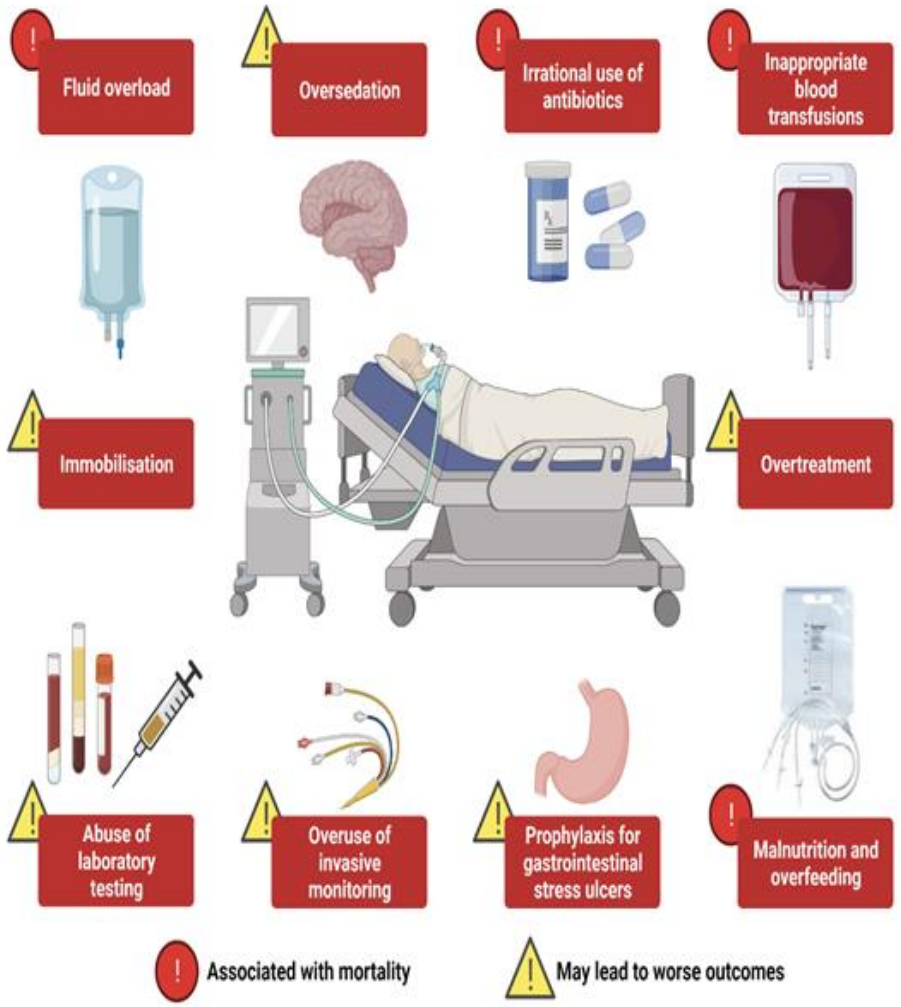
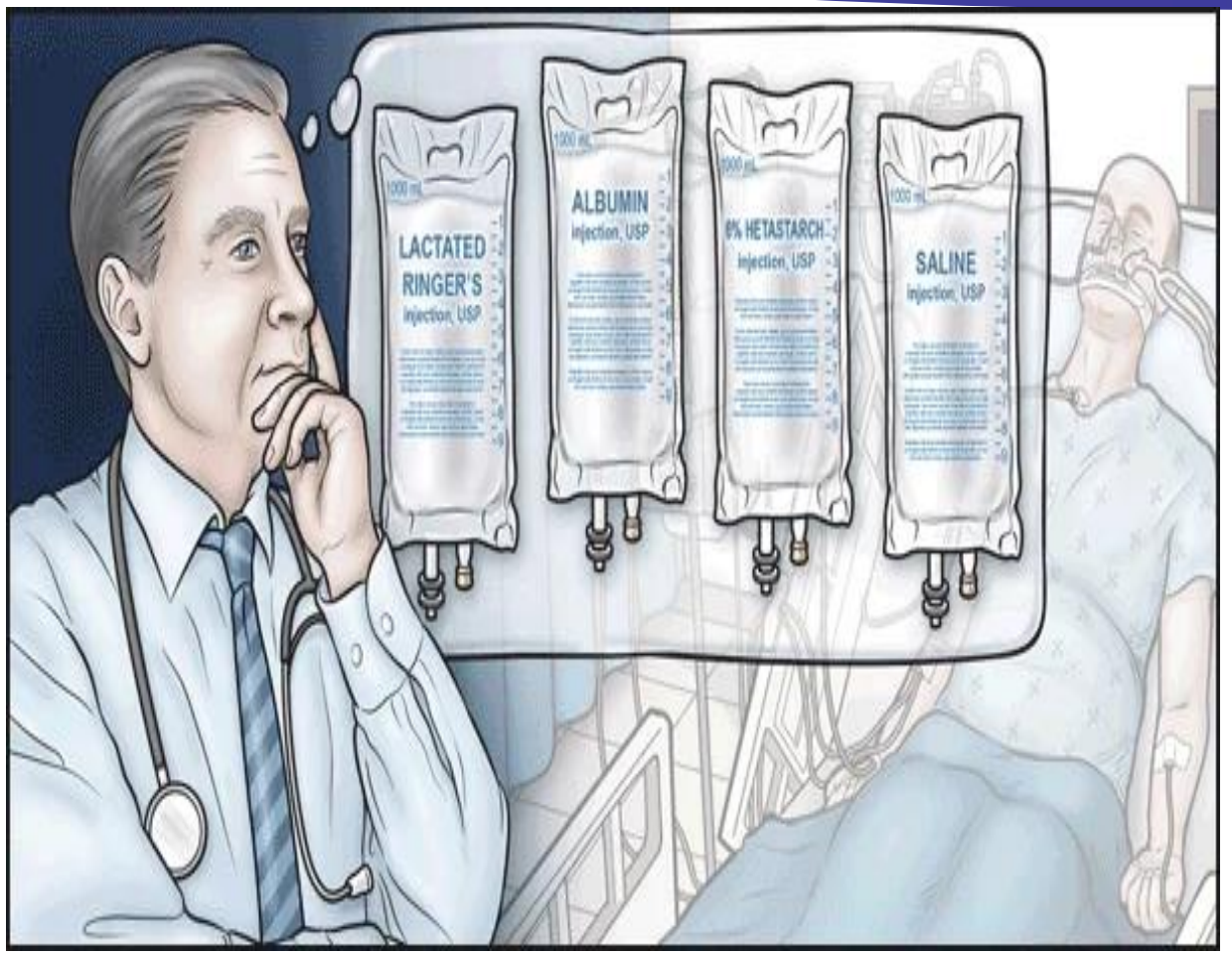


