Acute Complications of Hemodialysis

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Intradialytic hypotension

- **Definition: A decrease in systolic BP ≥20 mm Hg or a decrease in MAP ≥ 10 mm Hg associated with symptoms**
- **Complication: cardiac arrhythmias, coronary and/or cerebral ischemic events**
- **Long-term side effects: volume overload due to suboptimal ultrafiltration, LVH, and interdialytic hypertension**
- **A third of dialysis patients**

Risk Factors of Dialysis Hypotension

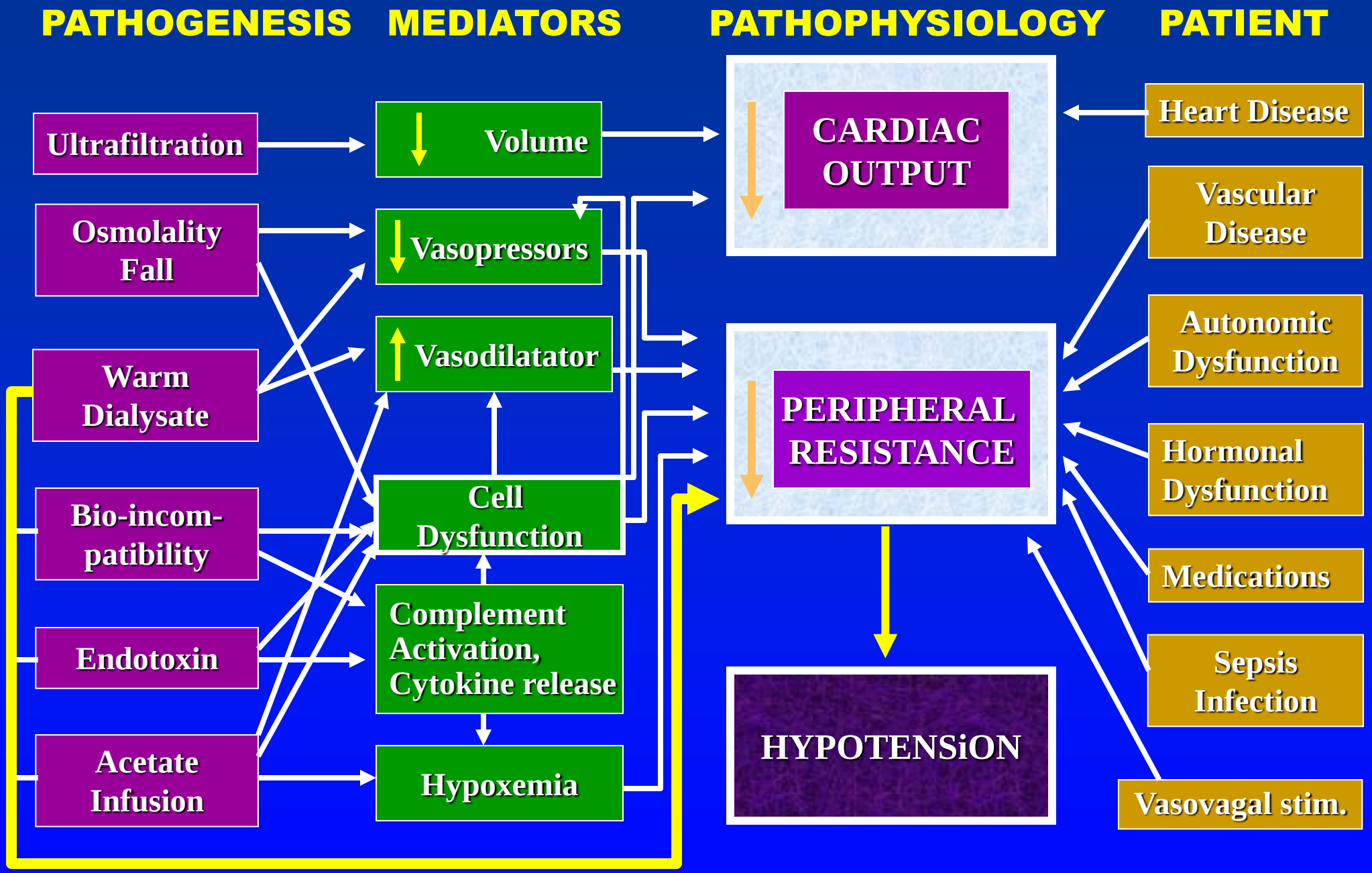
- Low body mass
- Poor nutritional status and hypoalbuminemia
- Severe anemia
- Advanced age (Age > 65 years old)
- Cardiovascular disease
- Large interdialysis weight gain
- Low blood pressure (predialysis systolic BP <100 mm Hg)

