Slow Low Efficiency Dialysis

Dr. Ahmed Kamal Mohamed

Lecturer of Anaesthesia and Intensive Care

Acute Kidney Injury

- Acute kidney injury (AKI) is currently recognized for the complex clinical syndrome formerly known as acute renal failure (ARF).
- This transition in terminology serves to emphasize that the spectrum of disease is much broader than the subset of patients who experience renal failure requiring dialysis treatment.

Acute Kidney Injury

- **AKI occurs in a variety of settings, and has clinical manifestations ranging from a minimal elevation in serum creatinine levels to anuric renal failure.**

Acute Kidney Injury

The acute decline in kidney function is often secondary to an injury that causes functional or structural changes in the kidneys.

Acute kidney injury (AKI) is a common complication in critically ill patients and is associated with a mortality rate above 50%.

Acute Kidney Injury

Definition of AKI was published by the Acute Dialysis Quality Initiative (ADQI) in 2004. This consensus definition is termed the **RIFLE criteria.**

Table 1 | Classification and staging systems for AKI

System	Serum creatinine criteria	Urine output criteria
RIFLE class		
Risk	Serum creatinine increase to 1.5-fold OR GFR decrease >25% from baseline	<0.5 ml/kg/h for 6 h
Injury	Serum creatinine increase to 2.0-fold OR GFR decrease >50% from baseline	<0.5 ml/kg/h for 12 h
Failure	Serum creatinine increase to 3.0-fold OR GFR decrease >75% from baseline OR serum creatinine ≥354 μmol/l (≥4 mg/dl) with an acute increase of at least 44 μmol/l (0.5 mg/dl)	Anuria for 12 h
AKIN Stage		
1	Serum creatinine increase ≥26.5 μmol/l (≥0.3 mg/dl) OR increase to 1.5–2.0-fold from baseline	<0.5 ml/kg/h for 6 h
2	Serum creatinine increase >2.0–3.0-fold from baseline	<0.5 ml/kg/h for 12 h
3	Serum creatinine increase >3.0-fold from baseline OR serum creatinine ≥354 μmol/l (≥4.0 mg/dl) with an acute increase of at least 44 μmol/l (0.5 mg/dl) OR need for RRT	<0.3 ml/kg/h for 24 h OR anuria for 12 h OR need for RRT

The RIFLE and AKIN criteria have limitations, and further refinements that can provide a definitive classification are anticipated in the near future.

Tests for neutrophil gelatinase-associated lipocalin and cystatin C are widely available; these biomarkers exhibit optimal qualities to predict the occurrence and prognosis of AKI.

Impact

- Increased morbidity and mortality.
- Use of considerable health care resources.
- Overall Increased Health Care burden.