Figure 1. 10 common pitfalls in the management of critically ill patients

Spectrum of treatment related errors

- Fluid Overload
- Oversedation
- Irrational Use of Antibiotics
- Prophylaxis of Gastrointestinal Ulcers
- Inappropriate Blood Transfusions
- Abuse and Misuse of Laboratory Tests
- Invasive Monitoring
- Malnutrition and Overfeeding
- Overtreatment
- Immobilization
- Others

Fluid Management



- **Type of fluid**
- **Amount of Fluid**
- **Fluid challenge and Fluid resuscitation**

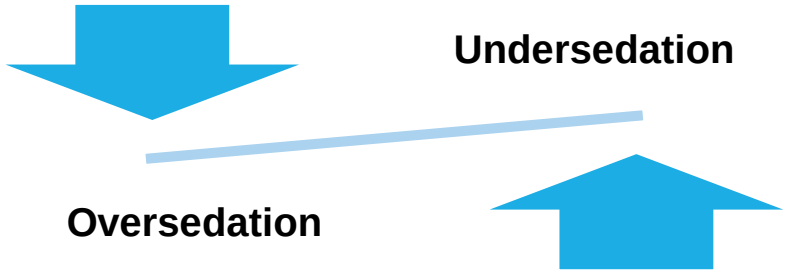
- Adverse events most frequently related to volume overload are acute kidney injury (AKI), prolonged hospital stay, pulmonary oedema, effusions, increased days on invasive mechanical ventilation (IMV) and higher mortality (Malbrain 2018; Pérez-Nieto 2021).

- A 65 years old man with a diagnosis of IHD and urosepsis is admitted in ICU. On examination, his BP is found 80/50 mm of Hg. Which fluid should we choose?

Sedation Management

Undersedation:

- PV asynchrony
- HD instability



Oversedation:

- Delayed weaning
- CINM

Sedation Management

- Benzodiazepine should be avoided
- Dexmedetomidine and propofol are good choice
- Antipsychotics including haloperidol, Quetiapine and risperidone can be used for agitated patients

Irrational Use of Antibiotic

AMS

Timing	Parameters*
Before treatment	Know national guidelines and local resistance rates Evaluate patient-specific factors (catheter use, immunosuppression, colonization, etc.) Evaluate possible pathogens Do not use antibiotics as a treatment tool for high fever Shorten the time to diagnosis
During treatment	Consider pharmacokinetic and pharmacodynamic properties Provide source control Daily assessment of clinical symptoms and culture results of infection Discontinue antibiotics at the appropriate time and de-escalation
After treatment	Use automatic early warning systems Cooperate and communicate

Irrational Use of Antibiotic

TRACHEAL ASPIRATE FOR C/S

Colony Count1 Profuse

CULTURE & SENSITIVITY REPORTS

Organism 1 Klebsiella pneumoniae.

