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HYPOTHETICAL CASE STUDY

Acute Kidney Failure and Fluid Overload in a Patient with Acute Decompensated Heart Failure

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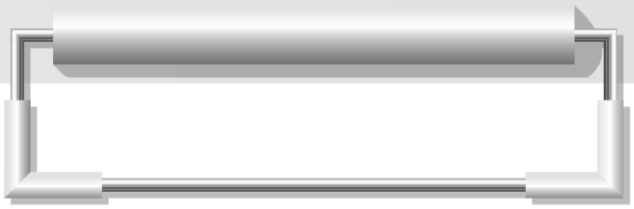
I INITIAL PRESENTATION



Patient presenting

76 y.o male presents to the ED with complaints of shortness of breath progressively worsening over the past 5 days

- Initial labs BP 146/92, HR 112, RR 28, Temp 99.2 F, oxygen saturation on room air 84%
- Na 125, K 4.8, Cr 1.05, WBC 7.6, Hgb 14.2, BNP 1500 pg/ml, Troponin x 2 0.08 ng/ml, 0.06 ng/ml
- CXR Bilateral congestion
- ECG rate 112 atrial fibrillation
- Urine output 10 cc recorded over the past 2 hours
- Body weight: 82 kg

Medical history

- 4 prior admissions for CHF exacerbation in the past year, most recent admission last month
- CABG 4-vessel 10 years ago
- Diastolic heart failure grade 2
- Systolic heart failure EF 35%
- Hypertension x 30 years

Medications

Aspirin 81 mg po qd
Plavix 75 mg po qd
Coreg 3.125 mg po bid
Apixaban 5 mg po bid
enalapril 5 mg po qd
Furosemide 40 mg po bid

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I INITIAL PRESENTATION DISCUSSION

Management of Acute Decompensated Heart Failure (ADHF)

A. ADHF is characterized by the development of shortness of breath, generally associated with rapid accumulation of fluid within the lungs.[1]

B. Following airway and oxygenation assessment and management, initial treatment is aimed at rapidly correcting hemodynamic and fluid volume abnormalities.[1]

Heart failure treatment guidelines recommend that renal replacement therapy (RRT)-Ultrafiltration be considered in patients with obvious volume overload, diuretic resistance and/or impaired renal function.[2]

Diuretic resistance and impaired renal function can limit the efficacy of fluid removal by medical management alone.[3-6]

Effective resolution of fluid overload in ADHF patients is critical to improving survival and reducing rehospitalizations.[5-7]

ACCF/AHA Heart Failure Guideline Recommendations for RRT [2]

- Obvious volume overload to alleviate congestive symptoms and fluid weight
- Refractory congestion not responding to medical therapy
- Impaired renal function

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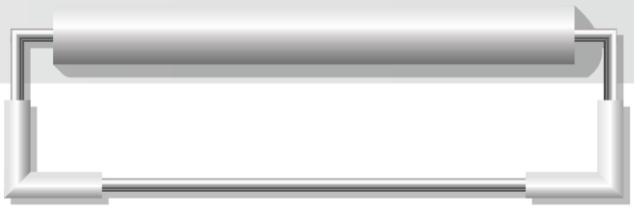
II ICU DAY 1



Patient status

Intubated on the ventilator, sedated on fentanyl drip 50 mcg/hr

Lasix drip 10 cc/hr

PRVC TV 500 RR 14 Peep 5 cm H2O FIO2 70%

PAC inserted, CVP 16 mm Hg, PAWP 24 mm Hg

CO 4.4 L/min

Signs and symptoms

- BP: 96/66
- HR: 110
- Temperature: 98.8 F
- Body weight: 84 kg

Test results

- Oxygen saturation: 96%
- SCr: 2.10
- BUN: 52
- Plasma potassium: 4.9
- Urine output: 5 cc over the past 6 hours

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III ICU DAY 1 DISCUSSION

The patient meets KDIGO criteria for Stage 2 AKI [11]

