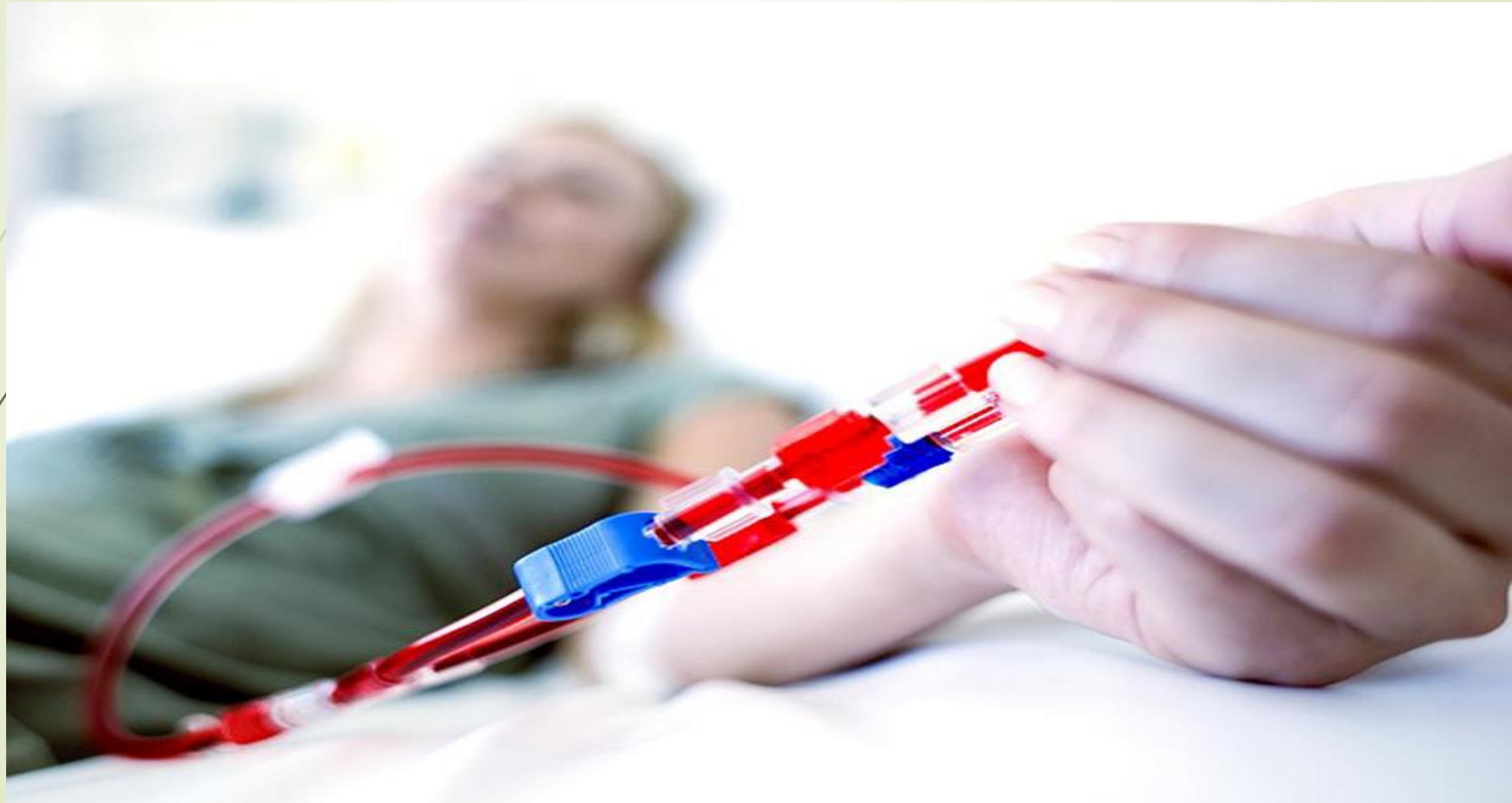
Atypical Dialysis Circumstances

Pregnancy- Drug Overdose

Emad Magdy Shawky

Hemodialysis Course, 11th OCT. 2016

10 TIPS To Approach A Pregnant Lady On Hemodialysis



1

CHANCE

Hormonal changes (Estrogen- progesterone- LH- Prolactine)

- **Anovulation (with or without Amenorrhea)**
- **Endometrial changes**

Kidney Int. 2016 May;89(5)

1

CHANCE

The Miracle Continues Against All Odds

Kidney Int. 2016 May;89(5)

1

CHANCE

❑ Increasing incidence

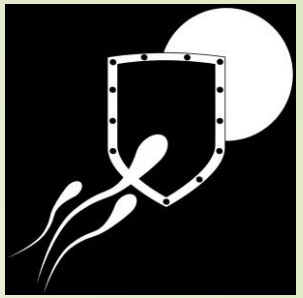
- ❖ May reach 7% of women on CHD rising from 1% 1980 (Improving Dx service, better anemia control)
- ❖ More with residual renal function.
- ❖ Less with PD.

❑ Increasing survival rates

- ❖ 1st successful 1971
- ❖ 30-50% increasing dialysis dose
  - ➢ 85% premature
  - ➢ 35% LBW (< 2kg)
  - ➢ Common complications : Respiratory distress- CP- Congenital anomalies

Kidney Int. 2016 May;89(5)

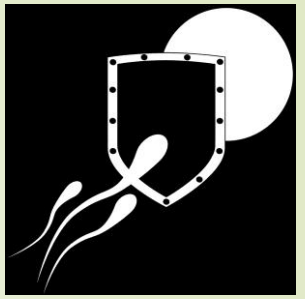
CONTRACEPTION



Medical, Ethical, And Emotional Complexities

Am J Kidney Dis. 2015 Dec;66(6):951-61

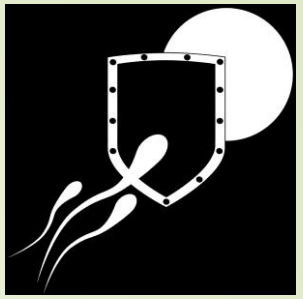
CONTRACEPTION



- The key pre-pregnancy factors predicting outcome include the following:
  - Degree of renal impairment rather than the aetiology of renal disease.
  - Control of hypertension
  - Degree of proteinuria

Am J Kidney Dis. 2015 Dec;66(6):951-61

CONTRACEPTION



Maternal Renal Outcomes According to Pre-pregnancy Serum Creatinine

Creatinine <1.5 mg/dl (130 µmol/l)

- Permanent loss of GFR in <10% of women
- Greatest risk if GFR <40 ml/min and proteinuria >1 g/day
- Major determinant of ESRD progression is hypertension
- 40% risk of preeclampsia if baseline proteinuria >500 mg/day

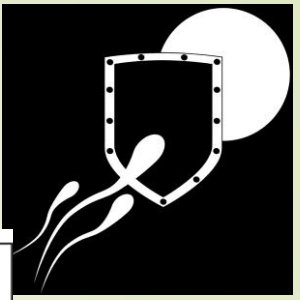
Creatinine 1.5-2.5 mg/dl (130-220 µmol/l)

- Decline or permanent loss of GFR in 30% of women
- Increased to 50% if uncontrolled hypertension
- 10% ESRD soon after pregnancy

Creatinine >2.5 mg/dl (220 µmol/l)

- Progression to ESRD highly likely during or soon after pregnancy

CONTRACEPTION

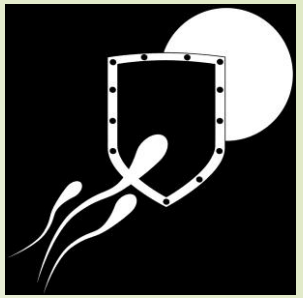


	RFH	NTPR 2001	UKTPR
Meanbirth age	34,9 weeks	36 weeks	
Mean birth weight	2204 g	2493 g	
Low birth weight(<2500g)	50%	45%	54%
Very low birth weight weight(1500g)	20%		18%
Fetal growth restriction	40.7%		8%
Small for gestation age(<10th percentile)	33%		

RFH (Royal Free Hospital)[26], NTPR 2001 National Transplatation Pregnancy Registry[27], UKTPR (UK Transplant Pregnancy Registry)[28]. (After permission from Thomson BC. Q J Med 2003; 96: 837-844).