Antibiotic Name	MIC	Interpretation	Break Point
Amikacin	32 mcg/ml	Resistant	>=16
Tigecycline	<=0.5 mcg/ml	**Sensitive**	**>=2**
Cefepime	>=32 mcg/ml	Resistant	>=16
Ceftriaxone	>=64 mcg/ml	Resistant	>=4
Cefuroxime	>=64 mcg/ml	Resistant	>=32
Ciprofloxacin	>=4 mcg/ml	Resistant	>=1
Colistin	<=0.5 mcg/ml	Intermediate	>=4
Ertapenem	>=8 mcg/ml	Resistant	>=2
Gentamicin	>=16 mcg/ml	Resistant	>=8
Imipenem	8 mcg/ml	Resistant	>=4
Meropenem	>=16 mcg/ml	Resistant	>=4
Piperacillin-tazobactam	>=128 mcg/ml	Resistant	>=128
Cefoperazone/Sulbactum	>=64 mcg/ml	Resistant	>=64
Trimethoprim/Sulfamethoxazole	>=320 mcg/ml	Resistant	>=320
Amoxicillin-Clavulanic Acid	>=32 mcg/ml	Resistant	>=32
Fosfomycin	32 mcg/ml	**Sensitive**	**>=256**

Possible ESBL, effectiveness of others cephalosporin and monobactum are uncertain.

Identification and susceptibility tests with MIC done by VITEK 2 Compact, Fully Automated Microbial Identification and Antibiotic Susceptibility System (BioMerieux S.A. France).

Irrational Use of Antibiotic

TRACHEAL ASPIRATE FOR C/S

Colony Count1 Moderate
Colony Count2 Profuse

CULTURE & SENSITIVITY REPORTS

Organism 1 Klebsiella pneumoniae.

Antibiotic Name	MIC	Interpretation	Break Point
Amikacin	32 mcg/ml	Resistant	>=16
Tigecycline	2 mcg/ml	Resistant	>=2
Cefepime	>=32 mcg/ml	Resistant	>=16
Ceftriaxone	>=64 mcg/ml	Resistant	>=4
Cefuroxime	>=64 mcg/ml	Resistant	>=32
Ciprofloxacin	>=4 mcg/ml	Resistant	>=1
Colistin	<=0.5 mcg/ml	Intermediate	>=4
Ertapenem	>=8 mcg/ml	Resistant	>=2
Gentamicin	>=16 mcg/ml	Resistant	>=8
Imipenem	>=16 mcg/ml	Resistant	>=4
Meropenem	>=16 mcg/ml	Resistant	>=4
Piperacillin-tazobactam	>=128 mcg/ml	Resistant	>=128
Trimethoprim/Sulfamethoxazole	>=320 mcg/ml	Resistant	>=320
Amoxicillin-Clavulanic Acid	>=32 mcg/ml	Resistant	>=32
Fosfomycin	<=16 mcg/ml	Sensitive	>=256

Organism 2 Pseudomonas aeruginosa

Antibiotic Name	MIC	Interpretation	Break Point
Amikacin	>=64 mcg/ml	Resistant	>=64
Tigecycline	>=8 mcg/ml	Resistant	>=8

Irrational Use of Antibiotic

URINE FOR C/S

Identification and susceptibility tests with MIC done by VITEK 2 Compact, Fully Automated Micro
Identification and Antibiotic Susceptibility System (BioMerieux S.A. France).

