Applying Race-Agnostic eGFR for Medication-Related Decisions: Case Vignettes

ANSWERS & RATIONALE

CKD intercept

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Contents

Acknowledgements

Authors: Charles Foster, PharmD, BCPS, BCCCP; Erica Anderson, PharmD, BCPS; Tracy Anderson-Haag, PharmD, BCPS, BCTXP; Andrew Bzowyckyj, PharmD, BCPS, CDCES; Wasim El-Nekidy, PharmD, BCPS, BCACP, BCIDP; Michelle Fravel, PharmD, BCPS; Joanna Hudson, PharmD, BCPS; Michael Ott, PharmD, BCPS; Lavinia Salama, PharmD, BCACP, BC-ADM, CDCES

Reviewers: Linda Awdishu, PharmD, MAS; Mary Ann Kliethermes, PharmD; Brianna Martin, PharmD, BCPS; Tom Nolin, PharmD, PhD; Glenda Roberts, BS; Wendy St. Peter, PharmD

Vignette 1 – Ambulatory Care/Anticoagulation #1

A 62-year-old female with atrial fibrillation is referred to you to discuss anticoagulation options. She is unable to complete routine lab monitoring necessary for warfarin but also has concerns that direct-acting oral anticoagulants (DOACs) may be cost prohibitive. After investigating her medication insurance formulary options and discussing options with the patient, you collaboratively identify generic dabigatran as the most practical approach for long-term anticoagulation to balance affordability, safety, and fewer monitoring requirements.

Past Medical History

- Non-valvular atrial fibrillation
- Obstructive sleep apnea
- Heart failure with preserved ejection fraction (HFpEF)
- Dyslipidemia
- Hypertension
- CKD Stage G3b

Current Medications

- Atorvastatin 40 mg daily
- Calcium carbonate 600 mg + vitamin D 25 mcg – 1 tablet daily
- Empagliflozin 10 mg daily
- Furosemide 20 mg daily
- Lisinopril 40 mg daily
- Metoprolol succinate 50 mg daily

Laboratory Information

	Today	3 months ago
Sodium (mEq/L)	137	138
Potassium (mEq/L)	4.5	4.8
Chloride (mEq/L)	98	97
CO2 (mEq/L)	26	26
BUN (mg/dL)	32	31
Serum Creatinine (mg/dL)	1.52	1.54
**eGFRcr (mL/min/1.73m^2)*	39	38
ALT (U/L)	15	—
AST (U/L)	19	—
Platelets (cells/mm^3)	*187*	—

*Standardized eGFRcr reported using the 2021 CKD-EPIcr equation

Measurements

	Today	3 months ago
Height (cm)	154.5	154.5
Weight (kg)	84.2	84.1
BMI (kg/m^2)	35.3	35.2
BSA (m^2) [Dubois method]	1.83	1.83
Blood Pressure (mmHg)	134/72	131/69
Pulse (bpm)	*66*	*68*

Electronic Health Record (EHR) Automated Reporting of Estimated Creatinine Clearance:
eCrCL$_{IBW}$ 29 mL/min [Formula: {((140–age) x ideal body weight)/(72xSCr)} x 0.85 (if female)]

VIGNETTE 1 – QUESTIONS

1. What is the patient's 2021 CKD-EPIcr $eGFR_{BSAadj}$ based on today's labs/measurements?
   A. 29 mL/min/1.73 m^2
   B. 34 mL/min
   C. 39 mL/min/1.73 m^2
   D. **41 mL/min**

2. Why is the $eGFR_{BSAadj}$ higher than the eGFR reported in the patient's chart?
   A. Because the patient's serum creatinine is greater than 1 mg/dL
   B. **Because the patient's body surface area is greater than 1.73 m^2**
   C. Because the patient's height is greater than 150 cm
   D. Because the patient's weight is greater than 72 kg

3. What dabigatran dosage is recommended based on the $eGFR_{BSAadj}$?
   A. 75 mg by mouth twice daily
   B. 110 mg by mouth twice daily
   C. **150 mg by mouth twice daily**
   D. 110 mg by mouth on first day, then 220 mg by mouth once daily

VIGNETTE 1 – ANSWERS & RATIONALE

1. D. 41 mL/min

- As a first step, we need to calculate the patient's body surface area (BSA) using the Du Bois and Du Bois formula:

$$\textbf{(84.2 kg)}^{0.425} \textbf{ X (154.5 cm)}^{0.725} \textbf{ X 0.007184 = 1.83 m}^2$$

- Next, we need to multiply the patient's indexed eGFR by the BSA and divide by 1.73

$$\textbf{39 mL/min/1.73 m}^2 \textbf{ X 1.83 m}^2 \textbf{ / 1.73 = 41.3 mL/min, rounded to the nearest integer = 41 mL/min}$$

- These calculations can also be performed using the National Kidney Foundation eGFR calculator found at kidney.org/professionals/gfr_calculator

2. B. Because the patient's body surface area is greater than 1.73 m^2

Automatically reported eGFR results are standardized to a BSA of 1.73 m^2 and expressed in units of mL/min/1.73 m^2. eGFR adjusted for BSA correlates better with measured GFR (expressed in mL/ min), particularly in persons who have a BMI that classifies them as having underweight, overweight, or obesity. The patient's BSA in this case is 5% higher than 1.73 m^2, therefore, her $eGFRcr_{BSAadj}$ is 5% higher when the adjustment for this patient's BSA is calculated, making B the correct answer. Additionally, there is no specific height, weight, or serum creatinine concentration cutoff for when BSA adjustment should be considered.

3. C. 150 mg by mouth twice daily

For non-valvular atrial fibrillation, the recommended dabigatran dosage is 150 mg by mouth, twice daily for patients with eCrCL >30 mL/min and 75 mg by mouth, twice daily for patients with eCrCL 15 to 30 mL/min. If we replace eCrCL with $eGFR_{BSAadj}$, the patient falls into the category of >30 ml/min and, therefore, should receive a dosage of 150 mg twice daily.

