Department of Anesthesia Techniques

Acute kidney injury

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- Acute kidney injury is defined :

An abrupt (within 48 hrs.) decrease in renal function that is clinically significant (i.e., can have adverse consequences).

- 70% of ICU patients have some degree of acute renal dysfunction,
- 5% require renal replacement therapy.

DIAGNOSTIC CONSIDERATIONS

Diagnostic Criteria

1. An increase in **serum creatinine** of ≥0.3 mg/dL within 48 hours, or

2. An increase in **serum creatinine of ≥50% within 48 hours,**

or

3. **A decrease in hourly urine output** **to 40 mEq/L).**

EXCEPTIONS: A prerenal disorder can be associated with a high urine sodium if there is ongoing diuretic therapy, or the patient has chronic renal disease with an obligatory sodium loss in urine.

INITIAL MANAGEMENT

- The following are recommendations for the initial encounter with a patient who develops AKI, especially when associated **with oliguria.**

- **A. What to Do**
  a. Reduce fluid intake as much as possible.
  b. Discontinue potentially **nephrotoxic drugs**.
  c. Adjust the dose of drugs that are excreted in the urine.

B. What Not to Do

a-Do not give furosemide to correct oliguria

Intravenous furosemide does not improve renal function in AKI, and does not convert oliguric to non-oliguric renal failure.

Furosemide can increase urine output during the recovery phase of AKI, and can be used at that time if volume overload is a problem.

b- Do not use low-dose dopamine to increase renal blood flow in AKI.

Low-dose dopamine does not improve renal function in patients with AKI, and it can have deleterious effects (e.g., decreased splanchnic blood flow, inhibition of T-cell lymphocyte function).

SPECIFIC CONDITIONS

- A. Contrast-Induced Nephropathy

Iodinated contrast agents can damage the kidneys in several ways, including

- direct renal tubular toxicity
- renal vasoconstriction
- the generation of toxic oxygen metabolites.

- The incidence of contrast-induced nephropathy (CIN) is 8– 9%. CIN appears within 72 hours after the contrast study, and most cases resolve within two weeks without renal replacement therapy.

Predisposing Conditions

The risk of CIN is increased by:

- diabetes
- dehydration
- renal dysfunction (serum creatinine >1.3 mg/dL in males, and >1.0 mg/dL in females),
- the use of nephrotoxic drugs.

Prevention

a. INTRAVENOUS HYDRATION:

- The most effective preventive measure in high-risk patients is intravenous hydration (if permitted) with isotonic saline at 100–150 mL/hr. started 3 to 12 hours before the procedure and continued for 6–24 hours after the procedure.
- For emergency procedures, at least 300–500 mL isotonic saline should be infused just prior to the procedure.

b. N-ACETYLCYSTEINE

- N-acetylcysteine (NAC) is a glutathione surrogate with antioxidant actions that has had mixed results as a protective agent for CIN.
- The high-dose NAC regimen is 1,200 mg orally twice daily for 48 hours, beginning the night before the contrast procedure.
- Drug-induced AIN is often (but not always) accompanied by signs of a hypersensitivity reaction; i.e., fever, rash, and eosinophilia.
- The onset of renal injury is usually several weeks after the first exposure, but can appear within a few days after a second exposure.

Myoglobinuric Renal Injury

- AKI develops in one-third of patients with diffuse muscle injury (rhabdomyolysis).
- The culprit is myoglobin, which is released by the injured muscle, and can damage the renal tubular epithelial cells.

•Diagnosis

- The widespread myocyte injury in rhabdomyolysis produces marked elevations in the creatine kinase (CK) levels in blood (CK levels of 20,000– 30,000 U/L are not uncommon).
- However, the diagnosis of AKI can be difficult in this setting because the injured myocytes release creatine, which elevates the serum creatinine, and oliguria can be the result of hypovolemia, which occurs with rhabdomyolysis.
- The distinguishing feature is the presence or absence of myoglobin in the urine.
- Myoglobin in Urine: Myoglobin can be detected in urine.