Colony Count1 10^5/mL

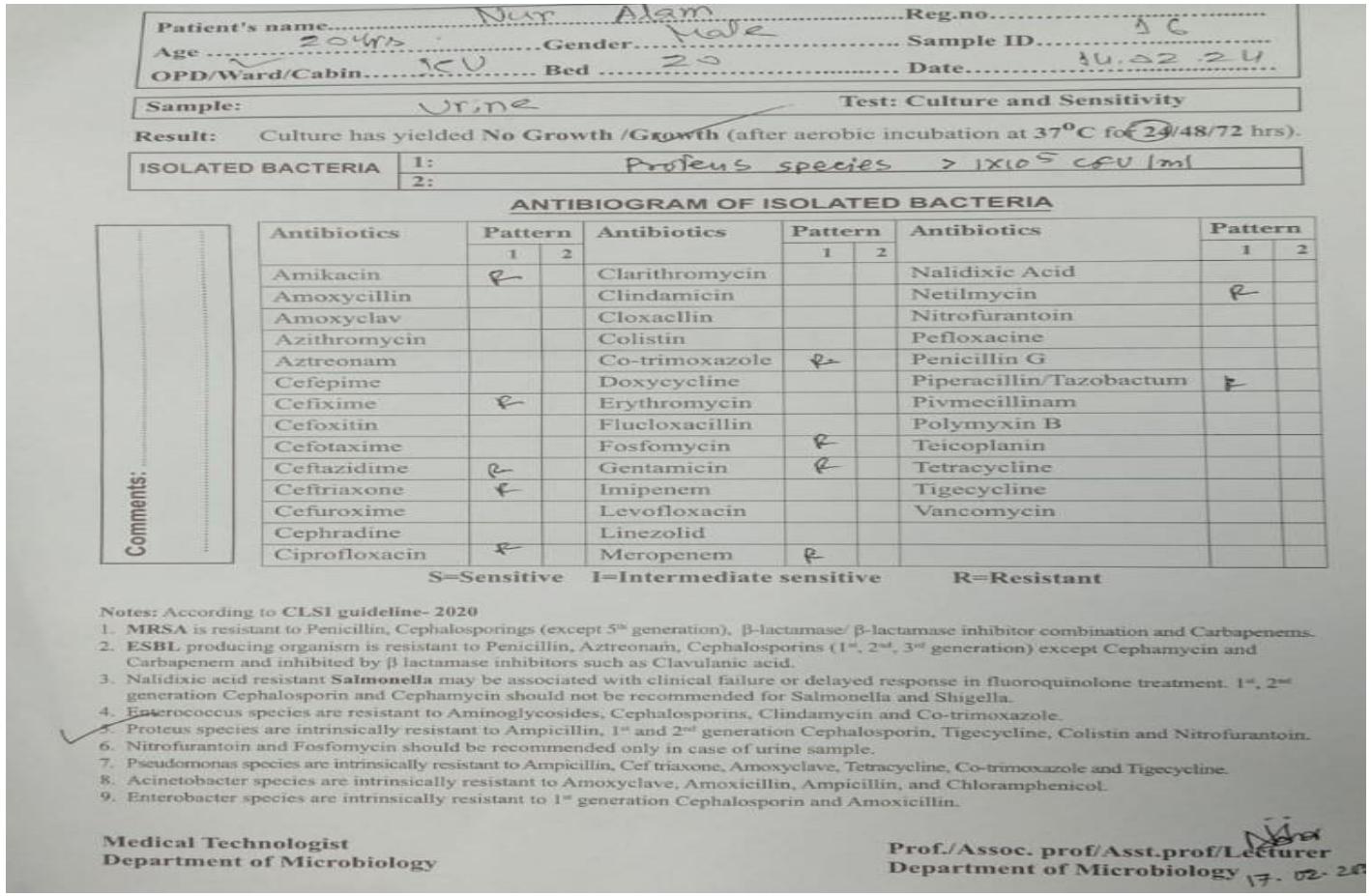
CULTURE & SENSITIVITY REPORTS

Organism 1 Enterococcus faecalis

Antibiotic Name	MIC	Interpretation
Tigecycline	<=0.5 mcg/ml	**Sensitive**
Ciprofloxacin	>=8 mcg/ml	Resistant
Daptomycin	>=8 mcg/ml	Resistant
Doxycycline	>=16 mcg/ml	Resistant
Erythromycin	>=8 mcg/ml	Resistant
Levofloxacin	>=8 mcg/ml	Resistant
Linezolid	2 mcg/ml	**Sensitive**
Nitrofurantoin	256 mcg/ml	Resistant
Penicillin	>=64 mcg/ml	Resistant
Teicoplanin	>=32 mcg/ml	Resistant
Tetracycline	>=16 mcg/ml	Resistant
Vancomycin	>=32 mcg/ml	Resistant
Benzylpenicillin	>=64 mcg/ml	Resistant

(VRE).

Irrational Use of Antibiotic



Patient's name: Nur Alam Reg.no:
Age: 20yrs Gender: Male Sample ID: 1C
OPD/Ward/Cabin: ICU Bed: 20 Date: 16.02.24

Sample: Urine Test: Culture and Sensitivity

Result: Culture has yielded **No Growth /Growth** (after aerobic incubation at 37°C for 24/48/72 hrs).

ISOLATED BACTERIA	1: Proteus species > 1X10⁵ CFU/ml
	2:

ANTIBIOGRAM OF ISOLATED BACTERIA

Comments:

Antibiotics	Pattern 1	Pattern 2	Antibiotics	Pattern 1	Pattern 2	Antibiotics	Pattern 1	Pattern 2
Amikacin	R		Clarithromycin			Nalidixic Acid		
Amoxycillin			Clindamicin			Netilmycin	R	
Amoxyclav			Cloxacllin			Nitrofurantoin		
Azithromycin			Colistin			Pefloxacine		
Aztreonam			Co-trimoxazole	R		Penicillin G		
Cefepime			Doxycycline			Piperacillin/Tazobactum	R	
Cefixime	R		Erythromycin			Pivmecillinam		
Cefoxitin			Flucloxacillin			Polymyxin B		
Cefotaxime			Fosfomycin	R		Teicoplanin		
Ceftazidime	R		Gentamicin	R		Tetracycline		
Ceftriaxone	R		Imipenem			Tigecycline		
Cefuroxime			Levofloxacin			Vancomycin		
Cephradine			Linezolid					
Ciprofloxacin	R		Meropenem	R				