This contrasts with the recommended dosage if the creatinine clearance auto-reported in the electronic health record (calculated using ideal body weight) was used, as it falls < 30 ml/min and would warrant a dosing recommendation of 75 mg twice daily. While it may seem that a recommendation using $eGFR_{BSAadj}$ to guide dosing is not aligned with dosing recommendations, there are several limitations to the use of creatinine clearance to guide dosing in this case:

- The equation used to estimate creatinine clearance (Cockcroft-Gault) was developed in an era when serum creatinine assays were not standardized, and therefore, the average SCr value across all lab assays has decreased by 12% compared to when the Cockcroft-Gault equation was developed. Furthermore, the original Cockcroft-Gault study samples are no longer available, so the equation cannot be reformulated for use with standardized serum creatinine assays.
- As the average body weight of the US population has increased, use of total body weight (or any single body weight parameter) across the body size or weight spectrum reduces Cockcroft-Gault equation accuracy.
- Most pharmacists and Cockcroft-Gault calculators use a variety of body weights (e.g., total body weight, ideal body weight, lean body weight, adjusted body weight) in the Cockcroft-Gault equation. Body weight parameters are inconsistently applied across institutions, practice settings, and patient-specific situations, leading to significant variability in results and interpretation.
- The Cockcroft-Gault equation was developed with data from 249 white males. The adjustment for female gender of 15% for females was estimated rather than scientifically quantified.

In this case, weight may be the limitation of greatest concern. The estimated creatinine clearance automatically reported in the EHR has been calculated using ideal body weight, while the patient's actual body weight is 77.86% greater than her ideal body weight. Increased body size is positively correlated with kidney filtering capacity, so using a weight that is substantially lower than the actual weight may likely lead to an underestimation of kidney function. In this situation, if adjusted body weight is used to calculate creatinine clearance instead of ideal body weight, then the result is 38 mL/min, which leads to the same dosing recommendation as when $eGFR_{BSAadj}$ is used. While one could argue that using $eGFR_{BSAadj}$ in this example offers no advantage over eCrCL with adjusted body weight, this argument assumes all practitioners would consistently use adjusted body weight for their eCrCL calculations. It also assumes all clinicians calculate adjusted body weight the same way. Using $eGFR_{BSAadj}$ requires no assumptions, allowing for ensured consistency across clinicians and practices which is a recognized advantage for optimization of patient care.

Patient Summary: Based on the information available about your kidney function and overall health, the dose of 150 mg twice daily balances your overall risks of stroke and bleeding, so the medicine remains safe and effective for you.

Vignette 2 – Ambulatory Care/Anticoagulation #2

A 68-year-old female with atrial fibrillation is referred to you to initiate direct-acting oral anticoagulant (DOAC) therapy for new onset atrial fibrillation and you find that rivaroxaban is the preferred agent on her insurance formulary.

Past Medical History

- Depression
- Hypothyroidism
- Osteoarthritis
- Atrial fibrillation

Current Medications

- Acetaminophen 650 mg twice daily
- Levothyroxine 88 mcg daily
- Metoprolol tartrate 25 mg twice daily
- Sertraline 100 mg daily

Social History

- No alcohol
- No smoking
- Vegetarian diet (since age 20)

Laboratory Information

	Today	3 months ago
Sodium (mEq/L)	137	138
Potassium (mEq/L)	4.5	4.8
Chloride (mmol/L)	98	97
CO2 (mEq/L)	26	26
BUN (mg/dL)	32	31
Serum Creatinine (mg/dL)	0.90	0.90
Cystatin C (mg/L)	1.41	1.44
**eGFRcr (mL/min/1.73m^2)*	70	70
***eGFRcys (mL/min/1.73m^2)*	44	43
****eGFRcr-cys (mL/min/1.73m^2)*	56	55
ALT (U/L)	15	—
AST (U/L)	19	—
TSH (mIU/L)	2.4	—
Free T4 (ng/dL)	1.1	—
Platelets (cells/mm^3)	*187*	—

*Standardized eGFRcr reported using the 2021 CKD-EPIcr equation
**Standardized eGFRcys reported using the 2012 CKD-EPIcys equation
***Standardized eGFRcr-cys reported using the 2021 CKD-EPIcr-cys equation

Measurements

	Today	3 months ago
Height (cm)	164.5	164.5
Weight (kg)	55	55
BMI (kg/m^2)	20.3	20.3
BSA (m^2) [Dubois method]	1.59	1.59
Blood Pressure (mmHg)	134/72	131/69
Pulse (bpm)	66	68

Electronic Health Record (EHR) Automated Reporting of Estimated Creatinine Clearance:
$eCrCL_{IBW}$ 53 mL/min [Formula: {((140–age) x ideal body weight)/(72xSCr)}x 0.85 (if female)]

VIGNETTE 2 – QUESTIONS

1. Which eGFR equation should be used for medication-related decision making in this patient?
    A. 2021 CKD-EPIcr eGFR
    B. 2021 CKD-EPIcr-cys eGFR
    C. **2012 CKD-EPIcys eGFR**
    D. 1976 Cockcroft-Gault eCrCL

2. What rivaroxaban dosage is recommended based on the 2012 CKD-EPIcys $eGFR_{BSAadj}$?
    A. **15 mg daily**
    B. 20 mg daily
    C. 10 mg twice daily
    D. 15 mg twice daily

VIGNETTE 2 – ANSWERS & RATIONALE

1. C. 2012 CKD-EPIcys eGFR

A vegetarian diet is known to be a non-GFR determinant of SCr, therefore, cystatin C would be a more reliable biomarker of kidney function, especially since it is readily available in this patient's electronic health record. If the patient's laboratory values would have shown severe hypo or hyperthyroidism, then they would have had non-GFR factors affecting cystatin C as well, potentially making the dual equation more appropriate (depending on the magnitude of impact on cystatin C). But, since this patient's thyroid function is within the normal range, 2012 CKD-EPIcys eGFR is recommended.

