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Prince LK, et al. The Acute Dialysis Orders Objective Structured Clinical Examination (OSCE):
Fellow Performance on a Formative Assessment of Acute Renal Replacement Therapy
Competence (Nephrology Education Research and Development Consortium—NERDC)

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*The OSCE test and rubric may be accessed at <https://nerdc.org>

Supplement 1.

NERDC Dialysis Orders OSCE

Examination Blueprint

Overall Objective: To assess proficiency in ordering acute RRT

1. Case 1.

1. Objective: Demonstrate ability to order CRRT in a septic, hypotensive, acidotic, hypoxic, coagulopathy oncology patient with AKI in the ICU.
 - a. Question 1. Assess acid-base status
 - i. 1.a. Detect an anion gap metabolic acidosis, taking into account hypoalbuminemia
 - ii. 1.b. Use the Winter's formula to assess compensatory respiratory alkalosis
 - b. Question 2. Using facility-associated standard order sets, write CRRT orders tailored to the specific clinical situation.
 - i. 2.a. Indicate CRRT machine to be used and filter set.
 - ii. 2.b. Indicate dialysis access type.
 - iii. 2.c. Indicate modality (e.g.: CVVH, CVVHD, CVVHDF)
 - iv. 2.d. Address coagulopathy with either a heparin-free method, or regional citrate. (Include details of intervention, including pre-filter replacement, and details of regional citrate administration, including calcium monitoring.)
 - v. 2.e. Address volume removal in hypotensive patient, who is near euvolemic at onset of therapy.
 - vi. 2.f. Address lactic acidosis with bicarbonate-containing replacement fluid and/or dialysate.
 - vii. 2.g. Address clinical monitoring of patient, including pressor titration parameters, during the procedure.
 - viii. 2.h. Indicate that Qb should be maintained on the lower side (50-200 ml/min) due to hypotension.
 - ix. 2.i. If using replacement fluid, indicate rate, electrolyte components, and pre-or post-filter infusion. If dialysate not used, must use physiologic replacement fluid.
 - x. 2.j. If using dialysate, indicate rate and electrolyte components (Must be calcium free if citrate is used.).
 - xi. 2.k. Must obtain at least 20 ml/kg/hr effluent (UF + dialysate) rate for any CRRT modality.
 - c. Question 3. Explain choice of bicarbonate concentration in dialysate and/or replacement fluid, taking into account potential for alkalosis if using citrate anticoagulation or high effluent rates.
 - d. Question 4. Demonstrate recognition that volume removal rate may increase as BP stabilizes and input volumes increase in oligoanuric patient.
 - e. Question 5. Understand principals of clearance in CRRT and impact on drug dosing.
 - i. 5.a. Calculate urea clearance, using effluent volume.
 - ii. 5.b. Recognize that drug dosing during CRRT must be based on attained clearance and known sieving coefficients.

2. Case 2

2. Objective: Demonstrate ability to order initiation of hemodialysis in a moderately uremic patient at ESRD, with CHF and a mature AV fistula.

- a. Question 1. Assess acid-base status.
 - i. 1.a. Detect anion gap metabolic acidosis.
 - ii. 1.b. Use delta-delta calculation to recognize underlying metabolic alkalosis.
- b. Question 2. Using facility-associated standard order sets, write hemodialysis initiation orders tailored to the specific clinical situation, including recognition of potential risk of dialysis disequilibrium syndrome.
 - i. 2.a. Order a baseline EKG, address cardiac and O2 saturation monitoring, and consider nasal cannula O2 (per facility SOP) in this patient with partially compensated congestive heart failure and volume overload.
 - ii. 2.b. Recognize risk of dialysis disequilibrium syndrome, and limit Qb and Qd to reduce clearance.
 - iii. 2.c. Limit clearance by using smallest surface area dialyzer available in facility.
 - iv. 2.d. Prescribe dialysate based on clinical situation and electrolytes, including recognition of normal serum potassium and underlying metabolic alkalosis with mild hypocalcemia (after correction for hypoalbuminemia).
 - v. 2.e. Concurrent flow may be used to limit clearance, but is optional.
 - vi. 2.f. Limit clearance by limiting treatment time.
 - vii. 2.g. To avoid hypotension, limit volume removal during first treatment.
 - viii. 2.h. Mannitol is no longer recommended, but if used, must be used correctly.
 - ix. 2.i. Adjust anticoagulation based on low risk of hemorrhagic pericarditis.
 - x. 2.j. Indicate dialysis access and consider specifying protocol for first use of fistula.
- c. Question 3. Indicate the two absolute indications for urgent initiation of chronic dialysis in ESRD.
- d. Question 4. Indicate four other indications for initiation of chronic dialysis in ESRD.
- e. Question 5. Know the pathophysiology, symptoms and signs of dialysis disequilibrium syndrome.