AKI Stage	SCr	Urine output
1	1.5–1.9 times baseline or ≥0.3 mg/dL (≥26.5 µmol/L) increase	<0.5 mL/kg/hr for 6–12 hours
2	2.0–2.9 times baseline	<0.5 mL/kg/hr for ≥12 hours
3	3.0 times baseline or increase in SCr to ≥4.0 mg/dL (≥353.6 µmol/L) or initiation of RRT or in patients <18 years, decrease in eGFR to <35 mL/min per 1.73 m^2	<0.3 mL/kg/hr for ≥24 hours or anuria for ≥12 hours

What factors would influence therapy choice as you address rising SCr levels? (Choose all that apply)

A. Extent of fluid overload
B. Need for hemodynamic stability
C. Available resources in terms of dialysis machines and trained staff
D. Ability to coordinate dialysis with other therapies including antibiotic therapy

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IV INITIATION OF DIALYSIS DISCUSSION

Diuresis may be limited by worsening renal function and diuretic resistance. RRT can effectively reduce fluid overload in ADHF patients who do not respond to medical therapy. [1-7]

Maintenance of hemodynamic stability to avoid further cardiac injury, arrhythmias, hypotension, and worsening renal function is a key goal of ADHF treatment. [8]

What modality of RRT might you use for this patient? Why?

A. CRRT
B. SLED*
C. Intermittent hemodialysis
D. Other

*Includes sustained or slow low-efficiency dialysis, slow extended dialysis, sustained low-efficiency daily dialysis, and sustained low-efficiency daily diafiltration

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IV INITIATION OF CRRT

Prescription

- Body weight: 84 kg
- Dose: 35 ml/kg/hr*
- Filter:
- BFR: 180 ml/hr
- PBP: N/A
- Dialysate: CRRT Solution BGK4/2.5 (5000 ml)
- Replacement: no replacement
- Net fluid removal: 200-300 cc/hour
- Anticoagulation: heparin 200 units/hour

*Dose selected in accordance with KDIGO guidelines

Clinical Rationale for choice

- The goal was to remove fluid without causing significant hemodynamic changes

Clinical considerations

- Need to remove fluid and maintain pulmonary artery wedge pressure <18 mm Hg
- Need for hemodynamic stability

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IV INITIATION OF CRRT DISCUSSION

CRRT is associated with improved hemodynamic stability and more controlled fluid removal compared with intermittent RRT [9]

While intermittent RRT may cause considerable fluctuations in fluid balance, CRRT is noted for its slow and steady removal of fluid and solutes [9]

CRRT offers better hemodynamic tolerance and control of fluid volume in high-acuity patients with hemodynamic instability and considerable fluid accumulation [9]

Current clinical guidelines recommend the use of continuous RRT in AKI patients who are hemodynamically unstable [9,11,12]

KDIGO [11]	We suggest using CRRT, rather than standard intermittent RRT, for hemodynamically unstable patients.
ADQI [9,12]	We recommend the use of continuous therapies in patients with hemodynamic instability and in situations in which shifts in fluid balance are poorly tolerated.

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IV INITIATION OF CRRT DISCUSSION

Selection of RRT modality requires careful consideration of patient-specific and logistical factors [9-11]

Continuous vs intermittent therapies provide different fluid flow rates and have different treatment duration limits [11,13-15]

AKI is associated with an increased risk of long-term dialysis dependence; [16] compared with IHD, use of CRRT for AKI management has been associated with a lower risk of this complication

While CRRT solutions are typically commercially prepared,[18] water treatment and quality testing may contribute to increased monitoring when using solutions prepared on-line for intermittent therapies [19,20]

Water treatment equipment may add to the footprint of intermittent therapy systems, potentially decreasing treatment mobility and impacting spacing considerations [21-24]

What dialysis options are available for your heart failure patients?