2. A. 15 mg daily

- We should use the eGFRcys instead of the eGFRcr or eGFRcr-cys equations, as discussed above, because the patient's vegetarian diet is considered a non-GFR determinant of SCr.
- As a first step in calculating the BSA-adjusted eGFR, we need to calculate the patient's body surface area (BSA) using the Du Bois and Du Bois formula:

$$\mathbf{(55\ kg)^{0.425} \times (164.5\ cm)^{0.725} \times 0.007184 = 1.59\ m^2}$$

- Next, we need to multiply the patient's indexed eGFRcys by the BSA and divide by 1.73

$$\mathbf{44\ mL/min/1.73\ m^2 \times 1.59\ m^2 / 1.73 = 40\ mL/min}$$

- These calculations can also be performed using the National Kidney Foundation eGFR calculator found at kidney.org/professionals/gfr_calculator
- The recommended dosage of rivaroxaban in atrial fibrillation is 20 mg daily for eCrCL > 50 mL/min and 15 mg once daily for eCrCl ≤ 50 mL/min; the manufacturer labeling specifically states that actual body weight should be used in the calculation of eCrCl. This patient's eCrCl using actual body weight is 52 mL/min which would warrant a dosage of 20 mg daily.
- Since the $eGFRcys_{BSAadj}$ of 40 mL/min is less than 50 mL/min, the recommended dosage based on the $eGFR_{BSAadj}$ is 15 mg daily. Since cystatin C is likely a more accurate biomarker to estimate kidney function given this patient's vegetarian diet, this is likely a dosage more tailored to this patient's actual kidney function.
- While not provided in this case, additional patient-specific factors affecting her risk of bleeding vs. risk of having a thromboembolic event should also be taken into consideration when deciding whether to be more conservative or aggressive with initial medication dosing.

Patient Summary: Based on the information available about your kidney function and overall health, the dose of 15 mg daily balances your overall risks of stroke and bleeding, so the medicine remains safe and effective for you.

Vignette 3 – Ambulatory Care/Comprehensive Medication Review

A 66-year-old female is referred to you for a pharmacotherapy consult. The referring provider is requesting your input on the appropriate doses for medications to treat an acute herpes zoster (shingles) flare given her CKD. Since you are reviewing the patient's profile, the referring provider also requests guidance on whether the patient's current medications are appropriately dosed for her kidney function.

Past Medical History

- Type 2 diabetes
- Hypertension
- Non-valvular atrial fibrillation
- CKD Stage G3a
- History of post-herpetic neuralgia

Current Medications

- Dapagliflozin 10 mg once daily
- Hydrochlorothiazide 25 mg once daily
- Losartan 100 mg once daily
- Metformin 1000 mg twice daily
- Rivaroxaban 20 mg once daily
- Rosuvastatin 10 mg once daily

Laboratory Information

	Today	3 months ago
Sodium (mEq/L)	140	140
Potassium (mEq/L)	4.5	4.4
Chloride (mEq/L)	100	99
CO2 (mEq/L)	26	26
BUN (mg/dL)	20	19
Serum Creatinine (mg/dL)	1.26	1.28
**eGFRcr (mL/min/1.73m^2)*	47	46
ALT (U/L)	18	—
AST (U/L)	18	—

*Standardized eGFRcr reported using the 2021 CKD-EPIcr equation

Measurements

	Today	3 months ago
Height (cm)	175	175
Weight (kg)	82	80
BMI (kg/m^2)	26.8	26.1
BSA (m^2) [Dubois method]	1.98	1.96
Blood Pressure (mmHg)	126/74	130/72
Pulse (bpm)	72	68

Electronic Health Record (EHR) Automated Reporting of Estimated Creatinine Clearance:
$eCrCL_{IBW}$ 46 mL/min [Formula: {((140–age) x ideal body weight)/(72xSCr)}x 0.85 (if female)]

VIGNETTE 3 – QUESTIONS

1. What is the patient's $eGFR_{BSAadj}$ based on today's labs/measurements?
   A. 46 mL/min
   B. 47 mL/min
   C. 50 mL/min
   D. **54 mL/min**

2. The referring provider is interested in prescribing **valacyclovir** for the patient's acute shingles flare-up. The FDA-approved prescribing information is provided below. What is the most appropriate dosage for this patient?

Indication	**Creatinine Clearance (mL/min)**			
	≥50	30–49	10–29	<10
Herpes zoster	1 gram every 8 hours	1 gram every 12 hours	1 gram every 24 hours	500 mg every 24 hours

   A. **1 gram by mouth every 8 hours**
   B. 1 gram by mouth every 12 hours
   C. 1 gram by mouth every 24 hours
   D. 500 mg by mouth every 24 hours

3. The referring provider is also interested in prescribing **pregabalin** to treat the patient's neuralgias secondary to her acute shingles flare-up. The FDA-approved prescribing information is provided below. What is the most appropriate dosage for this patient?