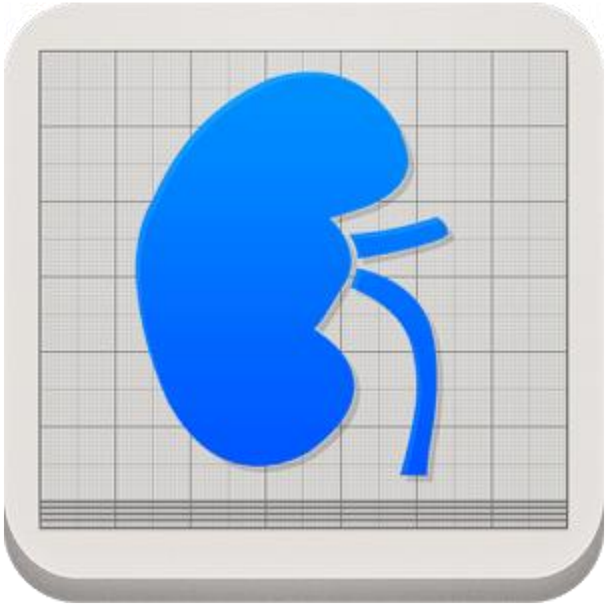
causes

- Multifactoral

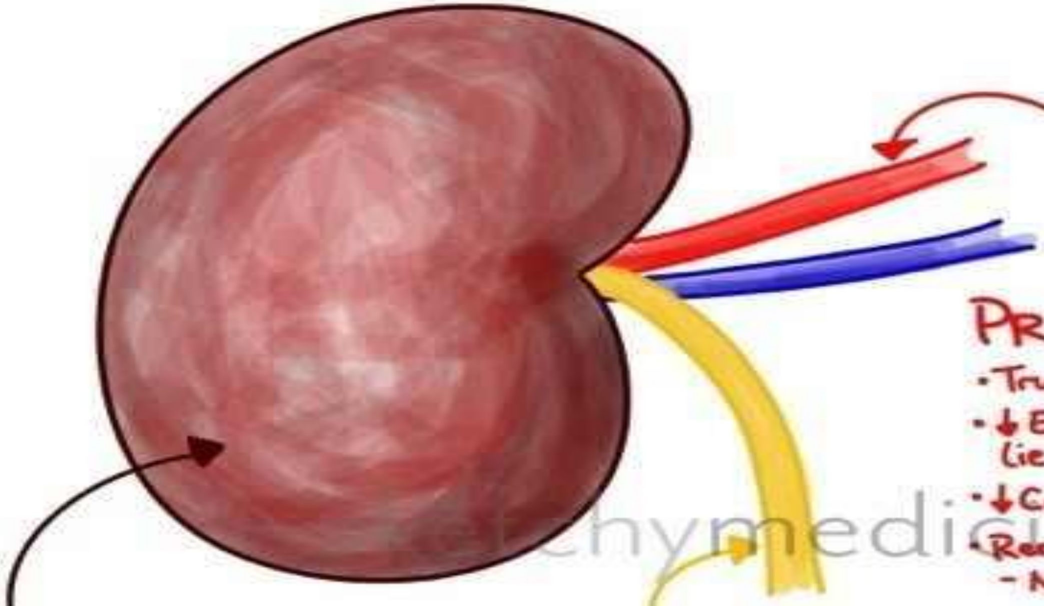
- 45 - 70% related to sepsis.

-Post surgical hypovolemia
 and hypoperfusion.

-Drug induced toxicity.



ACUTE KIDNEY INJURY



PRERENAL (30-60%)

- True volume depletion (ie diarrhea)
- ↓ Effective circulating volume (ie edema)
- ↓ Cardiac output
- Renal vascular disease (stenosis, embolus)
  - NSAIDs

RENAL (20-40%)

① Glomerular
- 1° Glomerulonephritis
  - Anti-GBM
  - ANCA
- 2° to infection or vasculitis
- Neprotic syndrome with ATN

② Vascular
- Embolic
- HUS (hemolytic uremic syndrome)
- Cyclosporine
- NSAIDs

③ Tubulointerstitial
- Acute interstitial nephritis (AIN)
- Acute tubular necrosis (ATN)

POSTRENAL (1-10%)

- Obstruction
  - Ureters
  - Bladder
  - Urethra

"RIFLE" AKI criteria

- Risk (50% ↑ sCr)
- Injury (100% ↑ sCr)
- Failure (150% ↑ sCr)
  - Or anuria for >24h
- Loss (>4 wks)
- End-stage (permanent loss)