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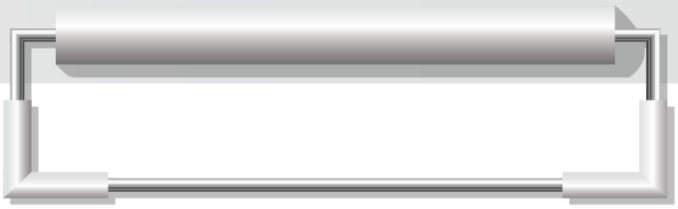
V ICU DISCHARGE



	Day 0	Day 1	Day 3	Day 8	Day 13
	Presentation	ICU arrival	CRRT started	CRRT completed	ICU discharge
SCr (mg/dL)	1.05	2.10	2.40	0.90	0.85
BUN (mg/dL)	26	52	68	34	24
K+ (mEq/L)	4.28	4.9	5.3	4.1	4.1
Urine output (mL/hr)	10	5	5	40	35
Body weight (kg)	82	82	84	70	71
BP (mmHg)	105/65	100/62	98/60	102/68	105/70
Wedge Pressure (mmHg)	N/A	24	25	16	N/A

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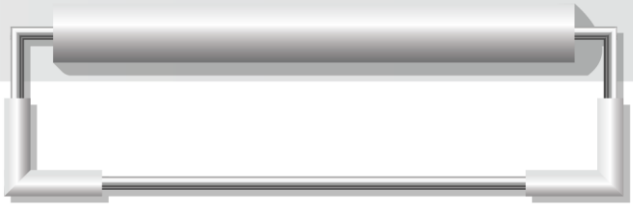

Patient status

Patient was managed initially by diuresis and optimizing heart failure. Addition of CRRT on Day 3 allowed patient to be diuresed and extubated on Day 6.

Signs and symptoms

- BP: 105/70
- HR: 68
- Body temperature: 98.2F
- Body weight: 71 kg

Test results

- Oxygen saturation: 98% RA
- SCr: 0.85
- BUN: 24
- Plasma potassium 4.1
- Urine output: 35 ml/hr

Discharge

Patient was discharged to telemetry and eventually to a skilled nursing facility without need for further dialysis. He followed up with his cardiologist.

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V SUMMARY

Managing Fluid Overload and/or AKI in Patient with ADHF

RISK

- Fluid overload is associated with increased mortality among critically ill patients with AKI.[25,26]
- Incomplete decongestion of ADHF is associated with increased complications and rehospitalizations. [5-7]

HEMODYNAMIC STABILITY

- Maintaining hemodynamic stability during ADHF is critical to avoiding further cardiac injury, arrhythmias, hypotension, or worsening renal function. [8]

OPTIMIZING THERAPY

CRRT is an effective method to achieve target fluid balance in congestive heart failure patients with volume overload. [1-8]

- While the selection of RRT modality requires careful consideration of numerous patient-specific and logistical factors, **CRRT is preferred** by many clinicians for AKI patients who are hemodynamically unstable and who have considerable fluid accumulation. [3,8-12]

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ACRONYMS/ABBREVIATIONS/REFERENCES

ACCF, American College of Cardiology Foundation; **ADHF,** acute decompensated heart failure; **ADQI**, Acute Dialysis Quality Initiative; **AHA**, American Heart Association; **AKI**, acute kidney injury; **BFR**, blood flow rate; **BMI**, body mass index; **BP**, blood pressure; **BUN**, blood urea nitrogen; **CABG**, coronary artery bypass grafting; **CHF**, congestive heart failure; **CRRT**, continuous renal replacement therapy; **CXR**, chest x-ray; **ECG**, electrocardiogram; **EF**, ejection fraction; **HR**, heart rate, **ICU**, intensive care unit; **IHD**, intermittent heamodialysis; **K+**, serum potassium level, **KDIGO**, Kidney Disease: Improving Global Outcomes; **RRT**, renal replacement therapy; **SCr**, serum creatinine; **SLED**, sustained low-efficiency dialysis; includes sustained or slow low-efficiency dialysis, slow extended dialysis, sustained low-efficiency daily dialysis, and sustained low-efficiency daily diafiltration; **UF**, ultrafiltration

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