Indication	**Creatinine Clearance (mL/min)**			
	≥60	30–59	15–29	<15
Postherpetic neuralgia	150 mg/day (divided in 2–3 doses)	75 mg/day (divided in 2–3 doses)	25–50 mg/day (divided in 1–2 doses)	25 mg once daily

   A. 75 mg by mouth twice daily
   B. 50 mg by mouth twice daily
   C. **25 mg by mouth three times daily**
   D. 25 mg by mouth twice daily

4. Which rivaroxaban dosage is most appropriate considering this patient's kidney function?
   A. **Continue 20 mg by mouth once daily**
   B. Increase to 15 mg by mouth twice daily
   C. Decrease to 15 mg by mouth once daily
   D. Decrease to 10 mg by mouth once daily

VIGNETTE 3 – ANSWERS & RATIONALE

1. C. 54 mL/min

- As a first step, we need to calculate the patient's body surface area (BSA) using the Du Bois and Du Bois formula:

$$\textbf{(82 kg)}^{0.425} \textbf{ X (175 cm)}^{0.725} \textbf{ X 0.007184 = 1.98 m}^2$$

- Next, we need to multiply the patient's indexed eGFR by the BSA and divide by 1.73

47 mL/min/1.73 m^2 X 1.98 m^2 / 1.73 = 53.8 mL/min, rounded to the nearest integer = 54 mL/min.

- These calculations can also be performed using the National Kidney Foundation eGFR calculator found at kidney.org/professionals/gfr_calculator. The other answer options are derived from incorrectly applying alternative calculations for this patient

2. A. 1 gm by mouth every 8 hours

The prescribing recommendation is provided as eCrCL, which reflects when this drug was developed. Cockcroft-Gault estimated creatinine clearance (eCrCl) is no longer the preferred method for medication dosing due to its limitations and lack of accuracy in diverse populations. The KDIGO recommendations and consensus from nephrology experts advocate for using race-agnostic eGFR equations with BSA adjustment instead of eCrCl for medication-related decisions.

Since eGFR adjusted for BSA ($eGFR_{BSAadj}$) correlates better with mGFR and medication clearance (both expressed in mL/min) than the standardized eGFR (in mL/min/1.73m^2), it should be used for medication-related decision making. The C-G $eCrCL_{IBW}$ of 46 mL/min, C-G $eCrCL_{AdjBW}$ of 50 mL/min (as the patient is in overweight BMI category, though still <130%$_{IBW}$), and $eGFR_{BSAadj}$ of 54 mL/min all place this patient's estimated kidney function around 50 mL/min, with the $eGFR_{BSAadj}$ likely being more accurate given the limitations with C-G eCrCL noted above. The 1 gram every 8 hours dosing is the most appropriate choice.

Patient Summary: Based on the information available about your kidney function and overall health, the dose of 1 gm every 8 hours helps balance your need to treat this infection with the risk of potential side effects from valacyclovir.

3. C. 25 mg by mouth three times daily

Although the dosing recommendation is provided as eCrCL, it is no longer the preferred method for medication dosing due to its limitations and lack of accuracy in diverse populations. Instead, race-agnostic eGFR equations with BSA adjustment ($eGFR_{BSAadj}$) are now recommended for medication-related decisions. Fortunately, the C-G $eCrCL_{IBW}$ of 46 mL/min, C-G $eCrCL_{AdjBW}$ of 50 mL/min (as the patient is in the overweight BMI category, though still < 130% IBW), and $eGFR_{BSAadj}$ of 54 mL/min all place this patient's estimated kidney function in the same dosing recommendation - 75 mg/day (divided in 2-3 doses). Therefore, of the available options, the best recommendation is 25 mg three times daily.

Patient Summary: Based on the information available about your kidney function and overall health, the dose of 25 mg three times daily will help give you pain relief while also lowering the risk of potential side effects from pregabalin.

4. A. Continue 20 mg by mouth once daily

Although the prescribing information is provided as eCrCL, it is no longer the preferred method for medication dosing due to its limitations and lack of accuracy in diverse populations. Instead, race-agnostic eGFR equations with BSA adjustment ($eGFR_{BSAadj}$) are now recommended for medication-related decisions. The C-G $eCrCL_{IBW}$ of 46 mL/min and $eGFR_{BSAadj}$ of 54 mL/min both place this patient's estimated kidney function around 50 mL/min, with the $eGFR_{BSAadj}$ likely to be more accurate given the limitations with C-G eCrCL noted above. Furthermore, while most institutions would likely use an ideal body weight when calculating C-G eCrCL for this patient since her weight is within 130% of ideal body weight, rivaroxaban product labeling specifically recommends using actual body weight when calculating eCrCL, which in this patient's case would be 57 mL/min. Therefore, when solely considering kidney filtration function, 20 mg by mouth once daily using $eGFR_{BSAadj}$ is likely most appropriate. The 15 mg twice daily and 10 mg once daily options are incorrect as those are dosing recommendations for other indications.

Since this patient's kidney function is very close to the threshold of 50 mL/min, it is also important to look more holistically at this patient to evaluate for safety and efficacy. Based on the information provided, she has multiple risk factors for stroke, while "age over 65" is her only risk factor for severe bleeding suggesting the benefits of anticoagulation outweigh the risks.

Patient Summary: Based on the information available about your kidney function and overall health, the dose of 20 mg once daily helps balance your overall risks of stroke and bleeding.

Vignette 4 – Ambulatory Care/GFR Biomarkers

You are working in a rural clinic with an attached outpatient pharmacy where you provide medication management and patient education. You are authorized to order labs and other measurements as needed for accurate assessment of kidney function at least annually.

The following is a list of patients who are scheduled for a clinic visit today. Each patient had a metabolic panel checked in the preceding days in preparation for their visit, and *all patients have stable kidney function*.