Supplement 2. NERDC Dialysis Orders OSCE Test

DO NOT ENTER YOUR NAME ON THIS TEST OR THE NAME OF YOUR PROGRAM.

PROGRAM DIRECTOR:

Did your program administer the OSCE in 2016 (last year)? _____ Yes _____ No

Nephrology Education Research and Development Consortium (NERDC)

Version: Final

Total Points: 58

January 30, 2016 (Amendment: 7 March 2017)

Anonymous ID Number:

Dialysis Orders OSCE: 3 scenarios

Time: Up to 120 minutes

Time it took you to complete test: _____

Are you a first or second year fellow? _____

If you are a second year fellow, did you take this test as a first year fellow? _____ Yes _____ No

This is a formative test. Please read the following cases carefully, write a set of dialysis orders (you should use the standard order sets available at your institution, if permitted by your Program Director), and answer content questions for each patient below. Normal laboratory values are given within each case.

Case 1. Acute CRRT for AKI (Total points: 20)

55-year-old anuric female in the ICU with septic shock. Pt has a past medical history significant for acute myelogenous leukemia, and prior to transfer was on the oncology ward. She is neutropenic, with an absolute neutrophil count of 200, and completed her initial induction cycle of cytarabine and daunorubicin 10 days ago. She complained of feeling feverish with body aches about midnight, but had no other specific complaints and general review of systems was negative. No other past medical history, no surgeries, medications as listed below, no known allergies, and no other pertinent history at this time. The ICU calls you for acute dialysis due to worsening acidemia, and have already placed a hemodialysis catheter.

Physical Examination: Wgt 80kg; O₂ saturation 92% on 70% FIO₂; RR 16-25

VS trend	6:00 am	7:00 am	8:00 am	9:00 am	10:00 am
HR (bpm)	145	140	120	125	120
BP (mmHg)	75/32	80/40	80/40	90/50	92/45
Temperature °F	103.5	103.5	102.7	102	102

Intubated, sedated female with no acute findings on exam except coarse breath sounds throughout and bilateral lower extremity petechia. No edema.

Tubes/Lines/Drains: Endotracheal tube, oral-gastric tube, Foley catheter, right IJ port, left IJ central line, 2-18 gauge IVs, and a **left femoral hemodialysis catheter**.

Vent setting: Intubated at 530 am. Assist Control; Tidal Volume 400ml; PEEP 8; FiO2 70%

Ins/Outs	6:00 am	7:00 am	8:00 am	9:00 am	10:00 am
Normal Saline	2000ml	0ml	1000ml	1000ml	250ml
Albumin 5%	0ml	250ml	0ml	0ml	250ml
Norepinephrine	Turned on	Titrated up	Titrated up	Stable high dose	Stable high dose
Vasopressin		Added	Stable dose	Stable dose	Stable dose
Blood products	1U PRBC	2U platelets			
Antibiotics/IV Medications	250 ml	50 ml	0 ml	100 ml	0 ml
Urine Output	15 ml	5 ml	0 ml	0 ml	5 ml

Labs

CBC	6:00 am	10:00 am
WBC (3.6-10.6K)	0.6	0.55
Hgb g/dL (12.8-17.7)	6	7.2
HCT (%) (37.5-50.9)	18	21.7
PLT (162-427K)	<10K	25K

Basic Metabolic Panel	6:00	8:00	10:00
Na (136-145 meq/L)	140	144	145
K+ (3.5-5.1 meq/L)	3.4	4.9	5.0
Cl- (98-107 meq/L)	103	110	112
HCO3- (22-26 meq/L)	20	15	6
BUN (5-20 mg/dL)	9	8	15
Cr (0.7-1.2 mg/dL)	0.8	1.1	1.1
GLucose (74-104 mg/dl)	99	97	105
Lactate (< 2 mmol/L)	6	13	22
Serum Albumin (3.5-5.2 g/dL)	2.5	2.3	2.3
Serum Calcium (8.6-10.2 mg/dL)	8.0	8.1	8.0
Serum Phosphorus (2.5-4.5 md/dL)	4.5		
iCa (1.1-1.35 mmol/L)	1.0		

ABG:	6:00	8:00	9:00	10:00
pH (7.35-7.45)	7.35	7.32	7.22	7.12
pCO2 (35-45 mHg)	36	30	25	19
PaO2 (75-100 mmHg)	125	90	62	65
HCO3 (22-26 meq/L)	19	15	10	6