S=Sensitive I=Intermediate sensitive R=Resistant

Notes: According to **CLSI guideline- 2020**

1. **MRSA** is resistant to Penicillin, Cephalosporings (except 5th generation), β-lactamase/ β-lactamase inhibitor combination and Carbapenems.
2. **ESBL** producing organism is resistant to Penicillin, Aztreonam, Cephalosporins (1st, 2nd, 3rd generation) except Cephamycin and Carbapenem and inhibited by β lactamase inhibitors such as Clavulanic acid.
3. Nalidixic acid resistant **Salmonella** may be associated with clinical failure or delayed response in fluoroquinolone treatment. 1st, 2nd generation Cephalosporin and Cephamycin should not be recommended for Salmonella and Shigella.
4. Enterococcus species are resistant to Aminoglycosides, Cephalosporins, Clindamycin and Co-trimoxazole.
5. Proteus species are intrinsically resistant to Ampicillin, 1st and 2nd generation Cephalosporin, Tigecycline, Colistin and Nitrofurantoin.
6. Nitrofurantoin and Fosfomycin should be recommended only in case of urine sample.
7. Pseudomonas species are intrinsically resistant to Ampicillin, Cef triaxone, Amoxyclave, Tetracycline, Co-trimoxazole and Tigecycline.
8. Acinetobacter species are intrinsically resistant to Amoxyclave, Amoxicillin, Ampicillin, and Chloramphenicol.
9. Enterobacter species are intrinsically resistant to 1st generation Cephalosporin and Amoxicillin.

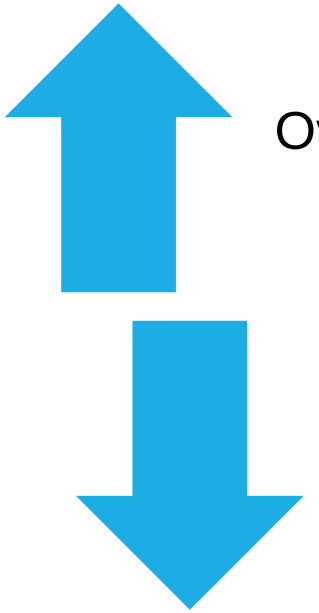
Medical Technologist
Department of Microbiology

Prof./Assoc. prof/Asst.prof/Lecturer
Department of Microbiology
17. 02. 24

Irrational Use of Antibiotic

- In 2011, WHO declared “Combat drug resistance: no action today, no cure tomorrow.”
- MDR, XDR and PDR are now commonly used terms in ICU.
- The day may be not to far when we will have so many costly antimicrobials in our shelf but not any to fight microorganisms in ICU.

Nutrition Management



Overfeeding

Undernutrition

Nutrition Management

- Prolonged fasting and hospital malnutrition have been shown to be associated with poorer outcomes and higher mortality (Galindo-Martín 2018)
- Enteral nutrition (EN) should be started within 48 h of admission, covering 100% calorie requirement (20-30 kcal/kg/day) within 3-7 days of the onset of critical illness (ESPEN 2021).
- Low protein intake is associated with higher rates of infection and mortality in critically ill patients. Thus, it should be included in the nutritional intake (0.8-1.2 g/kg/day)

ESPEN practical and partially revised guideline: Clinical nutrition in the intensive care unit

Pierre Singer [a, *], Annika Reintam Blaser [b, c], Mette M. Berger [d], Philip C. Calder [e], Michael Casaer [f], Michael Hiesmayr [g], Konstantin Mayer [h], Juan Carlos Montejo-Gonzalez [i], Claude Pichard [j], Jean-Charles Preiser [k], Wojciech Szczeklik [l], Arthur R.H. van Zanten [m], Stephan C. Bischoff [n]