Treatment

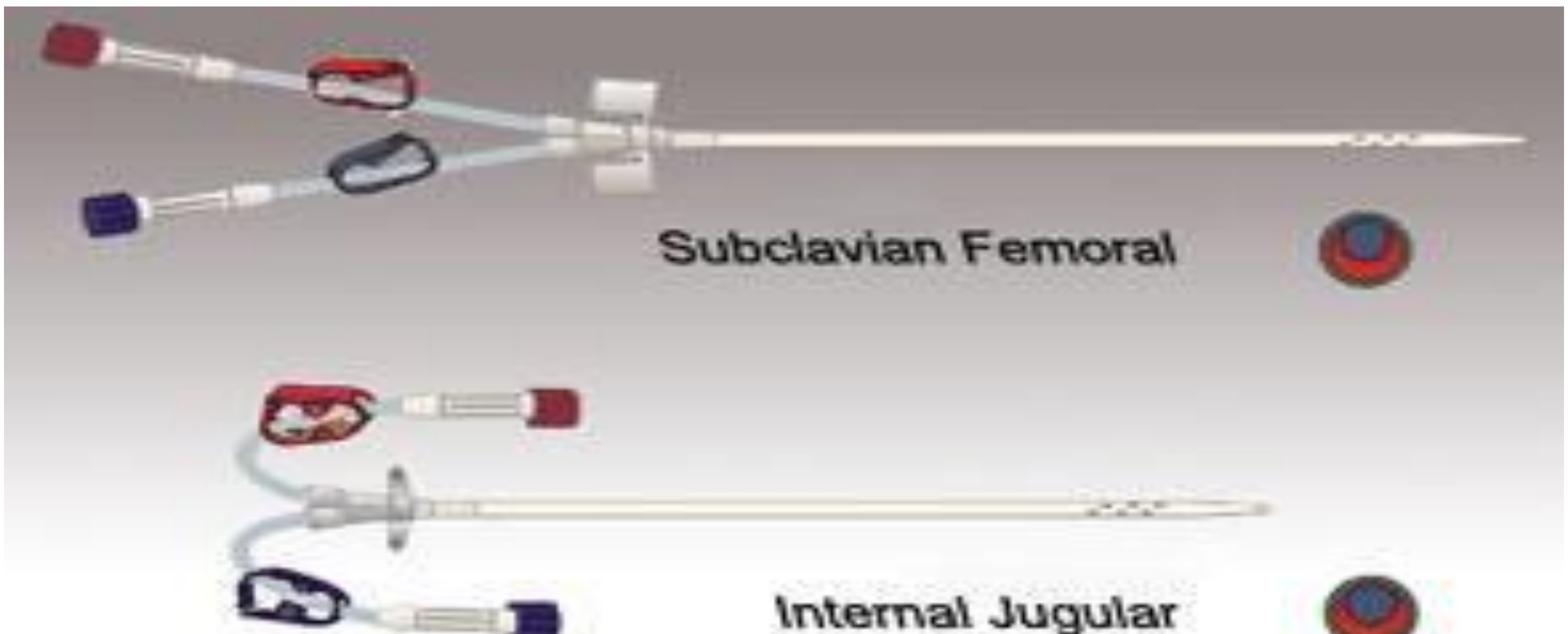
Renal replacement therapy

- Should not be delayed.
- Required in 5% Of our patients
- To correct metabolic derangements.
- Reduce fluid overload.
- Allow for the administration of necessary fluids and nutrition

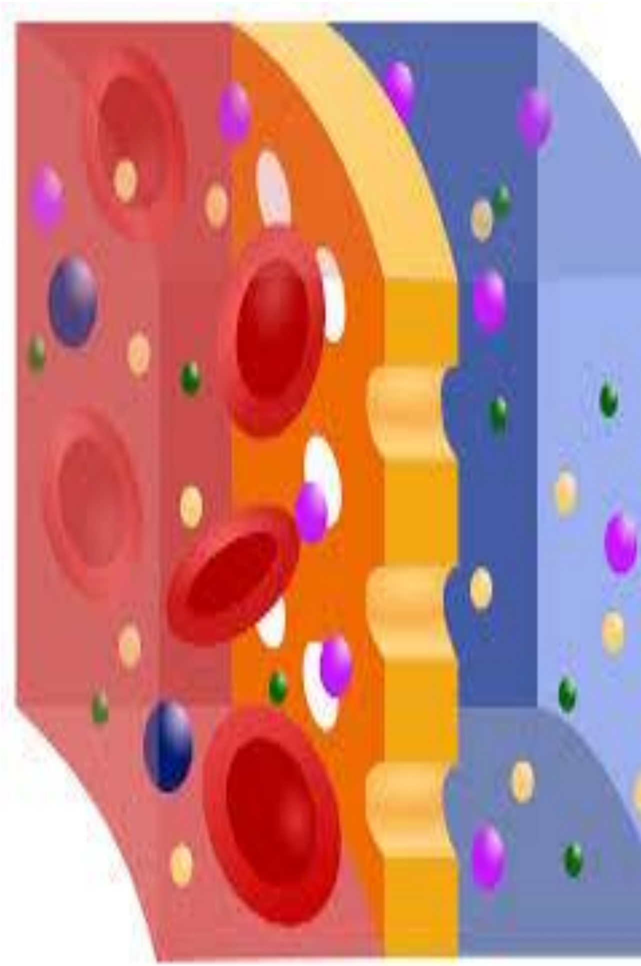
Principles of renal replacement therapy in acute kidney injury