INR: (0.8-1.2 in patient not on warfarin)	1.9		2.0	

Radiology: CXR, portable film: diffuse interstitial infiltrates consistent with pulmonary edema

Medications: Piperacillin/Tazobactam 2.25gms IV every 6 hrs; Fluconazole 400 mg PO daily; Esomeprazole 40mg po daily, vasopression under titration IV; norepinephrine under titration IV; propofol IV and fentanyl IV titration for sedation

Answer the following questions:

1. Completely describe the acid-base abnormality in this patient, including compensatory responses at 10 am. (You may assume a normal anion gap of 12 meq/L.)
2. **(15 points)** You and your attending decide to perform CRRT. With the above information, please write an initial set of CRRT orders for this patient using the standard CRRT machine and filter set at your institution (e.g. NxStage, Prisma/Prismaflex, Fresenius in CRRT mode). **Do not use SLED or SHIFT. Include patient and therapy monitoring as part of your orders, as well as nursing interventions in response to monitoring thresholds.**
3. Please explain your choice of bicarbonate concentration in your dialysate and/or replacement fluid.
4. Your patient is stable after 6 hour of CRRT. The pressor requirement has decreased significantly, and the current average hourly volume input is 250 ml/hour. Urine output remains < 10 ml/hour. What modifications might you make to your prescription?
5.
 - a. Estimate the patient's urea clearance in ml/min. (Show your work.)
 - b. In general, discuss how will you adjust drug dosing while the patient is on CRRT. (You need not make calculations for specific drugs.)

Answers:

1.

2. Please attach your orders. Put your anonymous ID number on them.

3.

4.

5.

Case 2. Dialysis Initiation in ESRD (Total points: 21)

75-year-old female with CKD stage 5, presumed secondary to hypertensive nephrosclerosis, with eGFR of 10 ml/min/1.73m² at last visit, has been lost to follow-up due to many hospital admissions for exacerbations of congestive heart failure over the past 3 months. She has worsening metabolic acidosis and increasingly difficult-to-control volume status. Her diuretics have been titrated upwards, which improved her dyspnea on exertion and lower extremity edema, but have resulted in an increasing BUN/Cr, with increasing “soft” uremic signs and symptoms such as poor appetite, and increasing fatigue. She has a left upper extremity arteriovenous fistula with a good thrill and bruit that has been evaluated by the dialysis nurses and vascular surgeons and deemed ready to use. Today, she is complaining of decreased appetite with nausea and vomiting, a “funny taste in her mouth,” inability to sleep after 2 or 3 am, and significant fatigue.

Past Medical History: HTN since age 35, noted after developing pre-eclampsia with first pregnancy; Hyperlipidemia; CKD stage 5 as above with worsening metabolic acidosis; congestive heart failure with ejection fraction of 35-40% on last Echocardiogram one month ago, and history of diastolic dysfunction; secondary hyperparathyroidism; anemia of chronic kidney disease

Past Surgical History: Placement of left upper extremity arteriovenous fistula 9 months ago. No other.

Allergies: none known

Family History: non-contributory.

Social History: lives with husband in single family home and works part-time in a nail salon. No history of tobacco or alcohol use.

Medications: amlodipine 10mg daily, carvedilol IR 12.5mg twice daily, telmisartan 40mg daily, lasix 80mg twice daily, atorvastatin 40mg daily, aspirin 325mg daily, calcium carbonate 650mg, 2 tabs twice daily with meals, calcitriol 0.25mcg three times a week, sodium bicarbonate 650mg two tabs twice daily, darbapoietin 25mcg subcutaneously once a month, ferrous sulfate 325mg two times daily

Physical Examination: HR 84 (regular rate and rhythm) ; BP 158/98; Ht: 5'0"; Wt: 135 lbs (126 lbs 3 months ago). RR 16. O2 saturation on room air: 94%

Significant findings include soft bibasilar crackles, + S4, no pericardial rub, and 2+ BLE pitting edema to knees. She has mild asterixis. Left upper arm fistula, well developed, with good thrill and bruit. Patient alert and oriented to person, place, time and situation.

Labs:

Na 144 meq/L (136-145); Cl 95 meq/L (98-107); K 4.5 meq/L (3.5-5.1); HCO₃ 25 meq/L (22-26); BUN 95 mg/dL (5-20); Cr 6.13 mg/dL (0.7-1.2); Glucose 84 mg/dL (74-104); Calcium 7.4 mg/dL (8.6-10.2); Phosphorus 7.4 mg/dL (2.5-4.5). Albumin 3.2 g/dL (3.5-5.2).

eGFR 5 ml/min/1.73m².