Patient 1

65-year-old male who is currently prescribed glipizide, lisinopril, metoprolol, and atorvastatin

- SCr: 1.41 mg/dL
- Weight: 123 kg
- Height: 70 inches
- PMH: hypertension, CV disease, type 2 diabetes, and class 3 obesity

Patient 2

62-year-old male who is currently prescribed amlodipine and tadalafil

- SCr: 0.92 mg/dL
- Weight: 78 kg
- Height: 72 inches
- PMH: hypertension, BPH, and ED

Patient 3

49-year-old female who is currently prescribed pregabalin

- SCr: 0.40 mg/dL
- Weight: 41 kg
- Height: 64 inches
- PMH: spinal cord injury with quadriplegia

Patient 4

75-year-old female who is currently prescribed a daily aspirin and as needed albuterol

- SCr: 0.61 mg/dL
- Weight: 68 kg
- Height: 66 inches
- PMH: former smoker (quit in 2004)

VIGNETTE 4 – QUESTIONS

1. Of the 4 patients you will see today, whose kidney function assessment should incorporate a measurement of cystatin C to be most accurate?
   A. Patients 1 and 2
   B. Patients 1, 2, and 4
   C. Patients 3 and 4
   D. **Patients 1 and 3**

2. In which patient would serum creatinine alone be reasonable for assessing kidney function?
   A. Patient 1
   B. **Patient 2**
   C. Patient 3
   D. Patient 4

VIGNETTE 4 – ANSWERS & RATIONALE

1. D. Patients 1 and 3

Non-GFR determinants of serum creatinine (SCr) and cystatin C (Cys) contribute to decreased accuracy of estimated GFR (eGFR). Both Patient 1 and Patient 3 have a body habitus and/or changes in muscle mass that are non-GFR determinants of SCr and/or cystatin C. Cystatin C can improve the accuracy of kidney function assessment when used alone (i.e., in people with any disorder causing muscle wasting (e.g., paralysis, quadriplegia) without comorbidities) or in combination with SCr (i.e., in people with class 3 obesity or muscle-wasting disorder with comorbidities or medications that may be non-GFR factor(s) for SCr) to estimate GFR. Patients 2 and 4 do not have non-GFR determinants that would impact accuracy of eGFR using SCr. In addition to body habitus and muscle mass considerations, other non-GFR determinants that reduce accuracy of kidney function estimation can be related to lifestyle, comorbidities, and even medications. Refer to Table 2 from the associated publication for additional examples and further comments on evaluating specific determinants.

Patient Summary: The cystatin C test gives us a clearer picture of how our kidneys are working than the usual way (using creatinine) based on your body characteristics.

2. B. Patient 2

Patient 2 has hypertension, BPH, and ED, but no significant conditions affecting muscle mass or other non-GFR determinants, so SCr is likely a reasonable biomarker for kidney function assessment. Patient 1 has a body habitus that can affect both SCr and Cys and using both together is suggested for accuracy. Patient 3 has a spinal cord injury with quadriplegia and reduced muscle mass that affects SCr concentrations, and Patient 4 does not have obvious non-GFR determinants; however, older patients often exhibit reduced muscle mass, which may affect concentrations of SCr; SCr for Patient 2 would be more reliable than for Patient 4. Estimating kidney function in older adults can be challenging, and clinical judgment is essential when evaluating risks and benefits of treatment decisions based on kidney function estimation. The eGFRcr-cys (adjusted for BSA) equation can be considered for GFR evaluation if there are no non-GFR determinants that would affect cystatin C, especially if a patient is initiating a medication that may require a more accurate estimate of kidney function.

Vignette 5 – Ambulatory Care/GFR Biomarkers

You are working in a rural clinic with an attached outpatient pharmacy where you provide medication management and patient education. You are authorized to order labs and other measurements as needed for accurate assessment of kidney function at least annually.

A 55-year-old male returns to his primary care provider (PCP) for a follow up visit. His PCP has discussed the need for him to see a nephrologist and to start additional drug therapy to manage his CKD, but the patient was reluctant to go to another doctor or add medications to his regimen. Since his last visit 6 months ago, he has learned more about kidney failure and what it means to need dialysis or require a transplant and would like to discuss additional treatment options for CKD.

Past Medical History

- Type 2 diabetes
- Hypertension
- CKD stage G4
- Class 2 obesity
- Gout

Current Medications

- Metformin 500 mg PO twice daily
- Lisinopril 20 mg PO daily (taking for 6 months)
- Allopurinol 100 mg PO daily
- ASA 81 mg PO daily

Laboratory Information

	Today	6 months ago
Potassium (mEq/L)	4.4	4.5
BUN (mg/dL)	28	30
Glucose (mg/dL)	150	168
Serum Creatinine (mg/dL)	2.74	2.69
Cystatin C (mg/L)	1.81	1.78
**eGFRcr (mL/min/1.73 m^2)*	27	27
***eGFRcr-cys (mL/min/1.73 m^2)*	31	32
UACR (mg/g)	330	250
HgA1C (%)	8.5	8.2

*Standardized eGFRcr reported using the 2021 CKD-EPIcr equation
**Standardized eGFRcr-cys reported using the 2021 CKD-EPIcr-cys equation

Measurements

	Today	3 months ago
Height (cm)	183	183
Weight (kg)	120	121
BMI (kg/m^2)	35.9	36.2
Blood Pressure (mm Hg)	138/75	136/76
Pulse (bpm)	74	72

Electronic Health Record (EHR) Automated Reporting of Estimated Creatinine Clearance:
eCrCL$_{IBW}$ 34 mL/min [Formula: {((140–age) x ideal body weight)/(72xSCr)}x 0.85 (if female)]

VIGNETTE 5 – QUESTIONS

1. Which estimate of kidney function should be used for the purpose of drug dosing?
   A. Standardized eGFRcr (mL/min/1.73 $m^{2)}$
   B. Standardized eGFRcr-cys (mL/min/1.73 m^2)
   C. **BSA-adjusted eGFRcr-cys (mL/min)**
   D. Estimated creatinine clearance (mL/min) reported by the EHR

2. When using the 2021 CKD-EPI eGFR equation for the purpose of drug dosing in a patient with obesity, the standardized eGFR result reported by the lab in mL/min/1.73 m^2 should be multiplied by:
   A. Body weight in kg
   B. **BSA divided by 1.73**
   C. Body weight in kg divided by 1.73
   D. 1.73 m^2, then divided by the patient's BSA