Hippokratia. 2011 Jan; 15 (Suppl 1): 8–12.

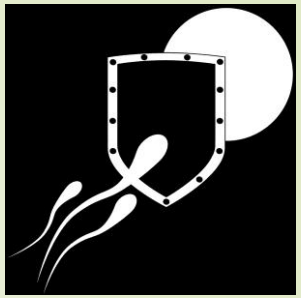
CONTRACEPTION



Pregnancy across the spectrum of chronic kidney disease

Michelle A. Hladunewich[1,2], Nir Melamad[2] and Kate Bramham[3]

Kidney International (2016) ■, ■–■; http://dx.doi.org/10.1016/j.kint.2015.12.050

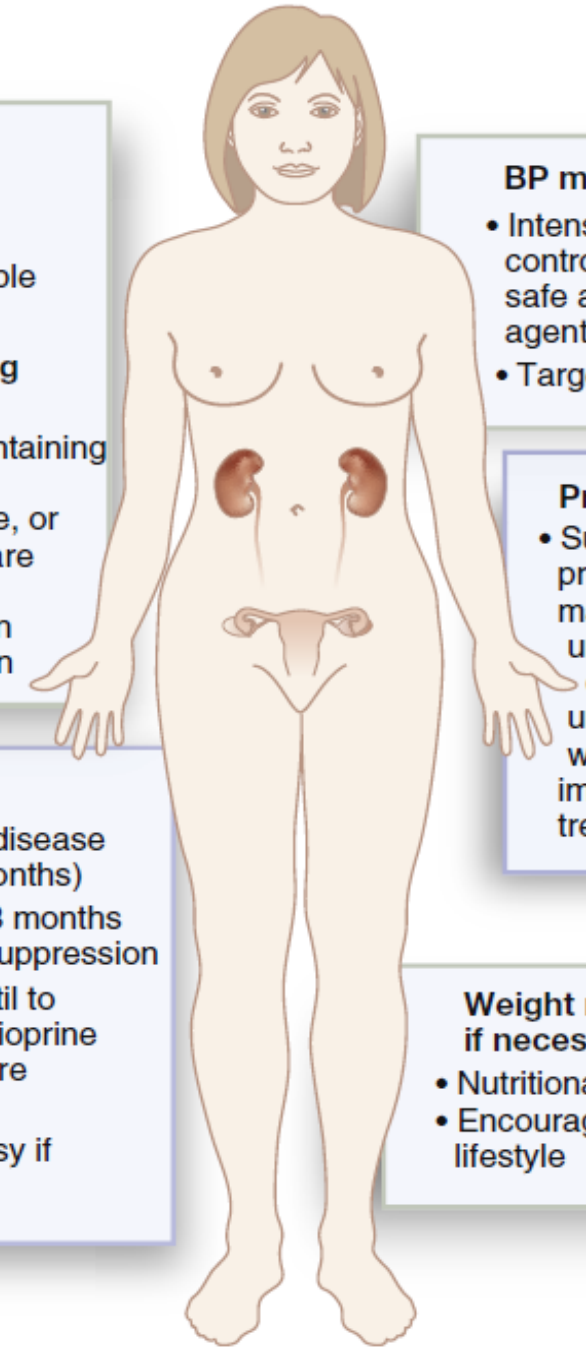


Medications when planning a pregnancy

- Initiate prenatal vitamins
- Stop medications not compatible with pregnancy (e.g., statins)

Contraception when avoiding pregnancy

- Avoid if possible, estrogen-containing preparations in women with hypertension, vascular disease, or significant proteinuria or who are smokers
- IUDs are not contraindicated in women on immunosuppression



BP management

- Intensive hypertension control with pregnancy-safe antihypertensive agents
- Target <140/90 mm Hg

Proteinuria

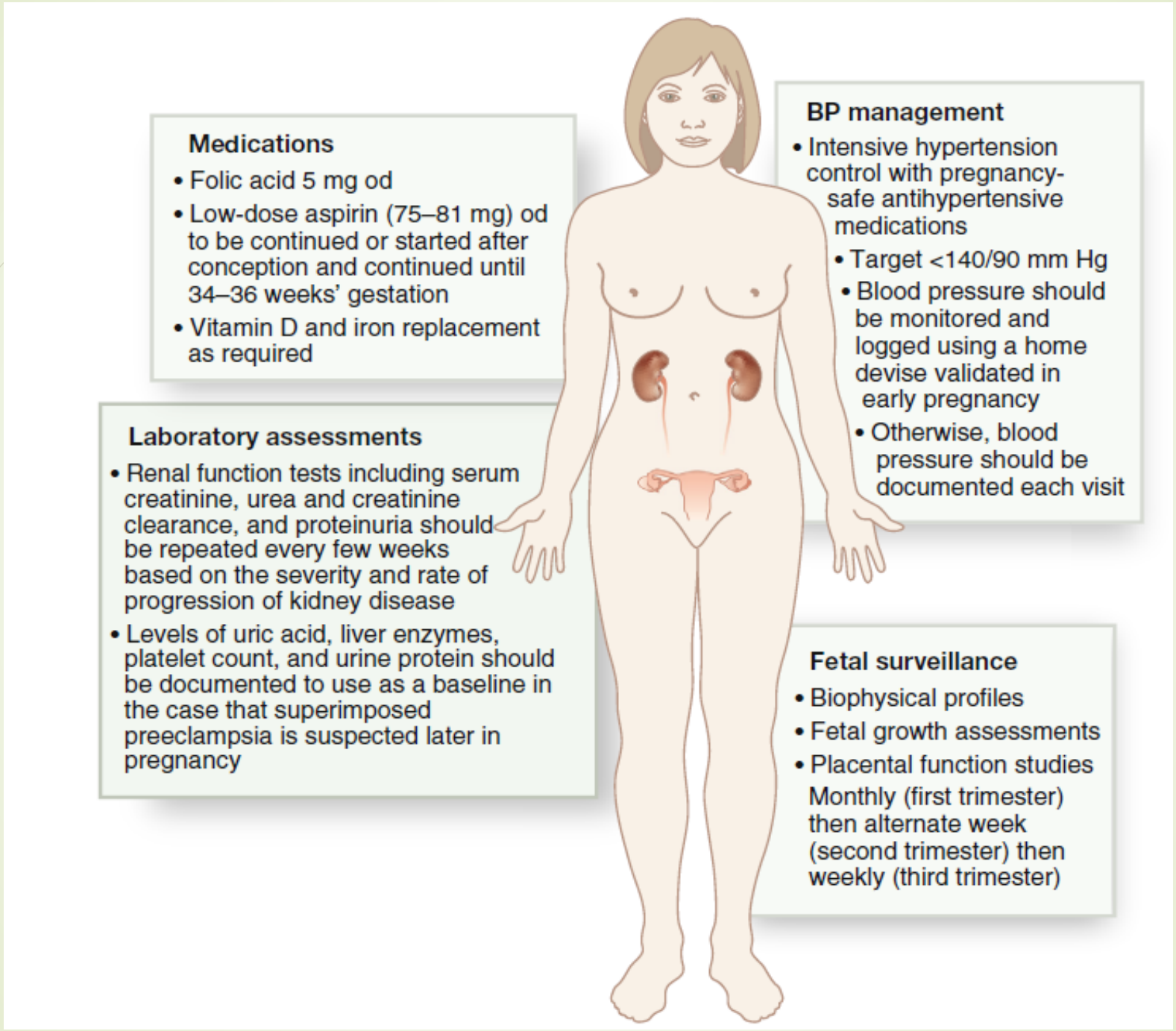
- Suppression of proteinuria with maximal ACEI/ARB until attempting conception or until conception in women with no immunological treatment options