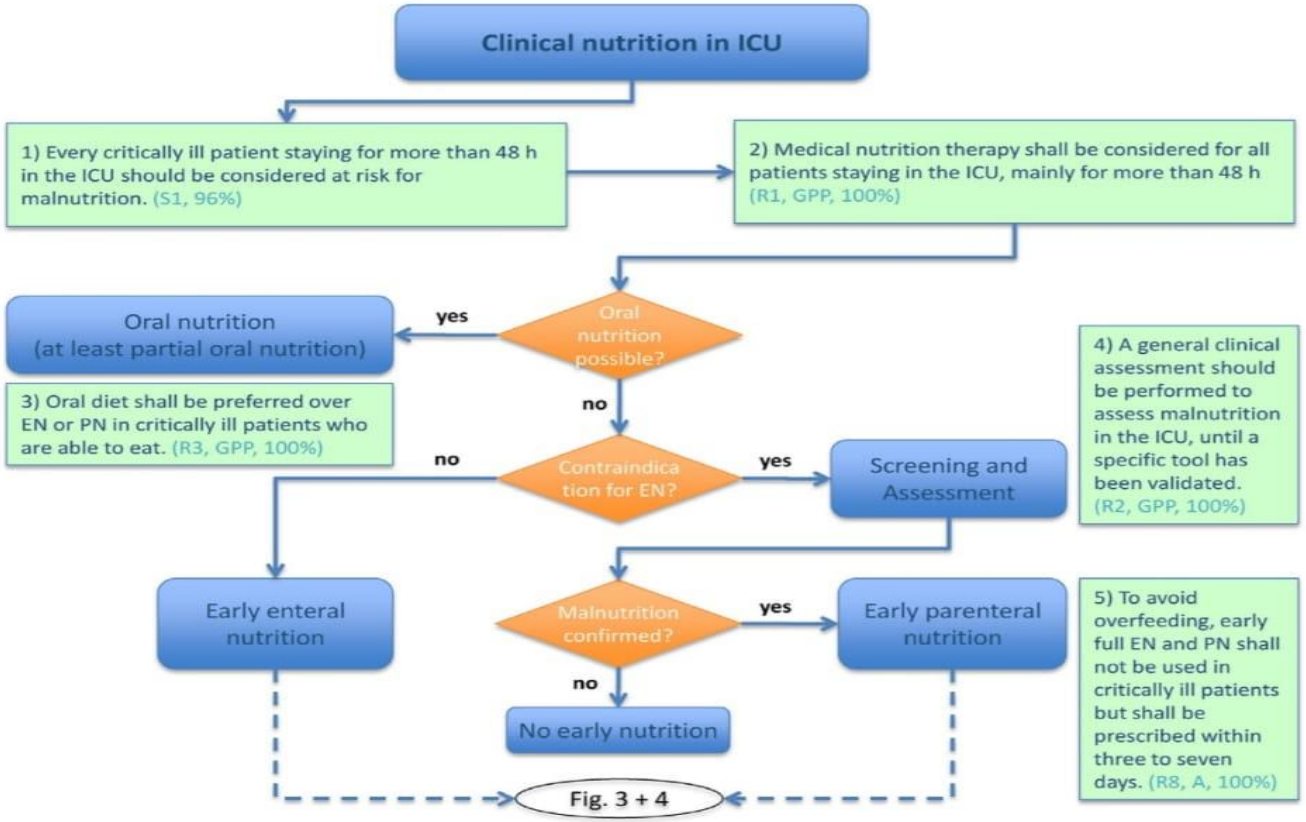
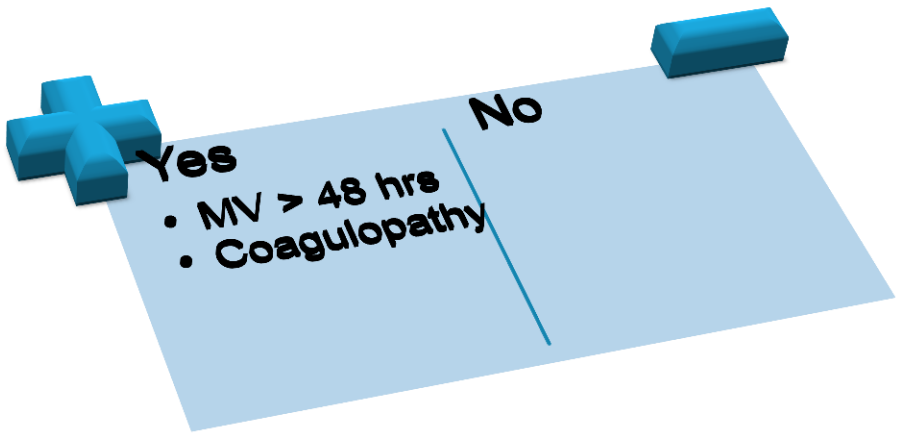


Fig. 2. General recommendations. Recommendations are presented in green boxes. References to other panels in ellipse. Abbreviations: see Fig. 1.

GI ulcer prophylaxis



- High chance of VAP
- CDI
- No reductions in mortality

Blood Transfusion

7 Vs 10

- A transfusion trigger of 7 g/dL appears to be generally safe, especially in the younger age group without significant comorbidities
- Unnecessary administration of blood products is associated with complications including increased length of hospital stay, transfusion related acute lung injury (TRALI), transfusion associated circulatory overload (TACO), increased costs, and higher mortality (Fung 2019).
- Restrictive transfusion strategy reduces the incidence of transfusion-related complications

- A 55 years old man with diagnosis of CLD and portal HTN is admitted in ICU with haematemesis and melaena. His Hb label is 7.2 gm/dl. Will we go for blood transfusion?