WBC 8.5K (3.6-10.6); Hgb 8.0 g/dL (12.8-17.7); Hct 25% (37.5-50.9), Platelets 241K (162-427)

Answer the following questions:

- 1) Recognizing that there is no pH and pCO₂, describe as completely as possible the acid-base abnormality(s). (Assume a normal anion gap of 12 meq/L.)
- 2) **(11 points)** Please write a complete set of dialysis orders for this patient's first day of dialysis, and delineate your plan for hemodynamic and respiratory monitoring, nursing interventions based on monitoring thresholds, choice of kidney, Qb/Qd, duration of first treatment, anticoagulation, and choice of dialysate composition.
- 3) In general (not necessarily in this patient), name the two absolute indications for urgent chronic dialysis initiation in ESRD.
- 4) Name 4 other compelling indications for chronic dialysis initiation in ESRD.
- 5) a) What neurologic condition could this patient be at risk for during and post-dialysis initiation?
b) What is the pathophysiology?
c) What are the symptoms and signs (list mild and severe)?

Answers:

1.

2. Please attach your orders. Put the anonymous ID number on them.

3. a.
b.

4. a.
b.
c.
d.

5. a.
b.

c. Mild:

Severe:

Case 3. Acute Inpatient Dialysis in an ESRD patient (Total points: 17)

55 year old, anuric man with ESRD secondary to obstructive nephrolithiasis presents at midnight on a Sunday to the emergency room with weakness, increasing shortness of breath, and dyspnea on exertion over the last 8 hours. He is on a Monday, Wednesday, Friday hemodialysis schedule and his last dialysis was Friday, for 4 hours 15 minutes. He left at his dry weight of 102kg. Upon questioning, he reports going to a family reunion on Sunday at noon and enjoying a lunch of crabs, shrimp, carrot raisin salad and French fries with sweet tea.

Past Medical History: ESRD due to obstructive nephrolithiasis s/p cadaveric renal transplant in 1995 and returned to ESRD due to chronic rejection. Gout, HTN, hyperlipidemia, paroxysmal atrial fibrillation, renal osteodystrophy

Past Surgical History: Cadaveric renal transplant in 1995, peritoneal dialysis catheter placement in 2004 and removal in 2006. Left upper arm AV fistula placed in 2006—which is functioning well with venous pressures <80 mmHg at 200 ml/min blood flow rate.

Allergies: None known.

No contributory family history

Social History: lives with wife in a single family home and is retired

Medications: warfarin 5mg daily, Lopressor 100mg twice daily, telmisartan 80mg daily, nephrocap 1 daily, colchicine 0.6mg per day prn acute gout flare, allopurinol 100mg daily, calcium carbonate 500mg three tabs with each meal, sevelamer carbonate 800mg three tabs with each meal and 1 tab with snacks, erythropoietin 4500 units subcutaneously three times weekly, ergocalciferol 50,000IU weekly, calcitriol 1 mcg three times weekly, lovaza 2 grams twice daily

Chronic Dialysis Prescription: L upper arm AVF; Optiflux 200; Qb 400 ml/min; Qd 600 ml/min; Dialysate: 140 mEq/L Na, 2 mEq/L K; 30 mEq/L HCO₃; 2.5 mEq/L Ca. Heparin (usually receives no more than 1000 units at beginning of therapy, due to warfarin use). 4 hours 15 minutes, three times weekly. Dry Weight 102 kg.

Physical Examination: VS: HR: 94--irregular; BP 196/106; afebrile; 86% O₂ saturation on room air→ increases to 92% on 6L O₂ by nasal cannula; Wt: 109kg

Significant findings include crackles ½ up bilateral lung fields with decreased breath sounds at the bases, 1+ BLE edema. His left upper arm AV fistula is well developed, and has a good thrill and bruit.

Labs:

Renal function panel: Na 138 meq/L (136-145), K 7.9 meq/L (3.5-5.1), Cl 100 meq/L (98-107), HCO₃ 24 meq/L (22-26), BUN 31 mg/dL (5-20), Cr 8.53 mg/dL (0.7-1.2), Ca 8.9 mg/dL (8.6-10.2), P 5.5 mg/dL (2.5-4.5)

INR: 3 (2-3 for patient on warfarin)

Chest X-ray: diffuse interstitial infiltrates, small bilateral pleural effusions

You are called at 1:00 am from the Emergency Room with the above information. The intern states that they have not initiated therapy for hyperkalemia because they think it is just a lab error because the patient received his full hemodialysis treatment last Friday, and will be receiving dialysis tomorrow routinely in the morning. They are awaiting a repeat potassium level.