Immunosuppression

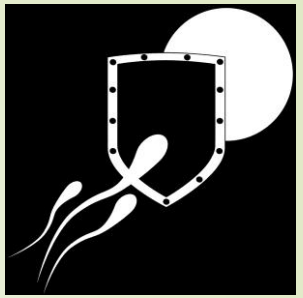
- Optimization of pre-existing disease (e.g., lupus inactivity for 6 months)
- Ensure disease stability for 3 months on pregnancy-safe immunosuppression
- Switch mycophenolate mofetil to alternative agent (e.g., azathioprine or a calcineurin inhibitor where appropriate)
- Consider repeat kidney biopsy if remission status is unclear

Weight reduction if necessary

- Nutritional consultation
- Encourage active lifestyle


Medications
• Folic acid 5 mg od
• Low-dose aspirin (75–81 mg) od to be continued or started after conception and continued until 34–36 weeks' gestation
• Vitamin D and iron replacement as required
Laboratory assessments
• Renal function tests including serum creatinine, urea and creatinine clearance, and proteinuria should be repeated every few weeks based on the severity and rate of progression of kidney disease
• Levels of uric acid, liver enzymes, platelet count, and urine protein should be documented to use as a baseline in the case that superimposed preeclampsia is suspected later in pregnancy
BP management
• Intensive hypertension control with pregnancy-safe antihypertensive medications
• Target <140/90 mm Hg
• Blood pressure should be monitored and logged using a home devise validated in early pregnancy
• Otherwise, blood pressure should be documented each visit
Fetal surveillance
• Biophysical profiles
• Fetal growth assessments
• Placental function studies
Monthly (first trimester) then alternate week (second trimester) then weekly (third trimester)

CONTRACEPTION



- IUD

Bleeding- Infection

- Oral contraceptives

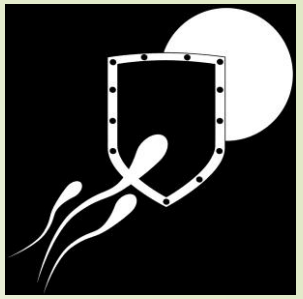
Hypercoagulability (access)

- Barriers

Safety

ACKD Journal, Vol 20, No 3 (May), 2013

CONTRACEPTION



- IUD

Bleeding- Infection

- Oral contraceptives

Hypercoagulability (access)

- Barriers

Safety

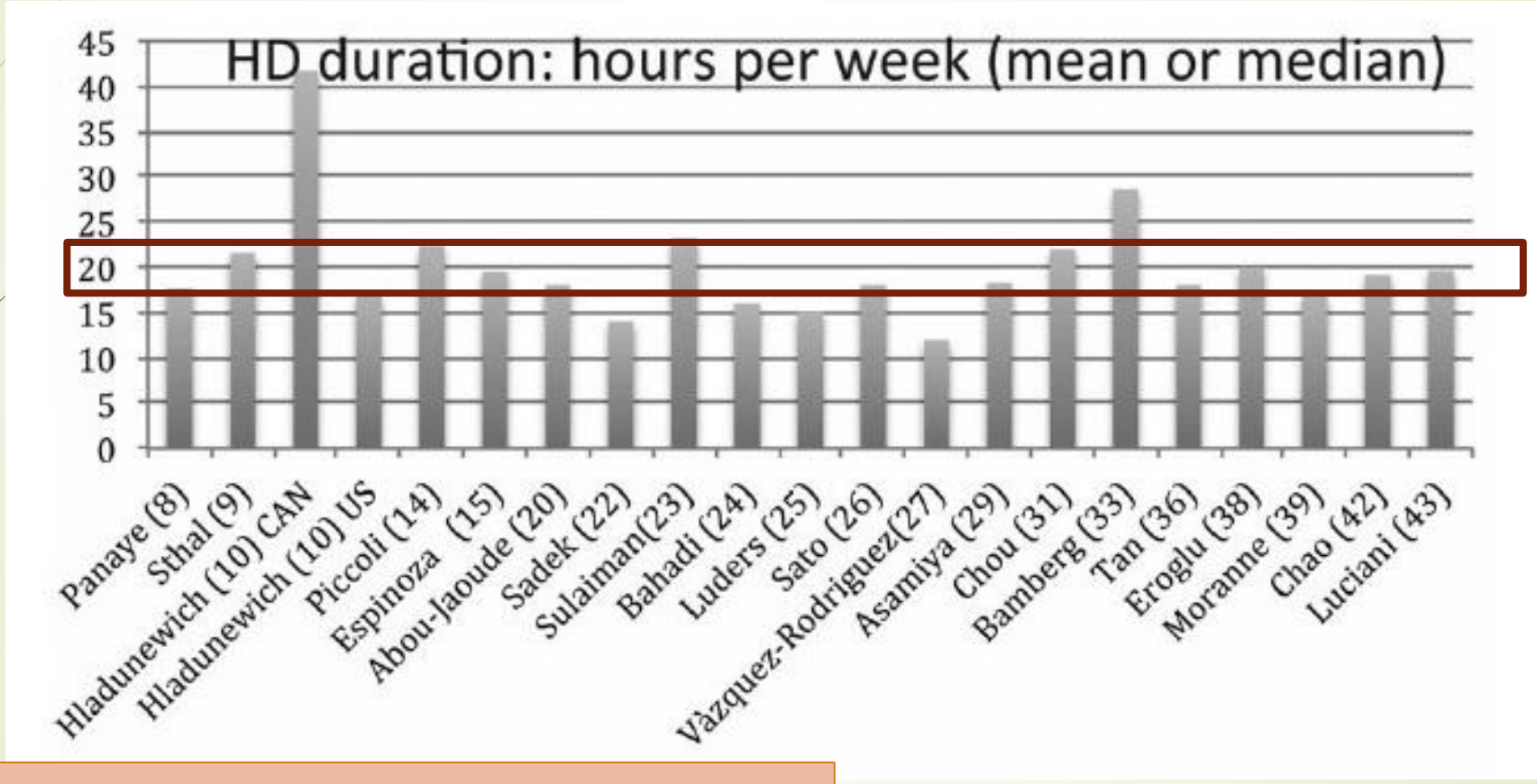
ACKD Journal, Vol 20, No 3 (May), 2013

Challenges In Prescription

- **Plasma volume Increased by 30%** >> hemodilution>>anemia
- **WT gain rate** plasma vol plus fetal and placental develop
- **Polyhydramnios** as high BUN>>fetal osmotic diuresis
- Bone and mineral metabolism **placenta converts some 25-hydroxyvitamin D3 to 1,25-dihydroxyvitamin D3**>>adjustment of vitamin D , Ca supplement
- **Respiratory alkalosis** hyperventilation (progest mechanical) – hyperemesis>>> compensation by M.Acidosis
- **EPO resistance** , cytokine release >> anemia

3.a.

DOSE AND ADEQUACY



Target BUN < 50 mg/dL
or even < 45 mg/dL

Nephrol Dial Transplant (2015) 0: 1–20

3.a.