3. The PCP is concerned about the use of metformin in this patient due to the warning in those with an eGFR <30 mL/min/1.73 m^2 and corresponding risk of lactic acidosis. Which is the appropriate course of action regarding metformin therapy?
   A. Discontinue metformin since his standardized eGFRcr is < 30 mL/min/1.73 m^2
   B. Discontinue metformin since estimates of kidney function are likely inaccurate in this patient
   C. **Continue metformin since his BSA-adjusted eGFRcr-cys is 44 mL/min**
   D. Obtain a measured CrCl to assess his kidney function and determine metformin dosing

VIGNETTE 5 – ANSWERS & RATIONALE

1. C. BSA-adjusted eGFRcr-cys (mL/min)

This patient has Class 2 obesity with a BMI above 35 kg/m^2. Obesity is a non-GFR determinant of serum creatinine and cystatin C that may decrease accuracy of the estimated GFR. The 2021 CKD-EPIcr-cys eGFR equation has the best accuracy when compared to measured GFR in individuals with a BMI ≥ 35. When cystatin C is available, this is the preferred assessment equation to use in someone with BMI > 35 with stable kidney function. The BSA-adjusted eGFR (in mL/min) should be used for drug dosing. Although in some institutions, the Cockcroft-Gault (C-G) estimated creatinine clearance (eCrCl) is automatically reported in the electronic health record, estimates of kidney function using the more contemporary eGFR equations (i.e. 2021 CKD-EPIcr eGFR, 2021 CKD-EPIcr-cys eGFR, 2012 CKD-EPIcys eGFR) are preferred given the limitations of the C-G equation. Also, the eCrCl value for this patient as reported by the EHR is based on ideal body weight, which is not appropriate for a patient with obesity.

2. B. BSA divided by 1.73

When the estimated GFR reported by the lab is used for drug dosing, it should be converted to the BSA-adjusted value (in mL/min) since drug clearance is proportional to GFR in mL/min. To convert to the BSA-adjusted value, the standardized value (reported in mL/min/1.73 m^2) must be multiplied by the patient's BSA (m^2), then divided by 1.73. This is especially important for individuals who have obesity with a BSA well above 1.73 m^2 or underweight with a BSA well below 1.73m^2.

3. C. Continue metformin since his BSA-adjusted eGFRcr-cys is 44 mL/min

The dosing recommendations for metformin are to discontinue metformin if the eGFR is < 30 mL/min/1.73 m^2. When making medication-related decisions in this patient based on kidney function there are some important considerations. As discussed in question 1, use of the 2021 CKD-EPIcr-cys eGFR equation that incorporates cystatin C and creatinine is likely to be more accurate in this patient with obesity. Both his standardized (mL/min/1.73m^2) and BSA-adjusted (mL/min) eGFR values using the combined SCr-Cys equation are above 30 so metformin may be continued. His eGFR-cr-cys when adjusted for BSA is 44 mL/min (confirm that you can do this calculation using an eGFR calculator with the 2021 CKD-EPIcr-cys equation). Other than the fact that he has obesity, there is no other information to suggest other non-GFR determinants that may make eGFR unreliable in this patient (see non-GFR determinants) and there is not a compelling reason to obtain a measured CrCl for confirmation. It is important to remember these equations are in fact estimates of kidney function and clinical judgment should always be part of the decision process. For example, if this patient had multiple risk factors for lactic acidosis, that may warrant a heavier emphasis on risk rather than benefit.

Patient Summary: Based on your overall health and your kidney numbers (GFR), it's safe to continue metformin for now, and we'll keep checking regularly to make sure it continues to be safe for you.

Vignette 6 – Inpatient Care/Infectious Disease/Transitions of Care

A 50-year-old man presents to the ED with worsening dyspnea after two recent hospitalizations for pneumonia. He was discharged one week ago after receiving vancomycin and cefepime, and he was prescribed ciprofloxacin to complete a 7-day course. On admission, imaging shows worsening patchy lung infiltrates leading to concerns for progressive pneumonia despite multiple antibiotics.

Past Medical History

- Hypertension
- Type 2 diabetes
- Neuropathic pain
- Autosomal recessive polycystic kidney disease (CKD Stage G3a)

Current Medications

- Amlodipine 10 mg daily
- Dapagliflozin 10 mg daily
- Gabapentin 300mg two times daily
- Metformin 1000 mg twice daily
- Sitagliptin 50 mg daily

Laboratory Information as reported in the Electronic Health Record

	Admis-sion	3 months ago
Creatinine (mg/dL)	3.08	1.54
Cystatin C (mg/L)	2.51	1.41
*eCrCL (mL/min)	30	61
**eGFRcr (mL/min/1.73 m^2)	24	55
***eGFRcys (mL/min/1.73 m^2)	23	51
*****eGFRcr-cys (mL/min/1.73 m^2)*	24	53

*eCrCl reported by using original Cockroft-Gault equation with actual body weight
**Standardized eGFRcr reported using the 2021 CKD-EPIcr equation
***Standardized eGFRcys reported using the 2012 CKD-EPIcys equation
****Standardized eGFRcr-cys reported using the 2021 CKD-EPIcr-cys equation

Measurements

	Today
Height (cm)	165
Weight (kg)	75
BMI (kg/m^2)	27.5
BSA (m^2) [Dubois method]	1.82

VIGNETTE 6 – QUESTIONS

1. The infectious disease physician consulted the pharmacy for dosing recommendations of piperacillin/tazobactam (Pip/Taz) for suspected pneumonia due to *Pseudomonas aeruginosa* infection. The FDA-approved prescribing information is provided below. Which of the following would be the most appropriate equation to estimate kidney function for the purpose of drug dosing?