Etiology of Dialysis Hypotension (I)

- Excessive rate and degree of ultrafiltration
- Inappropriate peripheral venodilation
- Autonomic dysfunction
- Inadequate vasoconstrictor secretion

Etiology of Dialysis Hypotensoin (II)

- Acetate dialysate
- Low calcium dialysate
- Eat shortly before dialysis
- Antihypertensive medications
- LV dysfunction


PATHOGENESIS
MEDIATORS
PATHOPHYSIOLOGY
PATIENT
Ultrafiltration
Osmolality Fall
Warm Dialysate
Bio-incom-patibility
Endotoxin
Acetate Infusion
Volume
Vasopressors
Vasodilatator
Cell Dysfunction
Complement Activation, Cytokine release
Hypoxemia
CARDIAC OUTPUT
PERIPHERAL RESISTANCE
HYPOTENSiON
Heart Disease
Vascular Disease
Autonomic Dysfunction
Hormonal Dysfunction
Medications
Sepsis Infection
Vasovagal stim.

Prevention and Management of Dialysis Hypotension (I)

- Limiting sodium intake
- Minimize interdialytic weight gain by education
- Blood sugar control
- Slow ultrafiltration
- Sodium modeling
- Raise dialysate calcium
- Lower dialysate temperature

Prevention and Management of Dialysis Hypotension (II)

- Switch to CAPD
- Hyperoncotic albumin
- Nasal oxygen
- Mannitol infusion

Prevention and Management of Dialysis Hypotension (III)

- **L-Carnitine therapy**
- **Sertraline**
- **Midodrine (midorine 2.5 mg)**
  1# Bid ~ 2# Tid, max: 40 mg/d
- **Blood transfusion or erythropoietin therapy**
- **Volume expansion**
- **Vasoconstrictor**