DOSE AND ADEQUACY

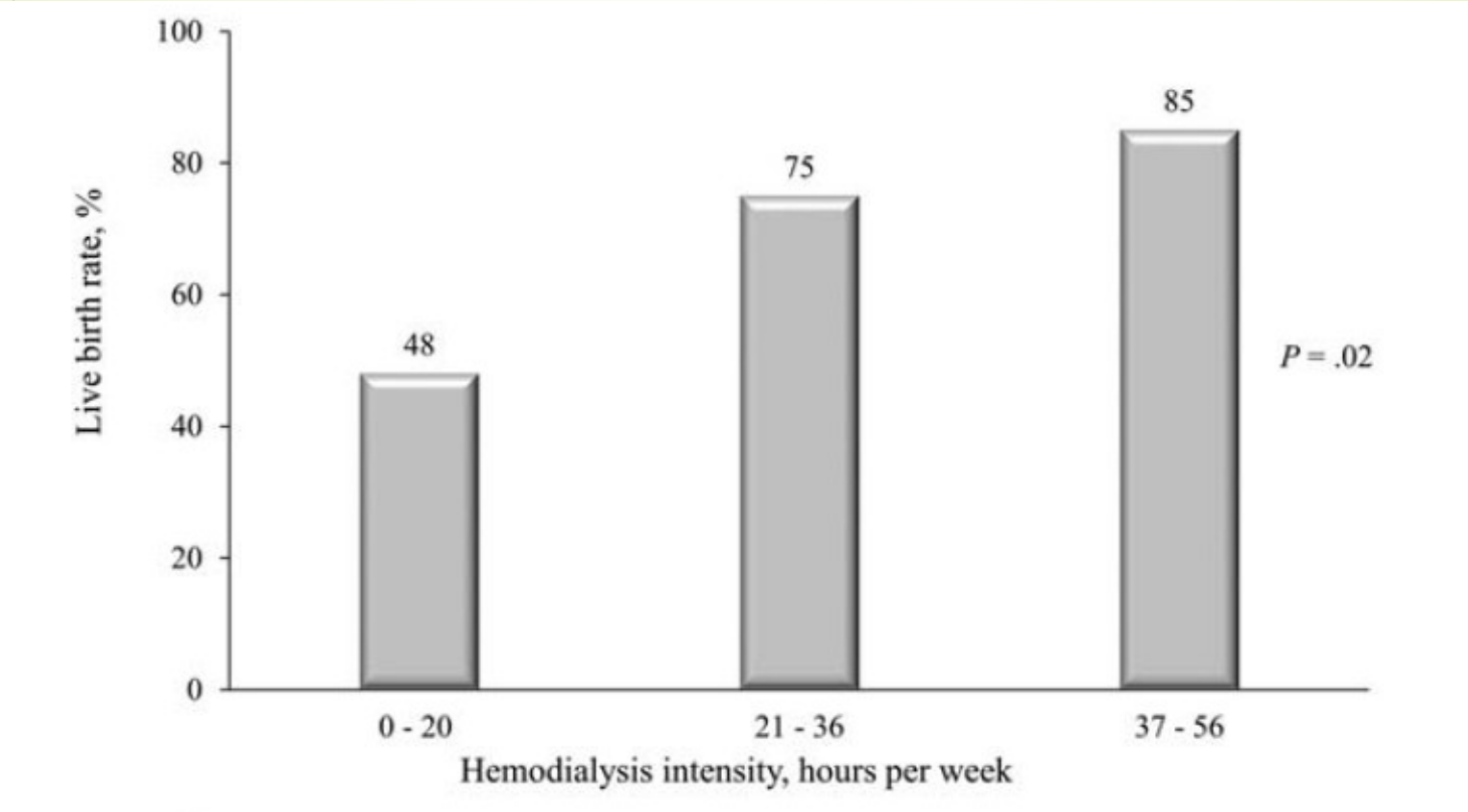
There was a trend toward better infant survival in women who received dialysis ≥ 20 hours per week and a weak correlation between numbers of hours of dialysis and gestational age(p=0.05).Seventy-nine persent of mature. The authors concluded, that increasing dialysis time may improve outcome, but prematurity remains a major cause of morbidity and likely contributes to a high frequency of long-term medical problems in surviving infant[16].

Polyhydramnios occurs usually between 19 and 20 weeks of gestation, it is associated with peak frequency of spontaneous second trimester abortion and with the onset of premature contraction and labor, and it is related to changes in fetal epidermal and renal function. It has been hypothesized that fetal skin may act as diffusing membrane permitting the extension of the fetal extracellular fluid space to the amniotic fluid causing biochemical changes of the amniotic fluid[17].

Hippokratia. 2011 Jan; 15 (Suppl 1): 8–12.

3.a.

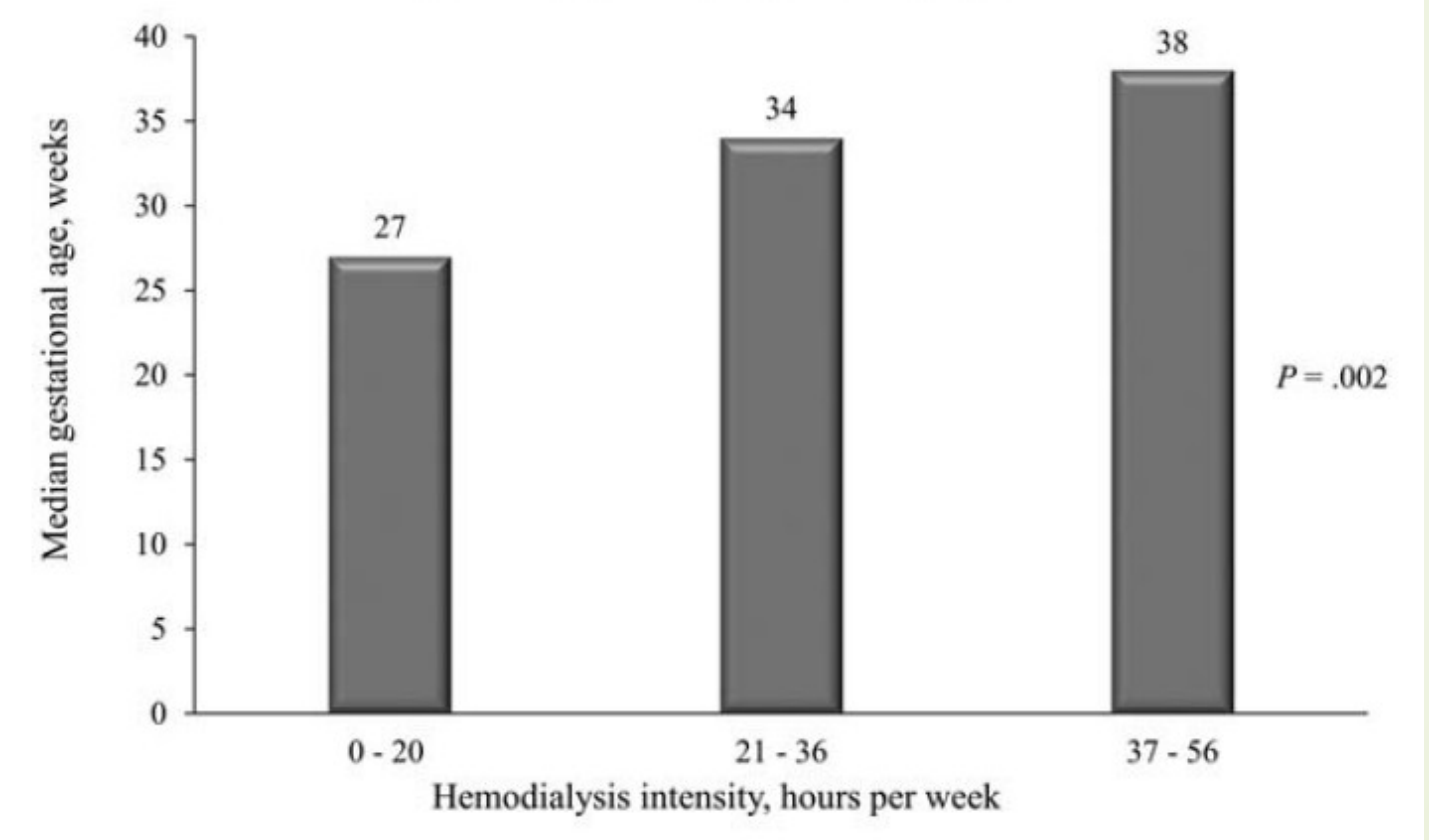
Intensive Hemodialysis Associates with Improved Pregnancy Outcomes: A Canadian and United States Cohort Comparison



J Am Soc Nephrol. 2014; 25:1103–1109.

3.a.