All modalities require a large bore central vein catheter placement to allow blood to flow into the extracorporeal circuit where the exchanges occur.

- The catheter has two lumens and can be used to return the dialyzed blood into the circulation.



- **The RRT involves transport of water and solute across a semipermeable membrane.**



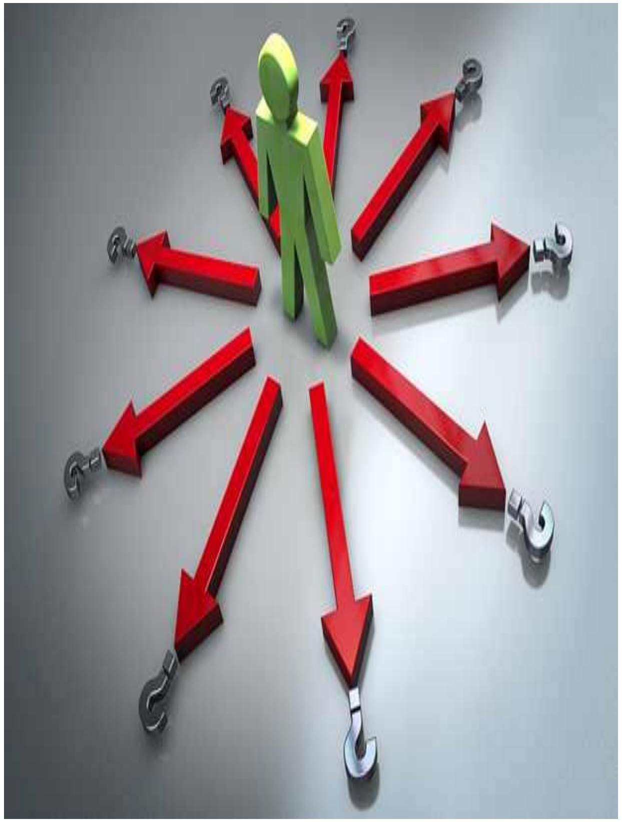
- The processes involved are ultrafiltration for water transport and diffusion and convection (or solvent drag) for transport of solute.
- In ultrafiltration, a hydrostatic pressure is used to cause water transport.
- In diffusion, solutes move from a higher concentration to a lower concentration along a gradient. By allowing blood and dialysate to flow countercurrent to each other in the dialyzer, the gradient for transport is sustained maximally.

In convection is one which uses large amount of water removal (as in ultrafiltration) to ‘drag’ along with it solutes that are in circulation.

Hence, convection is sometimes referred to as ‘solvent drag. The main determinant of solute removal is the ultrafiltration rate which in turn, depends on the membrane’s pore size, surface area, and water permeability as well as the transmembrane pressure.

Choices???

- **Number of renal replacement therapies include continuous and intermittent.**
- **Choice depends on availability , expertise, hemodynamic stability and reason for therapy.**



Classification of renal replacement therapy modalities:

1. Intermittent therapy
   a. Intermittent hemodialysis (IHD)
   b. Sustained low-efficiency dialysis (SLED)/Extended daily dialysis (EDD)
2. Continuous therapy
   a. Peritoneal dialysis (PD)
   b. Continuous renal replacement therapy (CRRT)

Continuous renal replacement therapy (CRRT)

i. Slow continuous ultrafiltration (SCUF)

ii. Continuous arterio-venous hemofiltration (CAVH)

iii. Continuous veno-venous hemofiltration (CVVH)

iv. Continuous arterio-venous hemodialysis (CAVHD)

v. Continuous veno-venous hemodialysis (CVVHD)

vi. Continuous arterio-venous hemodiafiltration (CAVHDF)

vii. Continuous veno-venous hemodiafiltration (CVVHDF)

CRRT

Advantages:

- Slow volume control with CV stability and good solute control

Disadvantages:

-Costly and complex.