Management

- Aggressive volume resuscitation to promote renal blood flow is the most effective measure for preventing or limiting myoglobinuric renal injury.
- Alkalinizing the urine can also limit the renal injury, but is difficult to accomplish.
- Dialysis About 30% of patients with myoglobinuric renal injury require dialysis

Abdominal Compartment Syndrome

- An increase in intraabdominal pressure (IAP) can adversely affect renal function by decreasing both renal perfusion pressure and the net filtration pressure across the glomerulus.
- As a result, oliguria is one of the first signs of intraabdominal hypertension (IAH).
- When IAH is associated with organ dysfunction, the condition in called abdominal compartment syndrome (ACS).

Predisposing Conditions

- ACS is traditionally associated with abdominal trauma, but several conditions can raise the IAP and predispose to ACS, including:
  - gastric distension
  - bowel obstruction
  - Ileus
  - Ascites
  - bowel wall edema
  - Hepatomegaly
  - positive-pressure breathing
  - upright body position
  - obesity.

- Several of these factors can co-exist in critically ill patients, which explains why IAH is discovered in as many as 60% of patients in medical and surgical ICUs.
- LARGE VOLUME RESUSCITATION:

can raise IAP by promoting edema in the abdominal organs (particularly the bowel).

One report of ICU patients with a positive fluid balance >5 liters over 24 hours found that 85% of the patients had IAH, and 25% had ACS.

Diagnostic Criteria

- The normal IAP is 5–7 mm Hg in the supine position. \
- IAH is defined as a sustained IAP ≥12 mm Hg.
- ACS is defined as an IAP >20 mm Hg plus acute organ dysfunction.

Management

a. General measures for reducing IAP include

sedation (to reduce abdominal muscle contractions),

avoiding elevation of the head more than 20° above the horizontal plane

avoiding a positive fluid balance.

b. Specific measures are dictated by the responsible condition, and can include

decompression of the stomach or bowel, percutaneous drainage of ascites

surgery (for abdominal injuries or bowel obstruction).

Renal replacement therapy (rrt)

artificial methods of solute clearance.

- Several methods are available, including:
  - Hemodialysis
  - Hemofiltration
  - Hemodiafiltration
  - High-flux dialysis
  - Plasma filtration.

Indications

The usual indications for RRT include:

a. Volume overload
b. Life-threatening hyperkalemia or metabolic acidosis
c. Manifestations of uremia (e.g., encephalopathy)
d. Removal of toxins (e.g., ethylene glycol)