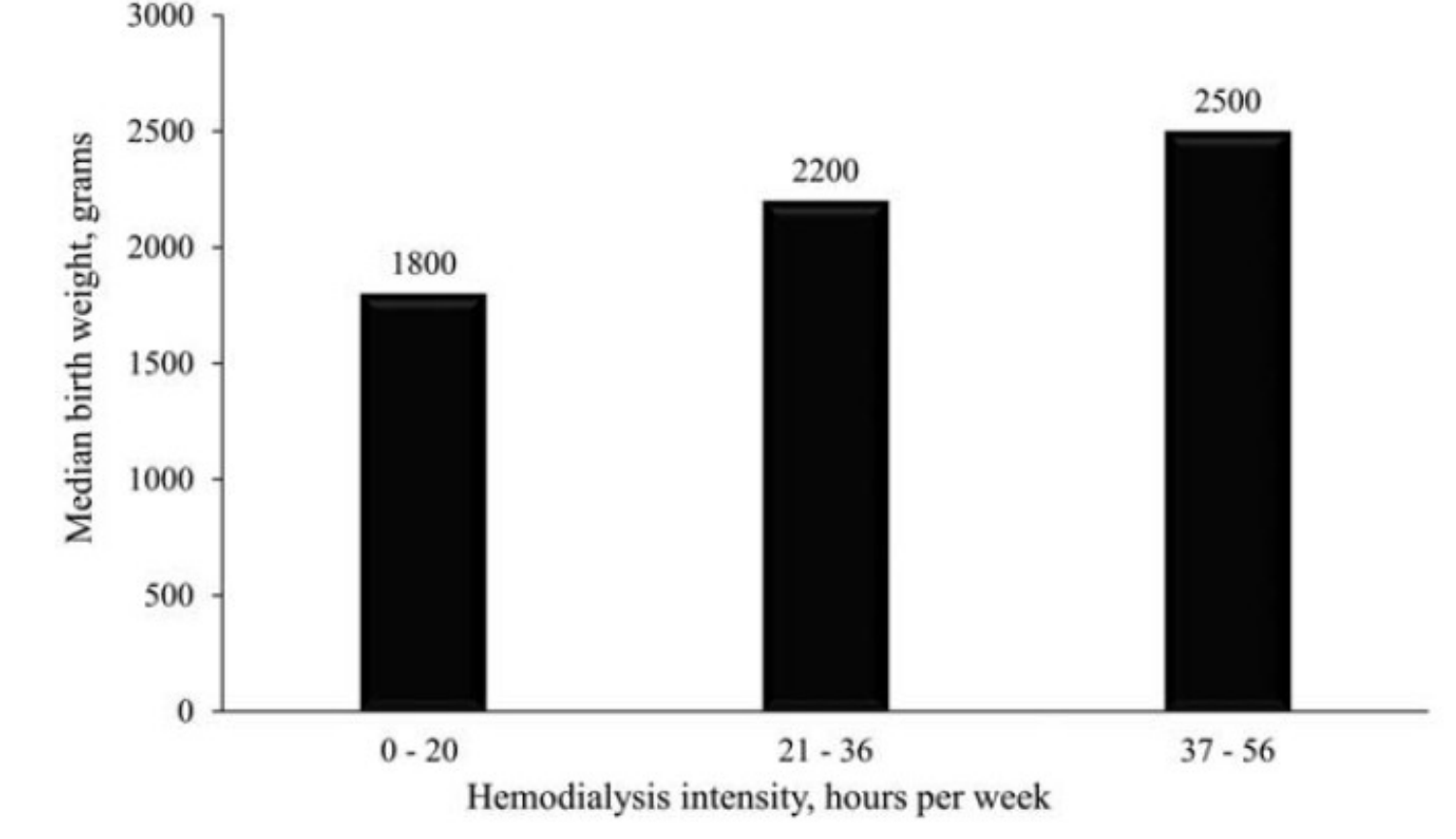
Intensive Hemodialysis Associates with Improved Pregnancy Outcomes: A Canadian and United States Cohort Comparison



J Am Soc Nephrol. 2014; 25:1103–1109.

3.a.

Intensive Hemodialysis Associates with Improved Pregnancy Outcomes: A Canadian and United States Cohort Comparison



J Am Soc Nephrol. 2014; 25:1103–1109.

3.b.

Dialyzer type, ultrafiltration volume

- **Small surface area dialysers**
- Reduce UF rate per session
- Avoid hypotension
- Avoid abrupt osmolarity changes

CLINICAL QUERIES: NEPHROLOGY 1 (2012) 205–214

3.b.

Dialyzer type, ultrafiltration volume

Dry BW assessment

- Predicted Wt gain: after 3m>> 0.5 Kg/wk
- Clinical: Bp control, (edema not reliable)
- **Hematocrit & Albumin levels**

Measure Hematocrit & Albumin at the initial first-trimester visit.

A rise in either value strongly suggests intravascular volume contraction, Opposite is not true

Advances in Chronic Kidney Disease, Vol 20, No 3 (May), 2013

3.c.

Heparin

- Pregnancy is a hypercoagulability state so theoretically there are increased requirements but it is not a rule.

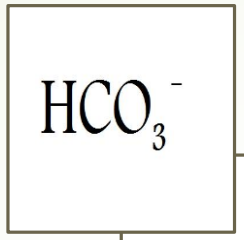
Individualization

Hemodialysis International 2016; 20:339–348.

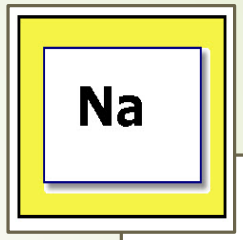
3.d.

Dialysate constituents

- **3 meq/l**
- **Intensive dialysis with risk of hypokalemia**



- **<25 meq/l**
- Target serum**18-22 mmol/l**



- **135 mmol/l**

Hemodialysis International 2016; 20:339–348

.

3.e.

Minerals and water soluble vitamins

- Give at **increased doses**, because they can be partially **removed by intensive dialysis**.
- **Folic acid** at a higher dose of 5 mg daily if on dialysis

Vitamins	
A	No supplement
E	No supplement
C	≥170 mg/d
Thiamine	3 mg/d
Riboflavin	3.4 mg/d
Niacin	≥20 mg/d
B_6	>5 mg/d
Folic acid	1.8 mg/d
Minerals	
Calcium	2,000 mg/d (from phosphate binders)
Phosphorus	1,200 mg/d
Magnesium	200-300 mg/d
Zinc	15 mg/d
Carnitine	330 mg/d

Hemodialysis International 2016; 20:339–348

BMD

placenta converts some 25-hydroxyvitamin D3 to 1,25-dihydroxyvitamin D3

- **Phosphate**: monitored frequently- **may stop phosphate binders** or need supplementation (important to fetal skeletal development)
- **Calcium:** increase dialysate calcium to **1.75 mmol/l – oral supplementation (1-2 g/d)-** take care of hyper or hypocalcemia

Kidney Int. 2016 May;89(5)

Anemia

- Target : 11g/dl.
- EPO : increase dose by 50%.
- Iron : monitored monthly (IV supp).
- CBC weekly.
- <8g/dl>> blood trasnfusion.

Kidney Int. 2016 May;89(5)

Hypertension And Superimposed PET

Drug	Placental passage	Teratogenicity	Fetal/neonatal effects	Safe in pregnancy	Safe in breast feeding	FDA
Antihypertensive medications						
Methyldopa	✓	✗	✗	Often used first line Maternal side effects may limit use (e.g., drowsiness)	✓	B
Beta-blockers	✓	✗	Fetal growth restriction in some studies Fetal bradycardia with atenolol in first trimester	Labetalol often used first line	Excreted into breast milk, but widely used without reports of neonatal side effects	C
Ca-channel antagonists (e.g., nifedipine, amlodipine)	✓	✗	✗	Usually used second line in conjunction with methyldopa or labetalol	Excreted into breast milk (<5% therapeutic dose), but widely used without reports of neonatal side effects	C
Furosemide or HCTZ	✓	✗	Provokes diuresis in fetus	Theoretically, may cause intravascular volume contraction and reduce placental perfusion, but can be used with caution for fluid overload or difficult-to-control hypertension	Excessive thirst in breast-feeding women; large doses may suppress lactation	C
Hydralazine	✓	✗	✗	Usually used in combination with sympatholytic agent to prevent reflex tachycardia	Excreted into breast milk, but no adverse effects reported	C
ACE inhibitors/ARB	✓	Second and third trimester teratogenicity includes oligohydramnios, neonatal anuria and renal failure, limb contractures, craniofacial abnormalities, pulmonary hypoplasia, and patent ductus arteriosus	Prolonged exposure can result in renal insufficiency and impairment in the urine-concentrating ability likely due to papillary atrophy and disturbed formation of the medullary concentration gradient	✗ —stop at conception	Enalapril, captopril, and quinapril are excreted in small amounts with no adverse effects reported	D

MA Hladunewich et al.: Pregnancy and chronic kidney disease

When to suspect pre-eclampsia?