Please answer the following questions:

- 1) **(6 points)** What orders, monitoring, treatments, and/or dispositions do you ask the intern to do at this point over the next 60-90 minutes, if any?
- 2) Is acute dialysis indicated? Why or why not?
- 3) Estimate the time it will take in this situation to begin dialysis.
- 4) **(4 points)** Please write a complete set of dialysis orders for this patient, including your patient and therapy monitoring plan during the treatment.
- 5) What are your criteria for stopping dialysis, and how long, at minimum, do you estimate that you will need to continue dialysis?
- 6) What is your monitoring plan (including follow-up labs) once the patient has completed your prescribed dialysis session?
- 7) Repeat potassium sent before the intern called you returned at 8.1 meq/L. In addition to dietary indiscretion, indicate at least 2 other potential contributors to his hyperkalemia.

Answers:

1.

2.

3.

4. Please attach your orders. Put the anonymous ID number on them.

5.

6.

7. a.

b.

Thank you for completing the test. Please complete the post-test survey at the link given to you by the program director. The survey is anonymous, and the ip address will not be available to your program director, or to NERDC. Your program director will grade your test, and give you the results. He/she will also send a copy of the graded test, the score, and this year's ITE score (if you have taken it) to NERDC, but your name will not be given to NERDC and you will remain anonymous.

Supplement 3. NERDC Dialysis Orders OSCE Rubric

Objective: To assess proficiency in ordering acute RRT

Total Points: 58

Rubric: To guide scoring of questions and order sets

Evidence-based/Standard of care items are **bolded**. There are 2 per question scenario.

(Case 1) Objective: Order CRRT in a septic, hypotensive, acidotic, hypoxic, coagulopathic oncology patient with AKI in the ICU. **(Total points: 20)**

1. a. Anion gap metabolic acidosis **(0.5 point)** with
 - b. Appropriate compensatory respiratory alkalosis. **(0.5 point)**

In part a, examinee must recognize that correction for hypoalbuminemia must be made when calculating the anion gap (2.5 meq/L increase in anion gap for each 1 g/dL decline in albumin below the baseline of 4 g/dL). (Vichot AA, Rastegar A. Use of the anion gap in the evaluation of a patient with metabolic acidosis. Am J Kidney Dis. 2014 Oct;64(4): 653-7.) The Winter's formula must be correctly used in part b, to assess respiratory compensation.
2. Initial CRRT orders (Use of standard order sets or forms is encouraged.) Examinee must recognize that this patient is severely hypotensive, acidemic (with a primary metabolic (lactic acidosis), coagulopathic, and hypoxic with probable pulmonary edema due to capillary leak/sepsis, but not markedly total body volume overloaded—although ongoing inputs must be handled in the setting of anuria. Must meet minimum of 20 ml/kg/hr effluent rate, and use bicarbonate dialysate/replacement fluid. Heparin anticoagulation is contraindicated. Orders as follows:
 - a. Indicate machine (NxStage, Prismaflex, Fresenius in CRRT mode; etc) and filter set. Options set by the individual training program or hospital. **(1 Point)**
 - b. Indicate access type (double-lumen femoral temporary dialysis catheter). **(1 Point)**
 - c. Indicate modality (i.e., convection only, convection + diffusion, diffusion only) **(1 Point)**
 - d. Must address coagulopathy with heparin free saline boluses/flushes, continuous saline infusions, pre-filter replacement fluid, or use regional citrate. **Heparin is contraindicated. (2 points: 1 for correct intervention, 1 for details of intervention; -1 point if Heparin is used)**
 - i. If regional citrate is chosen, pre-filter infusion of sodium citrate (concentration and rate) must be specified, monitoring of ionized calcium post-filter and systemically, provision for calcium replacement peripherally, and specification of dialysate (if used) that does not contain calcium, and has appropriate Na (lower) concentration based on sodium concentration of citrate anticoagulant.
 - ii. If regional citrate used with NxStage, RFP453 dialysate (130 meq/L Na, 25 meq/L HCO₃, 0 meq/L Calcium) is required.
 - e. Must address volume removal. Patient should be started isovolemic, or at low net volume removal (100-250ml/hr as tolerated), with advancement as tolerated. **(1 Point)**
 - f. Must address acidemia secondary to lactic acidosis, and use bicarbonate containing dialysate/replacement fluid, if available. **(1 Point)**
 - g. Must address vital signs, pressor titration parameters, and mean arterial pressure (MAP) threshold <55-60mmHg or state MAP goals. **(1 Point—all must be present)**