Abuse and Misuse of Laboratory Tests

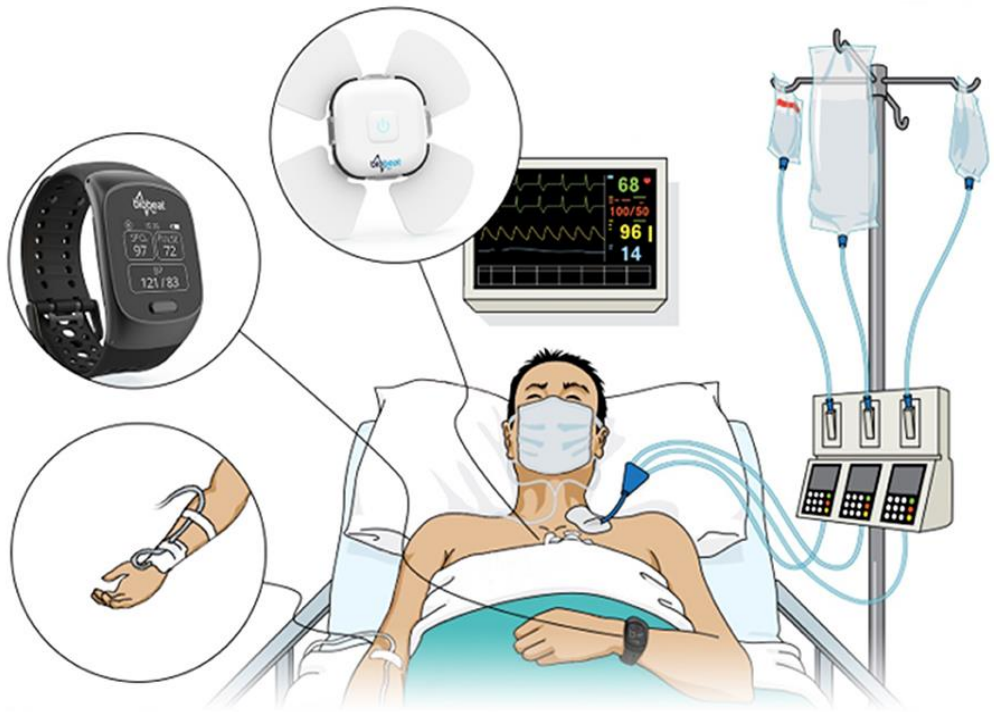
- **Routine investigation**

- ✓ **Should be based on diagnostic workups**
- ✓ **should only be justified on the principle of objective intervention**

- ✓ **Daily blood sampling requires 40-70 ml of blood every 24h**
- ✓ **Decrease in haemoglobin of about 1-1.2 g per day has been demonstrated (Fung 2019)**

Invasive Monitoring

- Pulmonary artery catheterization has now been abandoned in most ICUs
- The debate of its usefulness in patients undergoing cardiac surgery is still ongoing
- Arterial line, CV line, CVP monitoring, neuro-monitoring are not always necessary
- Infection, thrombosis and other vascular complications associated with invasiveness.
- Non invasive monitoring system comparable to invasive systems.



Immobilisation

- **Most critically ill patients remain immobilised, mainly when they are on MV, shock or with severe neurological conditions.**
- **Prolonged immobilisation has serious consequences, such as weakness (polyneuropathy or myopathy), risk of venous embolism, pressure ulcers, etc**
- **Benefits of early mobilisation include improved muscle strength, increased patient independence, minimising the complications and risks described above**

Overall Over treatment

- **Overtreatment includes performing interventions that are not desired by the patient and/or do not generate any benefit for the patient.**
- **Critically ill patients with chronic terminal illnesses or severe acute pathologies complicated by irreversible organ failure are often subjected to supportive therapies such as sedation, neuromuscular blockade, fluid therapy, vasopressors, inotropics, blood products, nutrition, antibiotics, and other drugs, which will only increase days of hospital stay and inappropriate use of resources (lab and imaging studies, drugs, surgeries, etc.), including ICU admission itself (Druml 2019).**

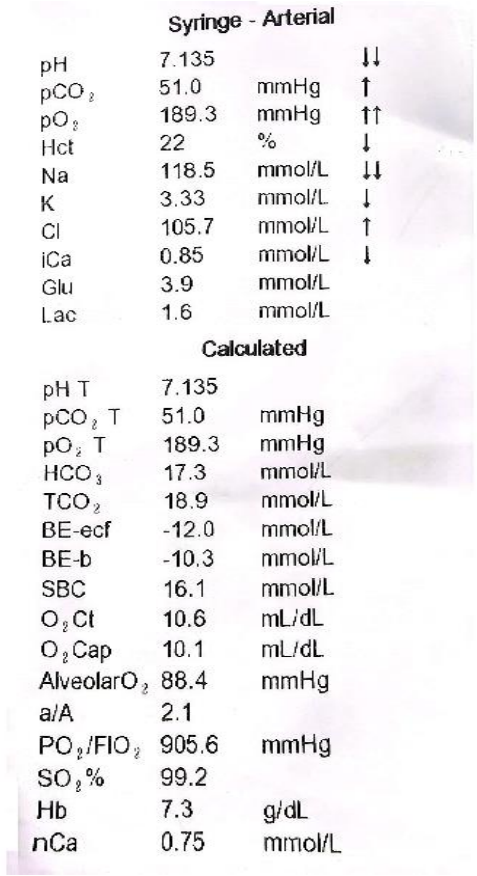
Others

Vasopressor and inotropes

- Debate regarding fluid vs vasopressor, which one first to commence to manage shock
- Blind use of noradrenalin for all case of hemodynamic instability without proper assessment of shock
- Debate regarding vasopressor vs inotropes and irrational use dopamine

- A 65 years old man with a diagnosis of IHD and urosepsis is admitted in ICU. On examination, his BP is found 80/50 mm of Hg. He is given adequate fluid challenge. Still his BP is 85/45 mm of Hg. Which vasopressor or ionotrope should we use?