Hemodialysis

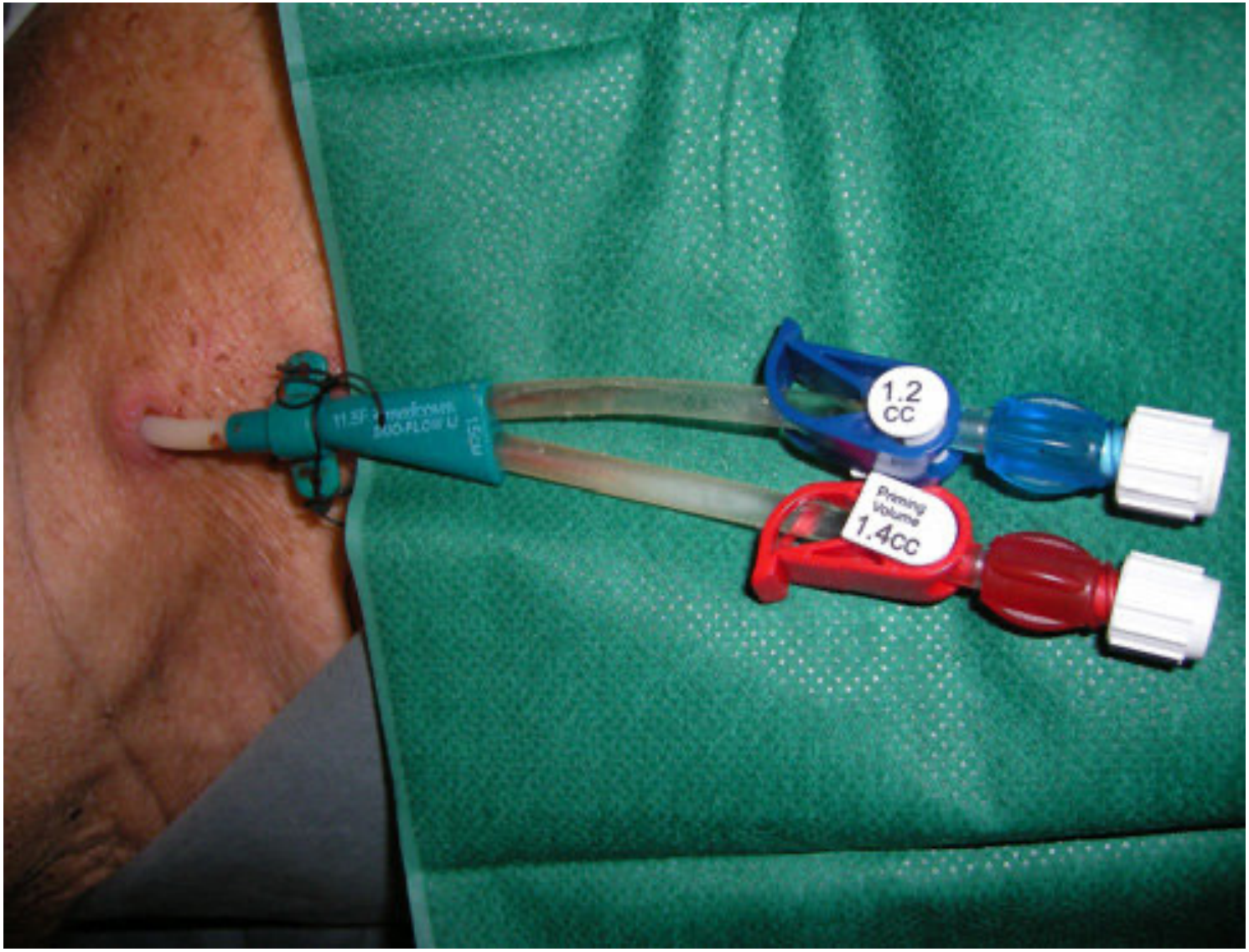
Hemodialysis removes solutes by diffusion, which is driven by the concentration gradient of the solutes across a semipermeable membrane.

- To maintain this concentration gradient, the blood and dialysis fluid are driven in opposite directions across the dialysis membrane. This is known as countercurrent متعاكس exchange .

Method To perform acute hemodialysis

a large-bore double-lumen catheter is inserted percutaneously into the internal jugular or femoral veins, and advanced into the superior or inferior vena cava.