Aspirin (75–150 mg/day)

The aim of aspirin is for the prevention of preeclampsia or perinatal death

Advances in Chronic Kidney Disease, Vol 20, No 3 (May), 2013

Fetal Assessment

- **Serial ultrasound examinations** are important for the early detection fetal growth restriction
- Assessment of the fetal heart rate (particularly during **the last portion of a session)**

Kidney Int. 2016 May;89(5)

Immune-suppressive Drugs

Immunosuppression medications						
Prednisone	Limited	Possible increase in oral cleft palate	Rare—except at large doses (cataracts, infection and adrenal insufficiency)	Maternal side effects include bone loss and possible osteonecrosis, gestational diabetes, hypertension, cataracts, adrenal insufficiency	✔ (Breast-feeding is not encouraged if dose >60 mg daily)	C
Azathioprine	✔	Possible sporadic congenital abnormalities	Transient immune alterations in neonates	✔	✔	D
Tacrolimus and cyclosporine	✔	✗	Hyperkalemia and renal impairment	✔ —usually increased doses required to achieve prepregnancy target levels Hyperkalemia, worsening hypertension, and	Excreted into breast milk, but 0.23%–0.5% of maternal weight-adjusted dose	C

MA Hladunewich et al.: Pregnancy and chronic kidney disease

Immune-suppressive Drugs

				nephrotoxicity are possible		
Mycophenolate mofetil	✓	Congenital abnormalities in 22.9%: cleft lip and palate, absent auditory canal, hypertelorism, microtia, brachydactyly of the fifth finger, limb abnormalities, and hypoplastic toenails	✗	✗ – STOP preconception	✗	D
Cyclophosphamide	✓ —animal data	✓	Chromosomal abnormalities and cytopenia	✗ (Only after the first trimester in life-threatening maternal disease)	✗	D
Sirolimus	Unknown	Unknown	Toxicity in animal studies, but not teratogenicity	✗ —Stop preconception	Unknown	C
Everolimus	Unknown	Unknown	Toxicity in animal studies, but not teratogenicity	✗ —Stop preconception	Unknown	C
Alemtuzumab	Unknown, but probable	Unknown	Unknown	Manufacturer recommends avoid pregnancy for at least 6 months after exposure	Unknown, but possible transfer into milk although neonate gastrointestinal digestion	C
Basiliximab	Unknown, but probable	Unknown	No toxicity or teratogenicity in monkeys	Manufacturer recommends avoid pregnancy for at least 4 months after exposure	Unknown but possible transfer into milk although neonate gastrointestinal digestion	B
Antithymocyte globulin	Unknown, but probable	Unknown	Unknown	Do not administer in pregnancy	Unknown but possible transfer into milk although neonate gastrointestinal digestion	C
Intravenous immunoglobulin	✓	✗	None reported	✓	✓	C

MA Hladunewich et al.: Pregnancy and chronic kidney disease

When to Terminate Pregnancy?

Indications for Delivery in Women with Preeclampsia or CKD
Inability to control blood pressure
Deteriorating glomerular filtration rate
Neurologic abnormalities, such as eclampsia, headaches with accompanying clonus and hyperreflexia, or repeated visual scotomata
Worsening thrombocytopenia
Increasing liver transaminase levels
Failure of fetal growth
Reversed or absent end-diastolic flow on cardiotocography

Comprehensive Clinical Nephrology. 5th edition,

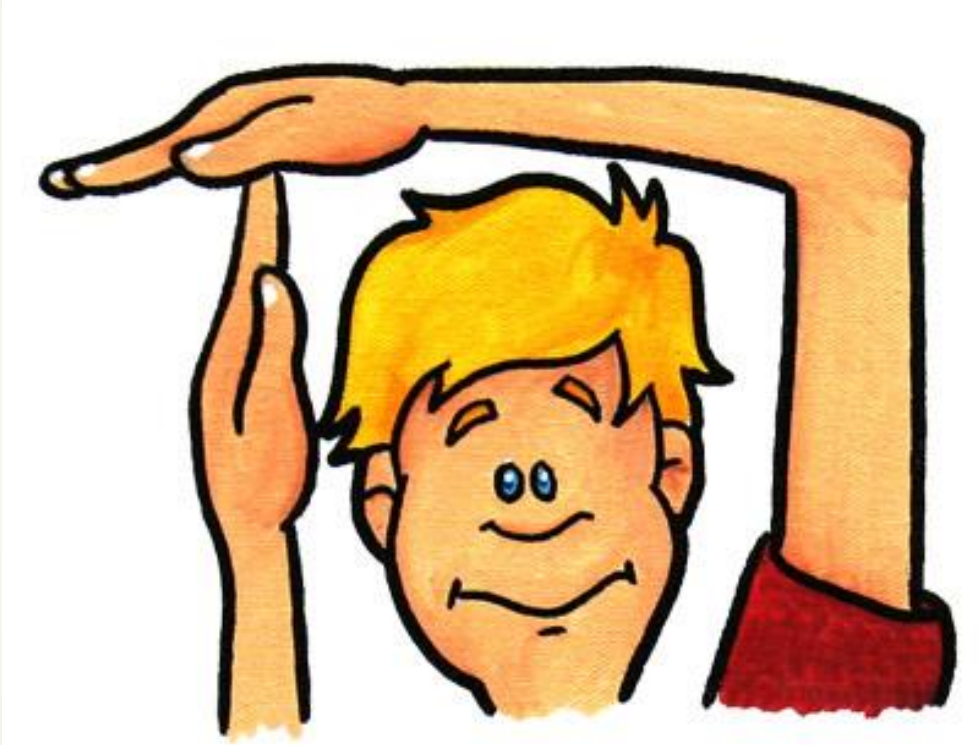
Breast Feeding

RESEARCH ARTICLE

PLoS One. 2015 Nov 16;10(11)

Got Milk? Breastfeeding and Milk Analysis of a Mother on Chronic Hemodialysis

- Significant variations in breast milk composition between pre- and post-HD samples suggest that **breastfeeding might be preferably performed after dialysis treatment.**
- In summary, our findings indicate that breastfeeding can be considered a **viable option for newborns of mothers on dialysis.**



Enhanced Drug Elimination

Case 1

- A 32 year old woman ingested 20 lithium carbonate 300 mg tablets in a suicide attempt
- She is drowsy and her speech is slurred
- Her serum **Li = 6 mEq/L**
- **Hemodialysis needed?**

- Na = 140
- K = 4.0
- Cl = 110
- HCO3 = 26
- BUN = 8 Cr = 1.0
- Glucose = 98
- EtOH = 0.16 gm% U Tox (+) benzo's

Blood Ethanol Result	Interpretation
Equal to or above 80 mg/dL (0.08%)	Legal intoxication in all states
80 to 400 mg/dL (0.08% to 0.40%)	Increasing impairment and depression of central nervous system likely
Above 400 mg/dL (>0.40%)	Loss of consciousness likely; potentially fatal

Case 2

- A 42 year old man brought from a board and care with mumbling, tremor, has a seizure in the ED
- Chronic Li use, no other meds
- BUN = 44 Cr = 2.6 Na = 148
- **Li = 3.8 mEq/L**
- Repeat Li 4 hours later = **3.6 mEq/L**
- **Hemodialysis needed?**

Enhanced Drug Elimination

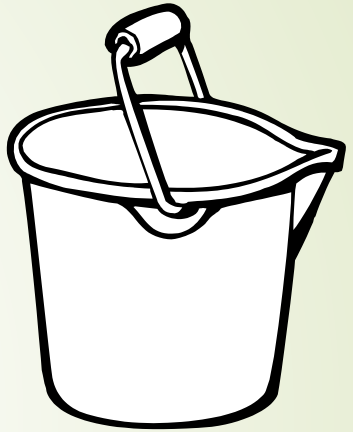
- Who needs it?
- Will it work?
- What's the best technique?