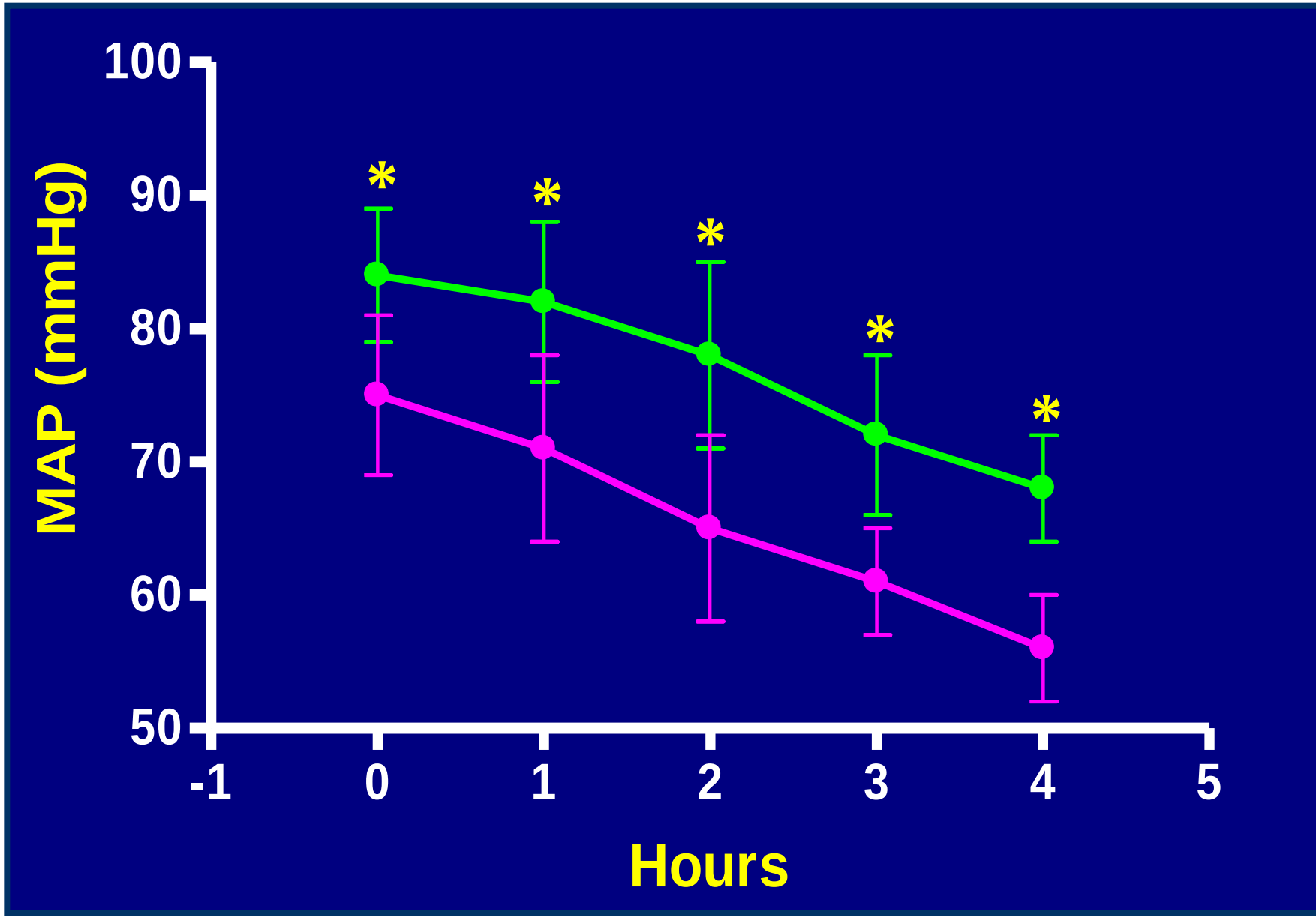


Figure. Serial changes in MAP HD before (●) and after (●)midodrine therapy.

Muscle Cramps

- 35-86% of hemodialysis patients
- Lower extremities
- Mechanisms: Rapid ultrafiltration, Intradialytic hypotension, tissue hypoxia
- Treatment: Quinine, Vit E, L-carnitine, Creatine monohydrate, sodium modeling, hypertonic solution

Acute Allergic Reaction

- First use syndrome
- Burning retrosternal pain
- Diffuse heat, cold perspiration, urticaria, pruritus, laryngeal stridor, bronchospasm, loss of consciousness
- Polyurethane function as a reservoir for ethylene oxide

Uremic Pruritus (I)

- **50-90% of dialysis patients**
- **Risk: male, high serum BUN, Ca, P, β2-microglobulin, duration of dialysis**
- **Diagnositc criteria**

1	Pruritus appears shortly before the onset of dialysis, or at any time, without evidence of any other active disease that could explain the pruritus.
2	more than or equal to three episodes of itch during a period of <2 weeks, with the symptom appearing a few times a day, lasting at least few minutes, and troubling the patient.
3	Appearance of an itch in a regular pattern during a period of 6 months, but less frequently than listed above.

Causes of itching in ESRD

(1) *Uremia related*
- (a) Uremic itching
- (b) Xerosis
- (c) Anemia of chronic kidney disease
- (d) Secondary hyperparathyroidism

(2) *Uremia unrelated*
- (a) Drug-induced hypersensitivity
- (b) Senility
- (c) Hepatitis
- (d) Diabetes mellitus
- (e) Hypothyroidism
- (f) Iron-deficiency anemia
- (g) Lymphoproliferative/solid tumors
- (h) Hypercalcemic states

Uremic Pruritus (II)

- Optimize the dialysis dose
- Treat anemia
- Treat 2nd hyperparathyroidism
- Ultraviolet B phototherapy
- Topical emollients
- Capsaicin
- Antihistamine
- Anti-serotonin agents

Arrhythmia (I)

- 30-48% of dialysis patients
- Risk factor:

▲ Compromised myocardium: CAD, Intermyocardiocytic fibrosis, Pericarditis

▲ Increased QT interval or dispersion

Arrhythmia (II)

- Electrolyte imbalance: hypokalemia, hyperkalemia, hypercalcemia, hypermagnesemia
- Anemia
- Increased LV mass
- Advanced age
- Acetate dialysate