- h. Must adjust Qb between 50-200ml/min (probably on the lower side due to hypotension). (1 Point)
 - i. For replacement fluid, indicate rate (1 pt), electrolyte components (1 pt), and pre- or post-filter infusion (1 pt). (Total: 3 Points) If dialysate not used, must use physiologic replacement fluid (i.e. NOT normal saline.) If not using replacement fluid (ie, CVVHD alone), give 3 points for free.
 - j. For dialysate, indicate rate (1 pt), electrolyte components (1 pt) (Must be calcium free if citrate is used). (Total: 2 Points) If not using dialysate (ie, CVVH alone), give 2 points for free.
 - k. **Must obtain at least 20 ml/kg/hr effluent (UF + dialysate) rate for any CRRT modality (Intensity of Renal Support in Critically Ill Patients with Acute Kidney Injury. NEJM 2008, 359:7-20.) (1 Point)**
3. Examinee must recognize that bicarbonate concentration should be physiologic range (25-35 mEq/L). If using citrate, bicarbonate should be on the lower side to avoid alkalosis, as citrate is an additional base source. If using high effluent rate, recognize that one should consider lower bicarbonate concentration to avoid alkalosis. (1 Point)
 4. Examinee must consider increase in volume removal rate, at least to keep even with input. (1 Point)
 5. Understanding of clearance calculation in the setting of CRRT and implications for drug dosing.
 - a. Examinee must calculate clearance based on volume of effluent per hour. The calculation would be [(volume effluent (ml)/hour)/60 minutes/hour]. (1 point)
 - b. Must recognized that drug doses should be based on clearance and known sieving coefficients, and not necessarily dosed for CrCl<10 ml/min. (1 points)

(Case 2) Objective: Order initiation of hemodialysis in a moderately uremic patient with an AV fistula. (Total points: 21)

1. Anion gap metabolic acidosis (0.5 point) with underlying metabolic alkalosis (0.5 point).
2. Orders for patient's first day of hemodialysis. The examinee must acknowledge the risk (albeit low) of dialysis disequilibrium syndrome, and decrement dialysis efficiency accordingly. Also must recognize the risk of cardiovascular events/symptoms appearing during first dialysis (esp. in this patient with cardiomyopathy), and consider dialysate K concentration of 3 mEq/L or greater and 2.5 mEq/L Calcium. Recognize that AV fistula is being used for the first time. Recognize patient has an anion gap acidosis, but an underlying metabolic alkalosis, and is at risk for tetany--use a 25 mEq/L HCO₃ dialysate (or lowest available at facility). Patient is volume overloaded, but volume removal should be extremely gentle on the first day (if at all), and isolated UF (which does not involve clearance of urea) may be considered.
 - a. EKG before initiation, nasal cannula O₂, and cardiovascular monitoring plan during treatment. (1 point)
 - b. Low blood flow and dialysate rates (Not more than 200-250 ml/min Q_b; Q_d no more than 2X Q_b). (1 point).
 - c. Smaller surface area (lower clearance) kidney: (Lowest available or not more than 1.2 m²). (1 point)
 - d. Dialysate: 140 mEq/L Na (or standard Na bath) (1 pt); 3-4 mEq/L K (1 pt); 25-32 mEq/L HCO₃ (1 pt); 2.5 mEq/L calcium (1 pt) dialysate. (Total: 4 points. Note here that patient has underlying alkalosis and marginally low serum calcium (about 8.0 mg/dL corrected for albumin). Higher HCO₃ dialysate should not be used, due to risk of tetany. The patient has a normal serum potassium, so low potassium dialysate should be avoided, unless there is only a standard dialysate available. Dialysate K < 3 meq/L has been associated with an increased risk of sudden cardiac death in retrospective cohort studies, although prospective data is lacking. (Jadoul M, et al. Modifiable practices associated with sudden death among hemodialysis patients in the DOPPS. Clin J Am Soc Nephrol. 2012 May;7(5):765-74.)
 - e. Concurrent flow (optional)
 - f. Short time (1-3 hours)—no more. (1 point)
 - g. Limited volume removal first treatment (No more than 10ml/kg/hr), or use isolated UF. (1 point)
 - h. Mannitol +/-, 0.5-1 gm/kg, but must be stopped 15-30 minutes before end of procedure. Another way is to give 5-10 gm mannitol bolus if symptoms occur—but it shouldn't be done as a prn order. (UpToDate is no longer recommending mannitol.) (Optional use with no points for use or no use, but minus 1 point if used incorrectly)
 - i. Tight Low dose heparin or heparin free—She is at (low) risk for hemorrhagic pericarditis. (1 point)
 - j. Indicate access (AV fistula) (1 point). Bonus point for using 17 g needles for first use of access and/or limiting number of attempted needle sticks before calling physician . (Bonus 1 point)
3. Must recognize that uremic encephalopathy (mild-severe) and serositis (pleural, pericardial) are urgent/absolute indications for initiation of chronic dialysis in ESRD. (Daugirdas, Blake and Ing, Handbook of Dialysis (5th Ed); 2015, Wolters Kluwer Health, Philadelphia, PA. Singh A, Kari J. Chapter 2. Management of CKD Stages 4 and 5. Pp29-31, Table 2.3) (2 points—1 point for each)
4. May chose from the following: Intractable and not responsive to conservative therapy: a) volume overload/CHF/HTN; b) hyperkalemia; c) acidosis; d) hyperphosphatemia; e) weight loss/malnutrition; f) gastrointestinal dysfunction/nausea/vomiting; g) decline in function and/or well-being; h) uremic platelet dysfunction. (4 points—1 point for each)