Who needs it?

- **Critically ill despite supportive care**
  - eg, intractable shock
- **Known lethal dose or blood level**
  - eg, salicylate; methanol / ethylene glycol
- **Usual route of elimination impaired** and total body elimination can be **increased by 30% or more**
- **Risk of prolonged coma**
- **Ingestion of a toxin with serious delayed effects**

Will it work?

- Volume of distribution:
  - **Is the drug accessible?**
  - **How big a volume to clear?**



- Clearance (CL):
  - **Does the method efficiently cleanse the blood?**

Volume of distribution (Vd)

- **Volume of distribution (Vd) is the theoretical dispersion of the substance in the body.**
  - Amount of drug in the body / concentration of the drug in plasma.
  - Affected by obesity, ECF volume
  - **Low Vd is < 1 L/kg**

Clearance

- Clearance is the theoretical **volume of blood from which the substance is removed per unit time.**
- Depends on the ability of a molecule to pass across the GBM into the urine, a function of **molecular size, charge, urine flow rate** (ml / min). Solute removal is via **convection (filtration) & modified by tubules.**

Two drugs with the same CL

Dialysis CL	Vd	Fraction eliminated in 60 min of dialysis
200 mL/min	500 L	1%
200 mL/min	50 L	17%

$$T_{1/2} = 0.693\ Vd / CL$$

Which method?

- Hemodialysis
- Continuous hemofiltration
- Hemoperfusion
- MARS

Hemodialysis (HD)

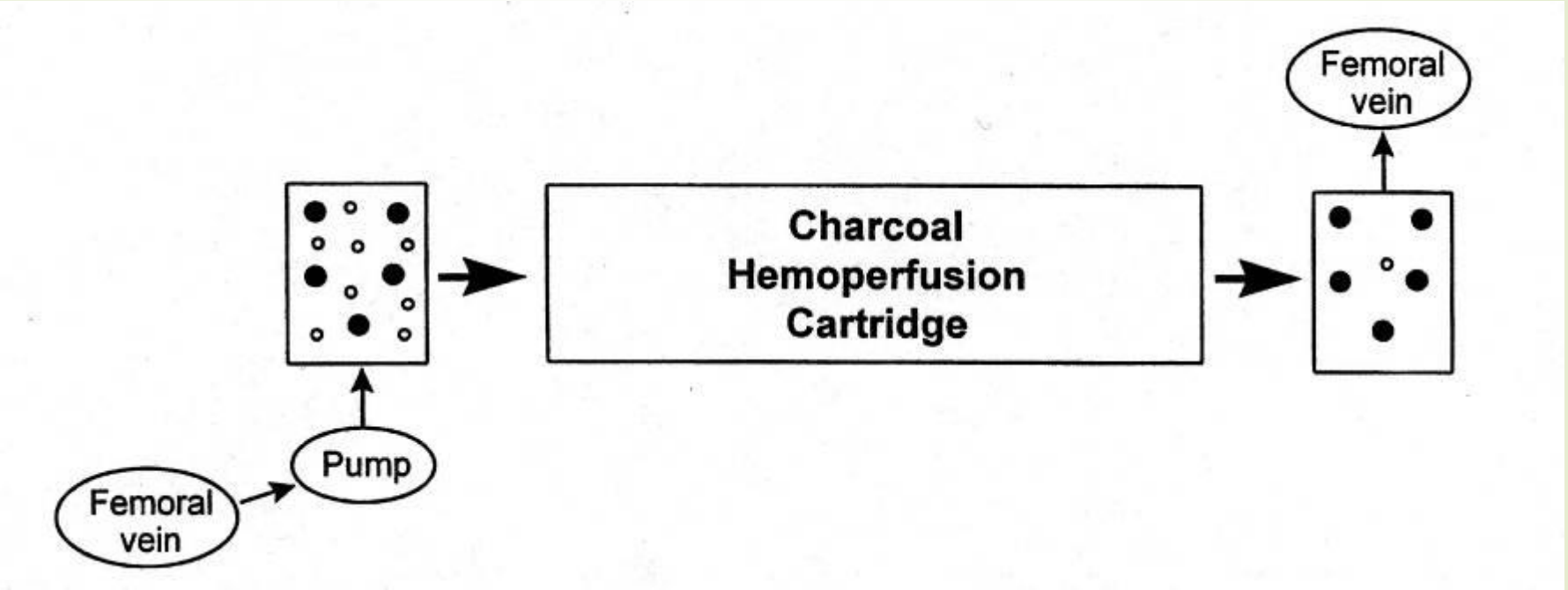
- Toxic substance must be **water soluble, have low MW, low protein binding, and low volume of distribution**
- Clearance of the toxin depends on **membrane surface area (& type), blood and dialysate flow rates**
- **High-flux membranes** can also remove higher MW toxins
- Risk for post-HD **"rebound" due to redistribution of toxin**

Continuous techniques

Continuous hemofiltration (CVVH, CVVHD)

- Blood passes through large hollow pore fibers, allowing **convective removal** of molecules up to 40kDa.
- Useful in **unstable patients**
- Prolonged duration of therapy, **minimizes rebound effects**
- CL lower than HD or HP, **but it can be performed 24 hrs/day**