- Venous blood is withdrawn through one lumen of the catheter by a pump in the dialysis machine, which propels the blood at a rate of 200–300 mL/min as it passes the dialysis membrane and returns through the other lumen of the catheter.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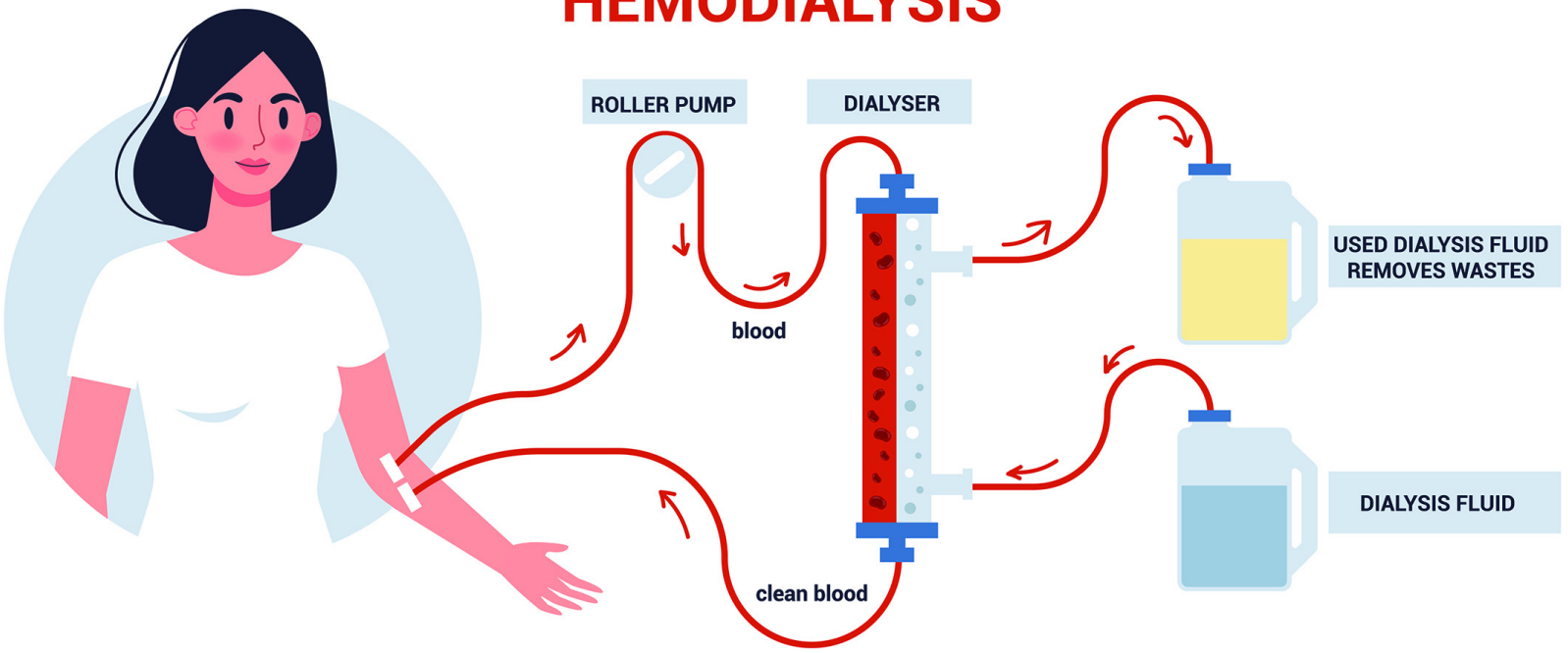


Advantages:

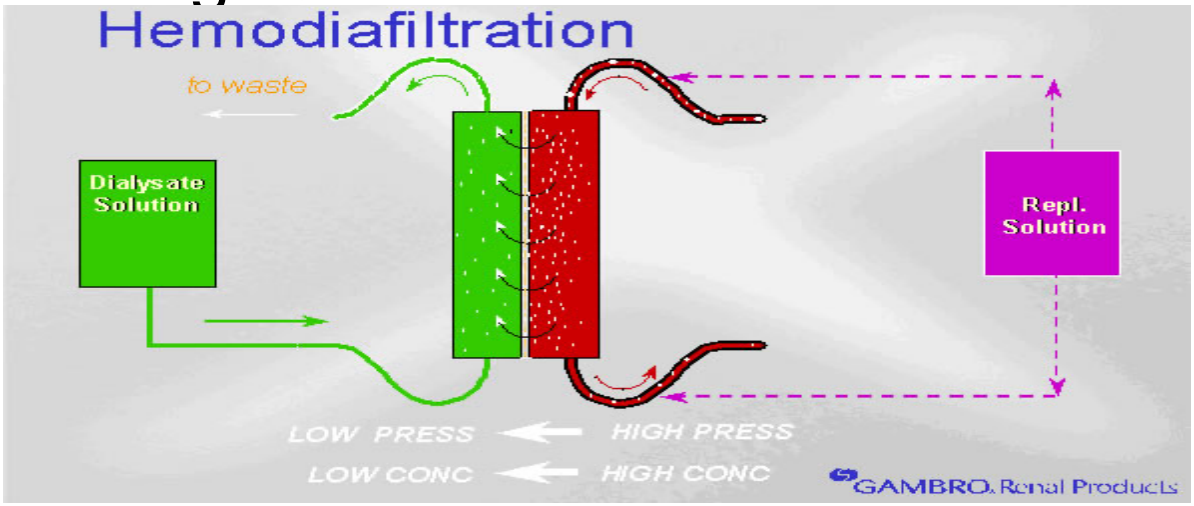
- The principal benefit of hemodialysis is rapid clearance of small solutes.
- Only a few hours of hemodialysis is needed to remove a day's worth of nitrogenous waste.