5. Must indicate that patient is at risk for dialysis disequilibrium syndrome. Early symptoms include nausea, vomiting, disorientation, restlessness, and headache. Seizures and coma can occur in severe cases. The physiology appears to be due to a rapid decrease in plasma solute concentration (osmolality) due to dialytic clearance, with water translating across the blood brain barrier to allow for osmotic equilibrium, with resultant cerebral cellular swelling and cerebral edema. Unclear as to the relative contribution of slower urea removal from brain relative to serum vs. existing idiogenic osmols vs. development of intracerebral acidosis. Dialysis should be stopped immediately if symptoms occur. (3 points: 1 for DDS, 1 for symptoms and signs (0.5 for mild; 0.5 for severe, which must include seizures), 1 for pathophysiology)

(Case 3) Objective: Manage acute and life-threatening hyperkalemia and volume overload in an ESRD patient on chronic dialysis (Total points: 17)

1. Examinee must recognize need to start acute medical therapy for hyperkalemia immediately.
 - a. Patient should be placed on a monitor, EKG done (1 point).
 - b. 1 gm of calcium (gluconate or chloride) should be administered over 2-3 minutes (1 point—0.5 point for Ca gluconate, 0.5 point for time (no greater than 5 minutes)).
 - c. Amp of 50% dextrose with 5-10 units regular insulin (with subsequent 10% dextrose infusion at 50 ml/hour optional). (1 point)
 - d. Transfer to the ICU, or maintain in a monitored setting in the ER, if that is the standard procedure for the hospital. (1 point)
 - e. Albuterol neb (10 mg in 4 ml saline over 10 minutes) may be used, but recognize the potential for tachycardia, and should not be used without prior insulin/dextrose. (1 point, 0 points if no insulin or dextrose.) (Epinephrine is NOT recommended: -1 point.)
 - f. Bicarbonate therapy is not indicated—he is not acidotic, and has been shown to have negligible effect in patients with ESRD. (-1 point) He is already volume overloaded. (Allon M, Shanklin N. Effect of bicarbonate administration on plasma potassium in dialysis patients: Interactions with insulin and albuterol. AJKD. 1996. Oct;28(4): 508-14.)
 - g. Potassium must be repeated 30-60 minutes after therapy, and monitored thereafter. (1 point)
 - h. (-1 point) for IV Lasix, as the patient is 20 years at ESRD, and is anuric, unless the examinee indicates that it could be used if the patient is not anuric, in which case, 0 points.
 - i. No points for sodium polystyrene sulfonate (Kayexalate™). It will not have an effect for 4-6 hours.
2. Must recognize the need for acute dialysis→ You must be able to remove the potassium. Diuretics will not help—as the patient is anuric. Potassium binders will not begin their effect for at least 4-6 hours. He is significantly volume overloaded (7 kg over dry weight), hypoxic, and anuric. (2 points. 1 point for recognizing need for acute dialysis. 1 point for correct explanation, i.e. hyperkalemia (0.5 point) and significant volume overload (0.5 point). No points for other options which do not include dialysis)
3. At minimum 1-2 hours. (1 point) The nurses should come in immediately. Recognize that it will take at least 30-60 minutes minimum to turn on and rinse the machine and prepare it for dialysis. Then, it must be brought to the ICU (or ER), and the patient must be accessed.
4. Examinee must decide on appropriate K concentration in the dialysate, and monitor appropriately, as well as plan for volume removal.
 - a. No 0 K bath. 1 or 2 mEq/L K dialysate are both fine. 30-60 minute iStat potassium after one at the beginning of therapy to guide therapy and adjust K+ in dialysis appropriately. Once K is in the 6-7 mEq/L range, switch to 2 mEq/L K dialysate, if on 1 mEq/L K bath. (2 points, 1 for dialysate selection, 1 for monitoring)
 - b. Up to 1-1.5 liter per hour or 10 mg/kg/hour volume removal. (He is 7 kg above dry weight) (1 point)
 - c. Continue dialysis and UF for at least 3-4 hours. (1 point)
 - d. Otherwise, standard orders: LUA AVF access. Na constant or Na modeling; Qb and Qd per standard prescription. Dialyzer per standard prescription. HCO₃ and Calcium per standard prescription. Heparin per standard prescription—1000 units at beginning of dialysis. (No points)