Creatinine Clearance (mL/min)		
>40	20 to 40	<20
4.5 g IV every 6 hours	*3.375 g IV every 6 hours*	*2.25 g IV every 6 hours*

   A. eGFR using the 2021 CKD-EPI equation with adjustment for BSA
   B. Creatinine Clearance (eCrCL) using the Cockroft-Gault equation
   C. eGFR using the MDRD equation with adjustment for BSA
   D. **None of the equations will accurately estimate kidney function**

2. The patient completed a seven-day course of appropriate antibiotics. By discharge, his serum creatinine had returned to baseline (1.54 mg/dL). The hospital medicine team requested pharmacy assistance in optimizing his gabapentin dosing for discharge. The FDA-approved prescribing information is provided below. Which of the following statements is most appropriate?

Creatinine Clearance (mL/min)			
≥ 60	30–59	15–29	< 15*
Maximum 1200 mg three times daily (3600 mg total daily dose)	*Maximum 700 mg twice daily (1400 mg total daily dose)*	*Maximum 700 mg once daily (700 mg total daily dose)*	*Maximum 300 mg once daily (300 mg total daily dose)*

*For patients with creatinine clearance <15 mL/min, reduce daily dose in proportion to creatinine clearance (e.g., patients with a creatinine clearance of 7.5 mL/min should receive one-half the daily dose that patients with a creatinine clearance of 15 mL/min receive).

   A. Increase the gabapentin dose to 600 mg three times daily given the patient's eCrCl > 60 mL/min
   B. **Continue gabapentin 300 mg two times daily given the eGFRBSAAdj is between 30–59 mL/min**
   C. Decrease the gabapentin dose to 300 mg once daily given the eGFR is < 30 mL/min/1.73m^2
   D. Switch the gabapentin to pregabalin 75 mg twice daily because the $eGFR_{BSAAdj}$ is > 60 mL/min

3. The endocrinologist requested a pharmacy consult to adjust the dosing of sitagliptin, metformin, and dapagliflozin based on the patient's kidney function upon discharge. As a reminder, his serum creatinine has returned to baseline (1.54 mg/dL). Which of the following statements is most appropriate?

   A. Based on the $eGFR_{BSAadj}$, reduce metformin to 500 mg twice daily, continue sitagliptin 50 mg daily, and continue dapagliflozin 10 mg daily with close monitoring of kidney function
   B. **Based on the eGFRBSAAdj, continue metformin 1000 mg twice daily, increase sitagliptin to 100 mg daily, and continue dapagliflozin 10 mg daily with close monitoring of kidney function**
   C. Based on the eGFR, continue metformin 1000 mg twice daily, increase sitagliptin to 100 mg daily, and continue dapagliflozin 10 mg daily with close monitoring of kidney function
   D. Based on the eCrCl, continue metformin 1000 mg twice daily, increase sitagliptin to 100 mg daily, and continue dapagliflozin 10 mg daily with close monitoring of kidney function

VIGNETTE 6 – ANSWERS & RATIONALE

1. D. None of the equations will accurately estimate kidney function

The patient's serum creatinine (SCr) today of 3.08 mg/dL is more than 1.5 times his baseline, meeting the KDIGO definition of acute kidney injury (AKI). In AKI, estimated GFR calculations—including eGFR and eCrCL—are unreliable due to the dynamic changes in kidney function. A key assumption in these equations is stable kidney function, which is not the case here. As a result, standard dosing adjustments based on $eGFR_{BSAadj}$ or eCrCL equations may lead to inappropriate dosing and potential toxicity if kidney function is overestimated. Clinicians should exercise caution when adjusting medications in unstable kidney function, considering additional patient- and medication-specific factors to guide clinical judgment

2. B. Continue gabapentin 300 mg two times daily given the $eGFR_{BSAadj}$ is between 30-59 mL/min

Cockcroft-Gault estimated creatinine clearance (eCrCL) is no longer the preferred method for medication dosing due to its limitations and lack of accuracy in diverse populations. The KDIGO recommendations and consensus from nephrology experts advocate for using race-agnostic eGFR equations with BSA adjustment instead of eCrCL for medication-related decisions.

The patient's baseline serum creatinine is 1.54 mg/dL, and his standardized eGFRcr is reported as 55 mL/min/1.73 m^2 using the 2021 CKD-EPIcr eGFR equation. Relying on the standardized eGFR, which is indexed to a BSA of 1.73 m^2, in patients who are over or underweight is not recommended. Rather, the BSA-adjusted eGFR is the preferred method for medication dosing. The patient's BSA is 1.82 m^2, meaning that using the indexed eGFR of 55 mL/min/1.73 m^2 underestimates his kidney function slightly. This could lead to inappropriate dose reductions.

To adjust the patient's eGFR for his BSA, the standardized eGFRcr should be multiplied by the patient's actual BSA of 1.82 m^2 then divided by 1.73 m^2, yielding an $eGFR_{BSAadj}$ of 58 mL/min. The National Kidney Foundation eGFR calculator may also be used.

Gabapentin is eliminated by the kidneys, and appropriate dosing according to kidney function is necessary to prevent drug accumulation and toxicity (e.g. excessive sedation, dizziness, confusion, respiratory depression, weight gain, and edema). Gabapentin prescribing information recommends a maximum daily regimen of 700 mg twice daily for patients with an eGFR between 30-59 mL/min.

According to the patient's kidney function prior to discharge, the dose of 300 mg two times daily is appropriate to continue. Reducing the dose unnecessarily could result in undertreatment of his neuropathic pain, leading to worsening symptoms and reduced quality of life, and increasing the dosage could lead to adverse effects from impaired clearance of the higher dosage. Pregabalin is an alternative to gabapentin, but switching is not necessary in this case and would also require dose adjustments. Additionally, the patient's $eGFR_{BSAadj}$ (58 mL/min) is not ≥60 mL/min, making this answer factually incorrect.

Patient Summary: Based on the information available about your kidney function and overall health, the dose of 300 mg two times daily will help give you pain relief while also lowering the risk of potential side effects from gabapentin. As you continue taking this medicine, please pay attention to how you feel and let us know if you notice any negative changes or new symptoms.