-Frequent interruptions.

-Continuous anticoagulation

-Nursing workload.

Continuous renal replacement therapies have advantages over conventionaL intermittent Dialysis with:

- Improved cardiovascular stability.
- Improved tolerance to ultra filtration allowing removal of obligatory fluid loads.
- Ability to maintain solute control especially ability to maintain solute control especially in the catabolic patient.

IHD

Advantages:

-Greater volume removal in shorter period

Disadvantages:

-High UF not tolerated.

-Periodic solute and fluid control problematic.

SLED

Advantages:

-Slow fluid removal with solute control.

-Cost efficient with decreased workload.

Disadvantages:

-Maintenance.

What is SLED?

SLED

Sustained Low-Efficiency Dialysis

- Hybrid between CRRT and IHD.
- First described in 1999.
- Low UF rates for HD stability.
- Low efficient solute removal for less imbalance.
- Longer and intermittent treatment times.
- Uses conventional HD machine and dialyzers
- 8-12hrs per day,5–7days a week.

Why SLED?

- Cost .
- Complexity and nursing workload.
- Safety- additives, anticoagulation.
- Flexibility.
- Patient rehab.

Principle Technical Considerations when Administering SLED in Critically Ill Patients

Hemodialysis Machines

- **The machine used to provide SLED should ideally have flexible options for dialysate flow (QD) allowing for low flows in the clinical situation mandate low solute clearance and ultrafiltration rate (UFR).**

- **These machines should also allow multiple options for hybrid treatment duration, allowing prolonged or even continuous treatments.**
- **The operating nurse or technician should be able to easily use the interface preferably with a dedicated SLED screen.**
- **With aim to optimize the usage of machines in the dialysis room the machine should be capable of changing between IHD and SLED.**

Dialysate

- **Dialysate for the commonly used single pass machines is generated on-line with a bicarbonate proportioning system using reverse osmosis treated tap water.**
- **A canister of dialysate concentrate lasts a single treatment without replacement (a maximum of approximately 16-17 h at 100 mL/min, and 5-6 h at 300 mL/min).**

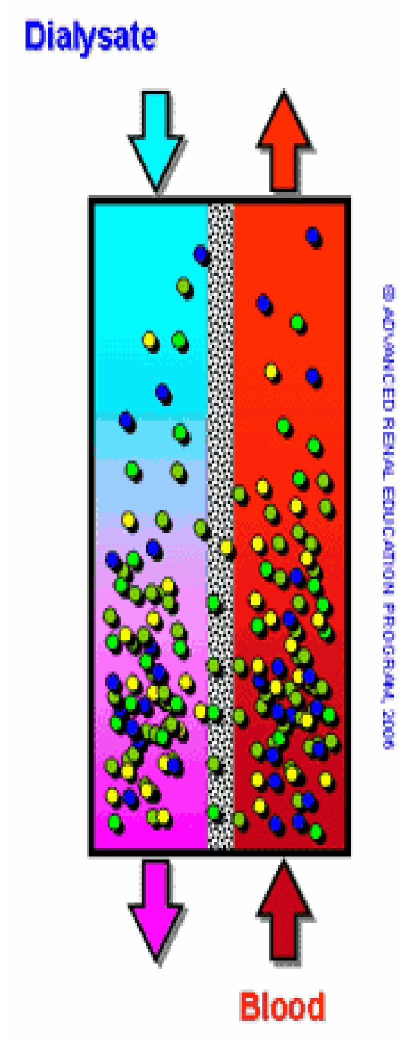
Dialysate composition

Dialysate composition is varied according to clinical need and is often prescribed as Potassium 3 mEq/L, Bicarbonate 28-32 mEq/L and Calcium 1.5-2.5 mEq/L.