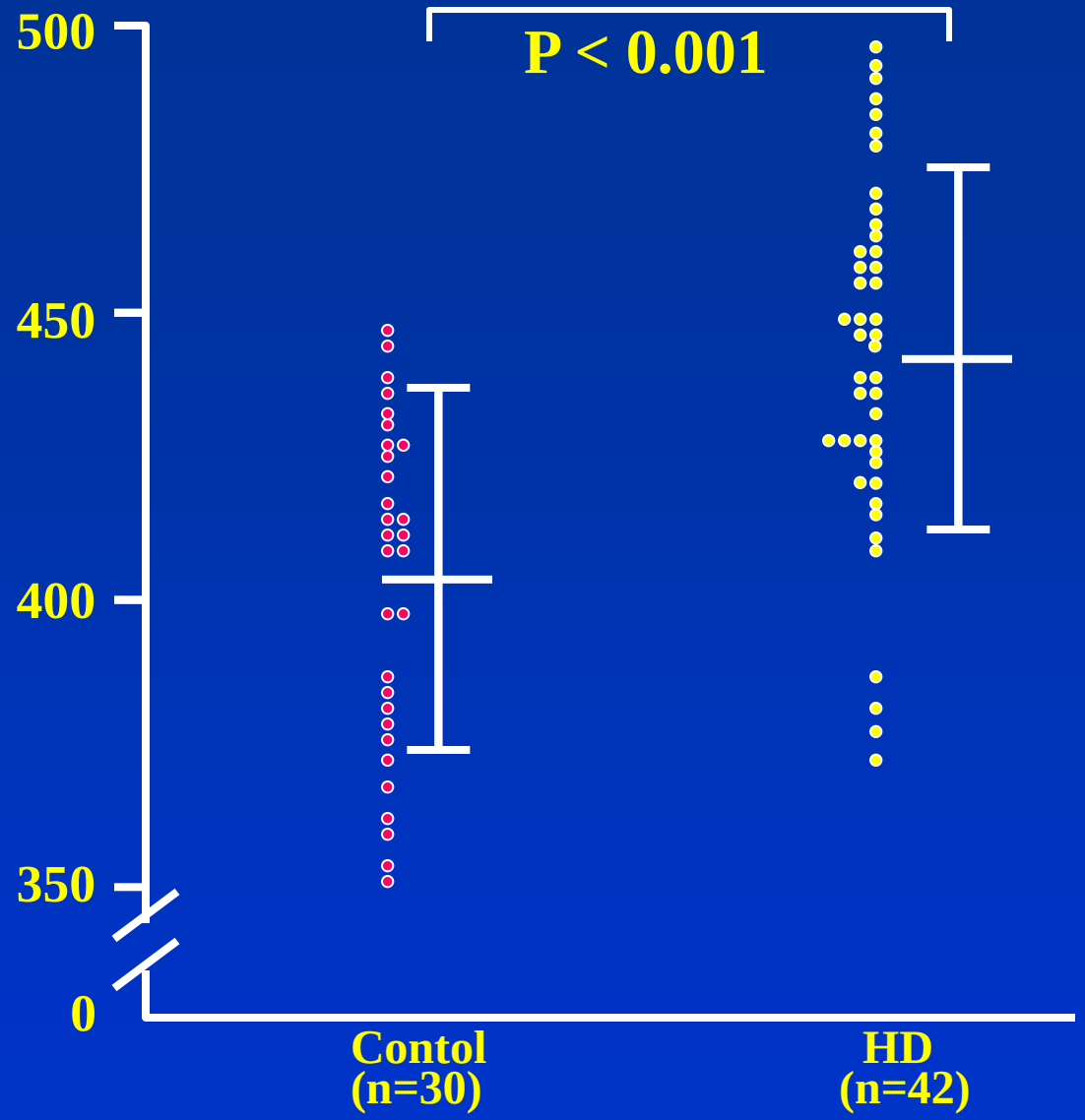


Fig. Distribution of QTc values among hemodialysis patients and controls. The mean value of QTc was significantly increased in hemodialysis patients (432.6 ± 24.9 ms) compared controls (402.0 ± 21.0 ms) (p<0.01)

Suzuki R. Clin Nephrol 49:240, 1998.

