

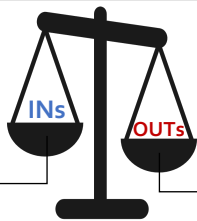
ACHIEVING A NEGATIVE FLUID BALANCE

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ADVANTAGES OF A NEGATIVE FLUID BALANCE:

- Volume overload is very common in the later (e.g. de-escalation) phases of critical illness.
- Achieving a negative fluid balance is key to liberation from MV, mobility, & ultimate recovery.



In people with sepsis, AKI, or who are post-op, risk of mortality **increased by 1.19x per liter** of positive fluid balance. Fluid overload (FO) is defined as:

$$FO(\%) = \left[\frac{\text{Fluid In} - \text{Fluid Out}}{\text{ICU admit wt}} \right] * 100$$

MINIMIZE INs

USE FLUIDS PARSIMONIOUSLY IN RESUSCITATION

Assess **fluid responsiveness** and/or **fluid tolerance** prior to boluses (**goal directed** instead of **empiric** fluids); examples include [VExUS](#), [Lung B-lines](#), [EtCO2](#), [PPV](#), PAC, [NICOM](#), etc

SWITCH IV TO PO

[Earlier IV to PO transitions](#) can limit IV fluids. Antibiotics & electrolyte replacements can be large volumes (>1 L/day)

USE HIGH CONCENTRATION MEDICATIONS

[Concentrate medications](#) for CVCs. Vasopressors, abx, & electrolyte replacement can be concentrated (e.g. at 'maximum' dose, 16 mg norepinephrine saves 2.1 L/day compared to standard 4 mg conc)

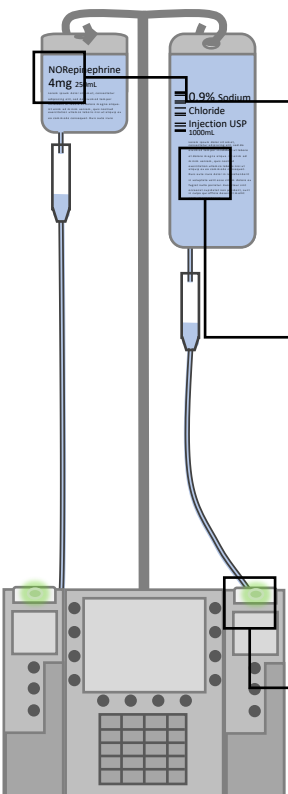
AVOID MAINTENANCE FLUIDS

ICU patients seldom require MIVF to replace insensible losses. [MIVF can be a huge fluid load](#). Even "KVO" infusions can be significant (e.g. 15 ml/hr = 2.7 L/week)

REMOVE UNECESSARY MEDS

Consider removing unnecessary IV meds to limit fluids. (e.g. low dose esmolol gtt can be 750 ml/day)

On rounds, always try to reduce the number of infusion pumps attached to the patient



MAXIMIZE OUTs

BOLUS LOOP DIURETIC

Assess UOP q 2hr

If no response, double the dose

Once an effective dose is found

Schedule more BOLUSES or start DRIP

consider THIAZIDE

consider SPIRONOLACTONE

consider ACETAZOLAMIDE

Consider ULTRAFILTRATION & RRT

Start with **LOOP DIURETICS** which are **short acting and rapidly titrated to achieve UOP**
FUROSEMIDE – Start with 20-40 mg IV (diuretic naïve), higher doses required in renal failure (dose = 30*Cr) or if on home diuretics (dose = 2x home dose); double dose q2 hrs until response or maximum dose reached (160-200 mg); 5-40 mg/hr (rebolus w/ increases), duration 6-8 hrs
BUMETANIDE – Start with 1 mg, max dose 10 mg; 0.5-2mg/hr, duration 6-8 hrs
TORSEMIDE – Start with 10-20 mg, max dose 100-mg; duration 4-6 hrs

Equivalent dosing of loop diuretics: furosemide 40 mg PO = furosemide 20 mg IV = bumetanide 1 mg PO/IV = torsemide 20 mg PO/IV = ethacrynic acid 50 mg IV/PO

Add a **THIAZIDE** to augment diuresis, address diuretic resistance, & to correct hypernatremia
CHLORTHIAZIDE 500-1000mg IV daily, duration is 50-60 hrs
METOLAZONE 5-10 mg PO daily, lasts 24-48 hrs
INDAPAMIDE – 5-10 mg PO daily

Add a **SPIRONOLACTONE** (or ENaC INHIBITOR) to normalize Potassium homeostasis especially in high aldosterone states (CHF, Cirrhosis)
SPIRONOLACTONE – 25-100mg PO daily; ideal furosemide:spironolactone ratio is 20:50
AMILORIDE – 5-10 mg PO daily

Add **ACETAZOLAMIDE** to correct a contraction metabolic alkalosis & further augment diuresis.
ACETAZOLAMIDE – 500 mg IV daily; increase to maximum of 500 mg TID

ULTRAFILTRATION is indicated for removal of fluids in volume overloaded patients who are refractory to diuresis. Timing is controversial. [Early nephrology consult may be associated with improved survival](#) in AKI.

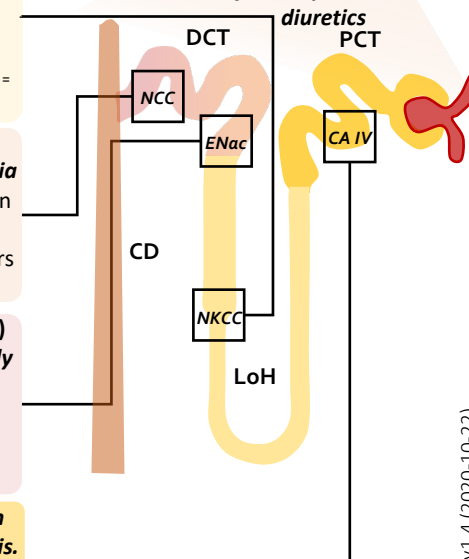
Evaluation of a patient with diuretic resistance

R/o compression
 POCUS exam to look for tense ascites or other etiologies

Optimize renal perfusion
 Perfusion = MAP - CVP
 Keep MAP > 65mmHg, reduce venous congestion (via fluid removal)

Exclude obstruction
 POCUS exam of bladder and kidneys to look for hydronephrosis

Sequential targeting of the nephron with diuretics



SPECIFIC CIRCUMSTANCES

- Hypoalbuminemia** – use bumetanide over furosemide (less albumin binding)
- Cirrhosis** – be cautious about over diuresis (risk for hepatorenal sx); use a 50:20 ratio of spironolactone:furosemide; check urine Na/K to evaluate efficacy of diuresis
- Nephrotic Sd** – 2x doses of loop diuretics

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