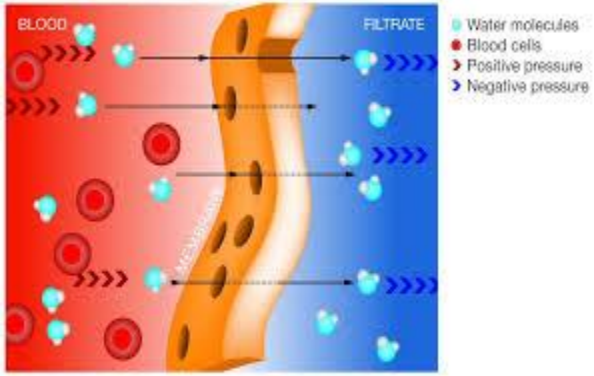
If the therapy is prolonged beyond 8 h it may be necessary to have higher potassium and lower bicarbonate concentrations.

Dialysate flow

- Dialysate flow rate (QD) is varied according to clinical need and dialysis machine specifications. The main factor governing QD is tolerance to ultrafiltration.
- If the targeted UFR is tolerated, treatment duration can be shorter (eg, 6-10 h), and QD should be higher in this setting (eg, 300 mL/min).
- If tolerance is low, duration will be correspondingly longer (eg, 10-18 h, even continuous), and QD correspondingly lower (eg,100-200 mL/min).



Ultrafiltration rate



- **Ultrafiltration goals are determined as per the clinical setting and cardiovascular stability.**
- **If a prescribed ultrafiltration goal can be achieved over a shorter period, higher UFR is prescribed as tolerated.**
- **If not, UFR will be lower, and treatment duration correspondingly longer.**

On-line fluid for filtrate replacement during hemodiafiltration

- **A major step forward is the use of on-line production of fluid for filtrate replacement avoiding the need for expensive commercial hemofiltration solutions.**
- **Fluid is produced from dialysate which is separated after the proportioning system and purified to achieve very low microbial counts, endotoxin concentration, and cytokine inducing activity.**

This technique will remarkably lower the cost and improve accessibility to SLED in the future.

Hemodialyzers:

Standard extracorporeal circuit tubing and hemodialyzers are used.

Anticoagulation

- **Unfractionated heparin is the most commonly utilized anticoagulant.**

Heparin

- In general, heparin is concurrently administered in the majority of hybrid treatments, although up to 40 percent of treatments may be completed without anticoagulation.
- Heparin regimens typically consist of a 1000-2000 unit bolus, followed by an infusion of 500-1000 units/hour to keep the activated partial thromboplastin time 10-20 s above or 1.5 times control.

Heparin

Heparin exposure is less for SLED than for CRRT. Mean heparin requirements vary according to the particular regimen, but are reported to be between 4000 and 10,000 units per treatment day, between 50 and 75 percent less than for CRRT.

Regional citrate anticoagulation has been to successfully maintain extracorporeal circuit patency during hybrid treatments.

For patients with heparin-induced thrombocytopenia, the direct thrombin inhibitor Argatroban can be used. In the absence of liver failure, a bolus of 250 ug/kg is given, followed by a 2 ug/kg per min infusion throughout the treatment.

CRRT,SLED, IHD

	CRRT	SLED	IHD
# Treatment week	7 days	5-6 days	3-5 sessions
# Hours/day	24hrs	8-12 hrs	4 hrs
Blood Flow (ml/min)	100-200	200-300	350 to 400
Dialysate Flow (ml/min)	20-30	300-350	500 to 800
Anticoagulation	Heparin or Citrate	Heparin or Nothing	Heparin or Nothing
Hemodynamic Stability	++	+/-	_ _
MD ordering	Nephrologists Intensivist Consult	Nephrologist Intensivist Consult	Nephrologist

Thank
You