Results of 24-Hour Holter ECG Monitoring

Arrhythmias Seen	No. of Tapes (%)
Ventricular ectopic beats (> 20/hr)	15 (24)
Ventricular ectopic beats (> 100/hr)	2 (3)
Episodes of ventricular tachycardia	5 (8)
Epidoses of supraventricular tachycardia	2 (3)
Episodic atrial fibrillation	7 (11)
Heart block (intermittent)	1 (1.6)

Jassal SV AJKD 30:219, 1997.

Bleeding During Dailysis (I)

- **Platelet dysfunction**
- **Impaired dense granule release of ATP and serotonin**
- **Reduced synthesis of thromboxane A2**
- **Elevated platelet cytosolic cAMP and calcium**
- **Impaired aggregation response**

Bleeding During Dialysis (II)

- Altered adhesive fibrinogen and vWf
- Impaired fibrinogen receptor (GPIIbIIIa) function
- Uremic toxin or inhibitors
- Erythropoietin augments GPIIbIIIa

Bleeding During Dialysis (III)

- **Pack RBC**
- **Cryoprecipitate, FFP(VIII/vWF)**
- Desmopressin (**DDAVP**) 4mcg/ml/Amp

  0.3mcg/kg in N/S 100ml over 15~30 min
- **Estrogen**

Air Embolism

- 1 ml/kg air may be fatal
- Occlude RV outflow tract and pulmonary vascular bed
- Thromboxane B2, endothelin
- Trendelenburg position with left side down
- Withdrawal of air from RA
- Hyperbaric oxygen

Dialysis Pericarditis I

- **Uremic pericarditis:**

  pericarditis before RRT or within 8 wks of its initiation

- **Dialysis pericarditis:**

  ≥ 8 wks after initiation of RRT

- **Incidence of dialysis pericarditis: 2-12%**

- **Etiology: inadequate dialysis, volume overload, infection, autoimmune, drugs**

Dialysis Pericarditis II

- Precordial pain, hypotension, dyspnea, fever, weight gain
- Heparin free dialysis
- Intensive dialysis
- NSAID
- Subxiphoid pericardiostomy

Dialysis Disequilibrium (I)

- Headache, vomiting, seizure, delirium
- Rapid correction of marked azotemia
- Cerebral swelling
- Reverse urea effect
- Acidosis of the CSF

Dialysis Disequilibrium (II)

- Shorten the duration
- Lower dialyzer blood flow
- Less efficient dialyzer
- Osmotic agents, high sodium
- IV diazepam

Hypokalemia

- Loss into dialysate, alkali therapy
- Renal or extrarenal losses
- Arrhythmia, hypotension, fatigue, weakness, paralysis
- CAD, digitalis, hypercalcemia, hypomagnesemia, meta alkalosis
- Adjust dialysate potassium and buffer

Hyperkalemia

- Dietary intake
- GI bleeding
- Overheated or hypotonic dialysate
- Medications
- Metabolic acidosis

Hypophosphatemia

- Intensive dialysis
- Phosphorus binders
- Reduced intake
- Dysfunction of erythrocytes, CNS, skeletal and cardiac muscle
- Phosphorus rich food

Hypercalcemia (I)

- Liberation of calcium from bone
- Intradialytic gain
- Phosphorus binders
- Widespread use of calcitriol
- Aluminum poisoning

Hypercalcemia (II)

- Low dialysate calcium
- Phosphorus binders during meals
- Discontinue vitamin D Therapy
- Treat aluminum toxicity
- Pamidronate

Endotoxin

- **Bacterial infections**
- **Header sepsis syndrome:**

  waterborne Xanthomonas–induced fevers
- **Pyrogens**

Hypertensive Emergencies

- Paradoxical, hypertensive response
- Rise in plasma catecholamine
- Activation of renin-angiotensin system
- Antihypertensive withdrawal
- Tx: Sublingual captopril and nifedipine

Bowel Ischemia

- Abdominal pain, acute diarrhea
- Dialysis hypotension
- Digitalis, β blockers
- Occlusive and non-occlusive infarction (25~60%)
- Heart: Congestive heart failure, arrhythmia (Af)
- Hyperkalemia, acidemia, leukocytosis
- Dx: Inappropriate pain, elevated LDH and CPK

THANK YOU