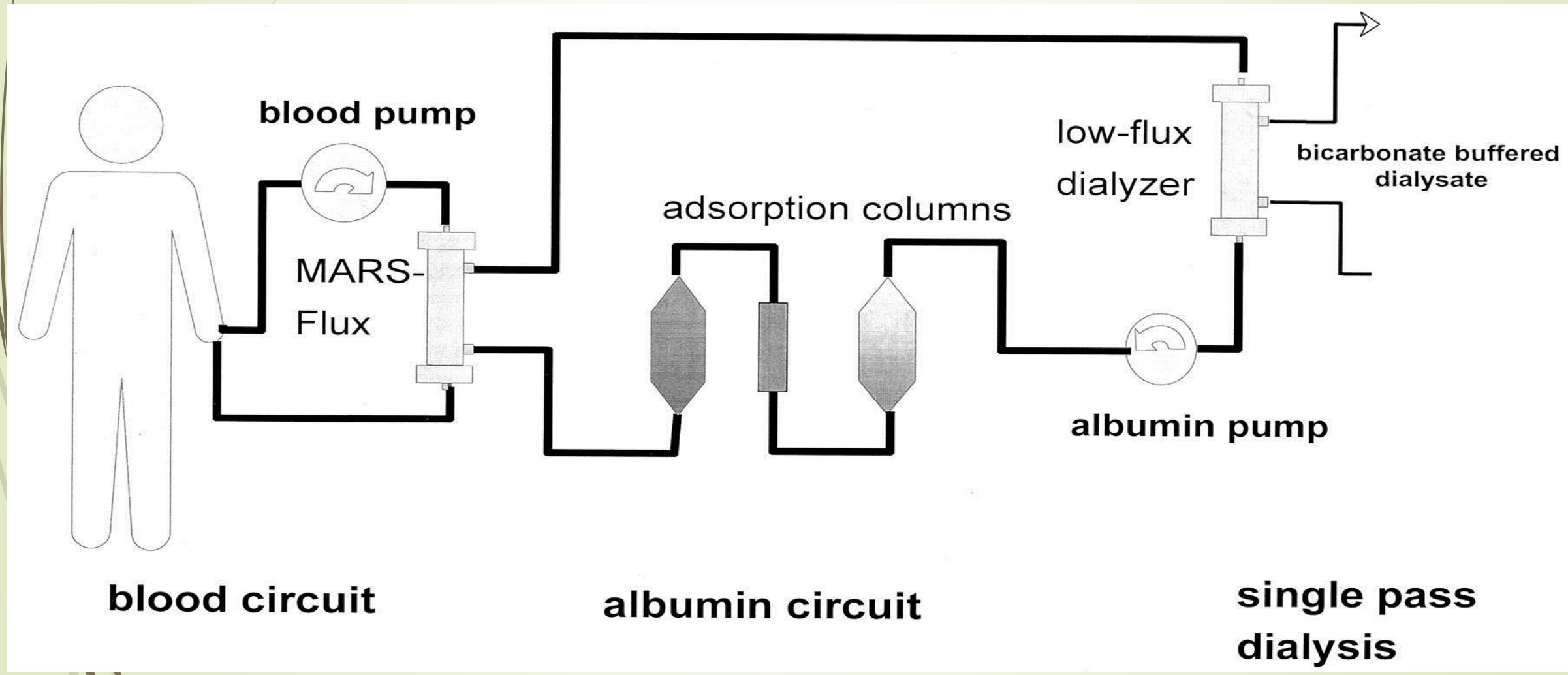
Hemoperfusion



- Blood passes through a **cartridge with sorbent material able to absorb the toxin**
- Charcoal based, synthetic resins, anion exchange
- Toxic substance must **have binding affinity to the sorbent & have a low volume of distribution**
- **Charcoal** efficiently removes molecules in 1000-1500 kDa range, but **doesn't remove protein-bound molecules**
- **Resins** more effective with **protein/lipid-bound toxins**
- Generally ***declining modality*** due to limited use, poor life of cartridges (change q2-3hrs), more technically difficult to perform, unable to correct acid-base, fluid, electrolytes
- Could combine with HD however (in series)

MARS

Blood purification system aimed at removing albumin-bound toxins



Extracorporeal properties

	Hemo-dialysis	Hemo-filtration	Hemo-perfusion
Solubility	Water	Water	Water or lipid
Molecular weight	< 500 Da	< 40 kDa	< 40 kDa
Protein binding	Low (< 80%)	Low	Low or high
Volume of distribution (Vd)	< 1 L/kg	< 1 L/kg	< 1 L/kg
Endogenous clearance	< 4 ml/min/kg	< 4 ml/min/kg	< 4 ml/min/kg
Distribution time	Short	Longer	Short

Some Poisonings for Which Extracorporeal Removal May Be Indicated

Hemodialysis	Hemofiltration	Hemoperfusion
Alcohols	Aminoglycosides	*Amanita* mushroom
Ethanol	Desferrioxamine	Barbiturate
Methanol	Sodium edetate	Carbamazepine
Ethylene glycol	Theophylline	Meprobamate
Isopropanol		Theophylline
β-Blockers		
Atenolol		
Sotalol		
Lithium		
Meprobamate		
Metformin		
Salicylates		
Theophylline		

Lithium

- Alkali metal Widely used for bipolar disorder
- Therapeutic range **0.6-1.2 mEq/L**
- **Toxicity = mainly CNS**
  - **Tremor, slurred speech, muscle twitching**
  - **Confusion, delirium, seizures, coma**
  - **Recovery may take weeks**
- Toxicity may occur as a result of ***acute*** **overdose or *chronic* use**

Pharmacokinetics

- **Completely absorbed orally**
  - Volume of distribution approx 0.8 L/kg
  - Slow entry into CNS
  - Initial serum levels do NOT reflect brain levels
- **Eliminated entirely by the kidneys**
  - Half-life 14-20 hours
  - Prolonged in patients with renal insufficiency
  - Promoting saline excretion hastens Li removal

Case 1

- A 32 year old woman ingested 20 lithium carbonate 300 mg tablets in a suicide attempt
- She is drowsy and her speech is slurred
- Her serum **Li = 6 mEq/L**
- **Hemodialysis needed?**

- Na = 140
- K = 4.0
- Cl = 110
- HCO3 = 26
- BUN = 8 Cr = 1.0
- Glucose = 98
- EtOH = 0.16 gm% U Tox (+) benzo's

Blood Ethanol Result	Interpretation
Equal to or above 80 mg/dL (0.08%)	Legal intoxication in all states
80 to 400 mg/dL (0.08% to 0.40%)	Increasing impairment and depression of central nervous system likely
Above 400 mg/dL (>0.40%)	Loss of consciousness likely; potentially fatal

Osmolar Gap

- Calculated Osm - Measured Osm = Osmolar gap
- Calculated Osm = 2 (Na) + Glu / 18 + BUN / 2.8
- Significant OG if > 15 mOsm/L

Drug (MW)	Toxic level	Corr. Factor	Toxic ΔOG
Methanol (32)	>50	3	17
Ethanol (44)	>400	4.5	88
Ethylene glycol (62)	>25	5	5
Isopropanol (100)	>350	5	75

Case 2

- A 42 year old man brought from a board and care with mumbling, tremor, has a seizure in the ED
- Chronic Li use, no other meds
- BUN = 44 Cr = 2.6 Na = 148
- **Li = 3.8 mEq/L**
- Repeat Li 4 hours later = **3.6 mEq/L**
- **Hemodialysis needed?**

case 1 . . .

- The Poison Control Center was consulted about hemodialysis
- The toxicologist advised:
  - ***IV saline at a rate of 150 cc/hr***
  - ***Recheck serum Li in 4 hours***

- **After 4 hrs, the Li was 2.2 mEq/L**
- **A 3rd level 4 hrs later was 1.1**
- **The patient gradually recovered from her alcohol and benzodiazepine intoxication**

Acute vs Chronic Li

- **Acute:**
  - High level, drops rapidly
  - Absent symptoms
- **Chronic:**
  - Often associated w/ renal insufficiency, DI
  - Occurs gradually
  - Symptoms more severe, even with lower levels (eg, 2 - 2.5 and above)

Lithium and dialysis

- serum level > 6? 8? 10? (acute)
- level > 4 ? (chronic)
- level 2.5-4 with severe Sx?

- Solute is often distributed across at least one remote body compartment **that is not directly accessible during HD.**

- If there is any resistance to solute movement between the accessible and the remote compartments, **disequilibrium will develop** over the dialysis session, reducing the efficiency of toxin removal (e.g, lithium) and will manifest **as a large postdialysis rebound**.

Extending the HD session beyond 4 hours can to some extent ameliorate rebound, but intermittent HD is an inefficient process that depends on the solute concentration presented to the dialyzer **so increasing dialysis session frequency can help**.

Lithium: summary

- 2-compartment model
  - Early levels misleadingly high
- Acute vs chronic intoxication
- Dialysis is not rapidly effective
  - Li is slow to leave intracellular compartment
- IV fluids often the best bet

Alcohols

- The ingestion of **as little as 1 g/kg of either methanol or ethylene glycol** is potentially lethal.
- Poisoning should be suspected in any patient presenting with nausea, vomiting, abdominal pain, impaired consciousness, convulsions, severe metabolic acidosis, **AKI and complicated by optic nerve damage if not treated.**
- The urine should be examined for the presence of needle shaped crystals of **calcium oxalate monohydrate** which are pathognomonic for ethylene glycol toxicity.
- Ethylene glycol is metabolized to glycolic acid and oxalate, resulting in **renal tubular injury and obstruction.**

Methanol, Ethylene Glycol

- Indications for dialysis:
  - Elevated level > 50 mg/dL
  - Severe acidosis
  - Increased osmolal gap > 10-15 mmol/L
- Notes:
  - HD only - not adsorbed to AC: Continuous extracorporeal treatment is less effective in removing ethylene glycol and methanol but may be used if intermittent HD is not available.
  - Give blocking drug (EtOH, 4-MP) - Note: need to increase dosing during dialysis