5. Examinee must recognize that potassium should be NORMAL ($< 4\text{-}5$ mEq/L) (1 point) and at least 3 hours must elapse (1 point) before discontinuation, as rebound is expected, especially as the medical therapy used will shift K into cells, thus preventing clearance. 3-4 hours of dialysis will allow removal of 3-4 liters of volume—leaving him still at 3-4 liters above dry weight.
 6. After dialysis is completed, must recognize need to repeat K⁺ in 2-4 hours, once again at 6 hours, as rebound is likely to occur. May need to repeat dialysis daily (especially due to volume overload). (1 point: 0.5 point for 2-4 hours post, 0.5 point for 6 hours post) (Blumberg A, Roser HW, Zehnder C, Muller-Brand J. Plasma potassium in patients with terminal renal failure during and after hemodialysis: Relationship with dialytic potassium removal and total body potassium. NDT. 1997; 12(8): 1629.)
 7. Other potential contributors (1 point):
 - a. Medications: Telmisartan, Lopressor (0.5 point—must include telmisartan)
 - b. Access Recirculation (unlikely in view of history, but a possibility) (0.5 point)
- No points for hemolysis, as there are two successive K values of approximately 8 meq/L.

Supplement 4. Post-Acute Dialysis OSCE Fellow Survey

1. I am a
 - a. First Year Fellow
 - b. Second Year Fellow
2. Question 1 permitted me to assess my proficiency in ordering acute CRRT in a critically ill patient with AKI.
 - a. Strongly agree
 - b. Agree
 - c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
3. If you have any comments or criticisms about Question 1, please enter them here.
4. Question 2 permitted me to assess my proficiency in ordering hemodialysis initiation in a moderately uremic patient at ESRD.
 - a. Strongly agree
 - b. Agree
 - c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
5. If you have any comments or criticisms about Question 2, please enter them here.
6. Question 3 permitted me to assess my proficiency in managing acute hyperkalemia and volume overload in an ESRD patient on chronic hemodialysis.
 - a. Strongly agree
 - b. Agree
 - c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
7. If you have any comments or criticisms about Question 3, please enter them here.
8. Overall, the Acute Dialysis OSCE was useful to me in assessing my proficiency in ordering acute renal replacement therapy.
 - a. Strongly agree
 - b. Agree
 - c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
9. If you have any comments or criticisms about the OSCE overall, please enter them here.

Supplement 5. Post-Acute Dialysis OSCE Program Director Survey 2017

1. Have you administered the OSCE previously (in 2016)?
 - a. Yes
 - b. No
2. If you answered “Yes” to #1, did you make any curriculum changes because of your previous experience with the OSCE?
 - a. Yes
 - b. No
3. If you answered “Yes” to #2, please describe any curriculum changes you made.
4. Question 1 permitted fellows to assess their proficiency in ordering acute CRRT in a critically ill patient with AKI.
 - a. Strongly agree
 - b. Agree
 - c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
5. If you have any comments or criticisms about Question 1, please enter them here.
6. Question 2 permitted fellows to assess their proficiency in ordering hemodialysis initiation in a moderately uremic patient at ESRD.
 - a. Strongly agree
 - b. Agree
 - c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
7. If you have any comments or criticisms about Question 2, please enter them here.
8. Question 3 permitted fellows to assess their proficiency in managing acute hyperkalemia and volume overload in an ESRD patient on chronic hemodialysis.
 - a. Strongly agree
 - b. Agree
 - c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
9. If you have any comments or criticisms about Question 3, please enter them here.
10. Overall, the Acute Dialysis OSCE was useful to fellows in assessing their proficiency in ordering acute renal replacement therapy.
 - a. Strongly agree
 - b. Agree

- c. Neither agree or disagree
 - d. Disagree
 - e. Strongly disagree
11. If you have any comments or criticisms about the OSCE overall, please enter them here.