Inappropiate use of Sodium Bicarbonate



Syringe - Arterial			
pH	7.135		↓↓
pCO_2	51.0	mmHg	↑
pO_2	189.3	mmHg	↑↑
Hct	22	%	↓
Na	118.5	mmol/L	↓↓
K	3.33	mmol/L	↓
Cl	105.7	mmol/L	↑
iCa	0.85	mmol/L	↓
Glu	3.9	mmol/L	
Lac	1.6	mmol/L	

Calculated		
pH T	7.135	
pCO_2 T	51.0	mmHg
pO_2 T	189.3	mmHg
HCO_3	17.3	mmol/L
TCO_2	18.9	mmol/L
BE-ecf	-12.0	mmol/L
BE-b	-10.3	mmol/L
SBC	16.1	mmol/L
O_2Ct	10.6	mL/dL
O_2Cap	10.1	mL/dL
AlveolarO_2	88.4	mmHg
a/A	2.1	
PO_2/FIO_2	905.6	mmHg
SO_2%	99.2	
Hb	7.3	g/dL
nCa	0.75	mmol/L

HFNC Vs NIV (BiPAP/ CPAP)

- Improper assessment of respiratory failure and blind use of either HFNC or NIV
- None is superior to other to prevent mortality but each one has some specific indications.
- HFNC is excellent for type 1 respiratory failure and NIV should always be considereds for type 2 respiratory failure.
- High chance of intolerance in case CPAP/ BiPAP if pressure set up is not adequate or if patient education is not done properly.

Invasive ventilation Vs Non invasive ventilation

- There are some clear indications of intubation and ventilation as well as providing NIV
- Irrational intubation leads to HAI and deprives other salvageable patients and loss of economy
- COPD exacerbation with type 2 respiratory failure, cardiogenic pulmonary edema and post-extubation respiratory failure are some excellent examples where non invasive ventilation should be used.
- Need to learn when to stop where palliative care is important than intensive care

Communication in ICU

- Communication is a powerful tool to prevent unwanted hazards
- Communication among the heath care team and communication among patient or attendants is equally important, all should have single moto to “doing good not harm”

Ideal Set-Up

Recommendations for Tertiary Care Hospital`s ICU Set-up…

- **Critical care unit should preferably be a closed ICU**
- **Protocols and policies are defined**
- **Must have provision of advanced cardiorespiratory monitoring—both invasive and non-invasive**
- **Intra- and inter-hospital transport facilities available**
- **Multisystem care and referral available round the clock**

- In-house blood bank, pharmacy and canteen services 24 × 7
- In-house CT scan and MRI facilities strongly recommended
- Bedside flexible bronchoscopy facility is desirable
- Bedside renal replacement therapy (RRT)
- Continuous renal replacement therapy (CRRT) and plasma exchange facility are recommended

- **Should become lead center for teaching and training in critical care**
- **Ultrasound and echocardiography in the ICU 24 × 7**
- **Optimum patient/nurse ratio (1:1 on patients on organ support e.g. mechanical ventilation, RRT, multiple inotropes; and 1:2 at least when patient is on non-invasive ventilation and/or requires less intense monitoring)**
- **Should act as a center for research, training and teaching, including tele-consultations and telemedicine center**

- **Should be equipped for both long-term acute care and palliative care**
- **Team should be well versed with transplant critical care**
- **ECMO-, ECCO2R- and LV-assist devices facilities**

High Dependency Unit (HDU)

- This is an area where patient care level is intermediate between ICU and other floors.
- It should be located near the ICU or within ICU complex, near emergency or in a ward.
- The nursing and supportive staff should have critical care experience/training.
- Patients after recovery from critical illness, patients of single organ failure and not requiring invasive monitoring or mechanical ventilation but need close observation due to vulnerability for deterioration preferably be admitted in HDU.

- **Size can be up to 50% of the main ICU.**
- **Doctor/Patient ratio and Nurse/Patient ratio may be relaxed (1:2 and 1:3 respectively).**
- **It may also be used as palliative unit for patients who are terminally sick and for end of life care, if other area is not available for care of such patients in the hospital**

THANK YOU ALL

LEARNING IS A NEVER ENDING JOURNEY