Disadvantages

- The need to maintain a blood flow of 200–300 mL/min through the dialysis chamber creates a risk for **hypotension**, especially in hemodynamically compromised patients.
- Hypotension occurs in about one of every three hemodialysis treatments.

Hemofiltration

- Hemofiltration removes solutes by convection, where a hydrostatic pressure gradient is used to move a solute-containing fluid across a semipermeable membrane. Since the bulk movement of fluid “drags” the solute across the membrane, this method of solute removal is also known as solvent drag سحب.



Fluid vs. Solute Removal

Hemofiltration can remove large volumes of fluid (up to 3 L/Hr), but the rate of solute clearance is slow, requiring continuous hemofiltration for effective solute clearance.

Because solutes are cleared with water, the plasma concentration of cleared solutes does not decrease during hemofiltration unless a solute-free I.V. fluid is infused to replace some of the ultrafiltrate that is lost.

Method:

- The popular method at present is continuous VenoVenous hemofiltration (CVVH), which has a circuit design similar to hemodialysis (i.e., a large-bore, double lumen catheter is used to cannulate one of the vena cava, and a pump is used to circulate blood through the hemofiltration chamber).

Advantages

a. It allows more gradual fluid removal than hemodialysis, and is less likely to produce hemodynamic instability.

b. It removes larger molecules than hemodialysis, and is more effective for removing toxins like ethylene glycol.

Disadvantages

- slow solute removal
- the need to infuse solute-free fluid to decrease the solute concentration in blood.
- As a result, it is not as efficient as hemodialysis as a surrogate kidney, and is not recommended for rapid correction of life-threatening hyperkalemia or metabolic acidosis

MCQ TEST

- 1- following criteria for the diagnosis of AKI

a) An increase in serum creatinine of ≥0.3 mg/dL within 48 hours

B)An increase in serum creatinine of ≥50% within 48 hours

C)A decrease in hourly urine output to 40 mEq/L).

D) All the above

E) None of the above

2- Risk factors for contrast induced nephropathy (all true except one)

a) Diabetes

b) Dehydration

c) renal dysfunction (serum creatinine >1.3 mg/dL in males, and >1.0

mg/dL in females)

d) use of nephrotoxic drugs.

e) Obesity

3- Predisposing condition for abdominal compartment syndrome to cause AKI (All true except one)

gastric distension

bowel obstruction

diarrhea

Hepatomegaly

positive-pressure breathing.

4- Renal replacement syndrome (all true except one)

refers to artificial methods of solute clearance

Several methods are available, including hemodialysis, hemofiltration, hemodiafiltration.

The usual indications for RRT include Volume overload, Life-threatening hyperkalemia

Used for metabolic acidosis Causes hemodynamic instability

5- Method To perform acute hemodialysis (all true except one)

a) a large-bore double-lumen catheter is inserted percutaneously into the internal jugular or femoral veins

b) Venous blood is withdrawn through one lumen of the catheter by a pump in the dialysis machine

c) propels the blood at a rate of 200–300 mL/min

d) blood passes the dialysis membrane and returns through the other lumen of the catheter.

e) the rate of solute clearance is slow