3. B. Based on the $eGFR_{BSAadj}$, continue metformin 1000 mg twice daily, increase sitagliptin to 100 mg daily, and continue dapagliflozin 10 mg daily with close monitoring of kidney function

As previously discussed, Cockcroft-Gault estimated creatinine clearance (eCrCl) is no longer the preferred method for medication dosing due to its limitations and lack of accuracy in diverse populations. Instead, race-agnostic eGFR equations with BSA adjustment should be used for medication-related decisions.

Relying on the standardized eGFR, which is indexed to a BSA of 1.73 m^2, in patients who are over or underweight is not recommended. Rather, the BSA-adjusted eGFR is the preferred method for medication dosing. The patient's BSA is 1.82 m^2, meaning that using the indexed eGFR of 55 mL/min/1.73 m^2 underestimates his kidney function compared to the $eGFR_{BSAadj}$ of 58 mL/min. This could lead to inappropriate dose reductions, particularly for metformin.

Per the 2020 KDIGO Diabetes Guidelines, metformin dosing recommendations based on eGFR are as follows:

eGFR (mL/min/1.73 m^2)			
≥ 60	30–59	15–29	< 15*
No dose adjustment required. *Maximum 2000 mg/day*	*May be continued at full dose.* *Consider dose adjustments in patients with conditions predisposing them to lactic acidosis*	*Maximum 1000 mg/day*	*Discontinue use*

Reducing the metformin dose to 500 mg twice daily is unnecessary, as the patient's $eGFR_{BSAadj}$ is 58 mL/min, and he has no intolerance symptoms or risk factors for lactic acidosis, such as COPD or heart failure. While the KDIGO Diabetes Guidelines reference the standardized eGFR indexed to a BSA of 1.73 m^2 for dosing, BSA-adjusted eGFR is preferred for medication dosing decisions.

For sitagliptin, dosing is also based on kidney function:

eGFR (mL/min/1.73 m^2)		
≥ 45	30–44	< 30
100 mg daily	*50 mg daily*	*25 mg daily*

Since this patient's $eGFR_{BSAadj}$ is 58 mL/min, continuing sitagliptin at 50 mg daily is inappropriate, as this dose is suboptimal and may result in reduced glycemic control. The correct dose in this case would be 100 mg daily. For dapagliflozin, no kidney adjustment is required for $eGFR_{BSAadj}$ ≥ 45 mL/min, making continued use of the current dose appropriate (especially for the benefit of slowing CKD progression independent of glycemic management). The regimen from answer B aligns with the 2020 KDIGO Diabetes Guidelines to optimize glycemic management, ensuring that all medications are dosed appropriately based on the patient's kidney function.

Patient Summary: Let's walk through these changes together so you feel comfortable with them and confident about managing your medications at home.

Vignette 7 – Inpatient Care/Infectious Disease/Anticoagulation

A 75-year-old woman was admitted to the hospital a week ago for diabetic foot infection. The infectious diseases team was consulted and recommended cefepime following successful surgical debridement.

Past Medical History

- Chronic kidney disease (Stage G3b)
- Type 2 diabetes
- Hypertension
- Dyslipidemia
- Coronary artery disease
- Atrial fibrillation
- Cerebrovascular event 3 years ago

Current Medications

- Amlodipine 10 mg daily
- Apixaban 5 mg twice daily
- Aspirin 81 mg daily
- Insulin glargine 20 units nightly
- Linagliptin 5 mg daily
- Rosuvastatin 20 mg daily

Laboratory Information

	Today
Creatinine (mg/dL)	1.40
Cystatin C (mg/L)	1.50
**eCrCl (mL/min)*	29
***eGFRcr (mL/min/1.73 m^2)*	39
****eGFRcys (mL/min/1.73 m^2)*	40
*****eGFRcr-cys (mL/min/1.73 m^2)*	41

*eCrCl reported using original Cockroft-Gault equation with actual body weight
**Standardized eGFRcr reported using the 2021 CKD-EPIcr equation
***Standardized eGFRcys reported using the 2012 CKD-EPIcys equation
****Standardized eGFRcr-cys reported using the 2021 CKD-EPIcr-cys equation

Measurements

	Today
Height (cm)	155
Weight (kg)	52.2
BSA (m^2)	1.49

VIGNETTE 7 – QUESTIONS

1. The attending physician consulted the pharmacy for cefepime dosage recommendations for this patient. The FDA-approved prescribing information is provided below. Which of the following regimens is most appropriate?

Creatinine Clearance (mL/min)			
>60	30–60	11–29	<11
2 g IV every 8 hours	*2 g IV every 12 hours*	*1 g IV every 12 hours or 2 g IV every 24 hours*	*1 g IV every 24 hours*

   A. Cefepime 2 g IV every 8 hours
   B. **Cefepime 2 g IV every 12 hours**
   C. Cefepime 1 g IV every 12 hours
   D. Cefepime 1 g IV every 24 hours

2. The cardiologist recommended holding apixaban and initiating therapeutic-dose subcutaneous enoxaparin for atrial fibrillation management during the hospital stay. Which of the following dosages is most appropriate (in addition to monitoring for anti-factor Xa levels)?

   A. **Initiate enoxaparin 50 mg SubQ q12h**
   B. Initiate enoxaparin 50 mg SubQ q24h
   C. Initiate enoxaparin 40 mg SubQ q24h
   D. Initiate enoxaparin 30 mg SubQ q24h

3. On discharge, the attending physician consulted the pharmacy for appropriate apixaban dosing. Which of the following statements is most appropriate?

   A. Change apixaban dose to 10 mg twice daily for 7 days followed by 5 mg twice daily
   B. **Continue with apixaban home dose of 5 mg twice daily**
   C. Reduce apixaban home dose to 2.5 mg twice daily
   D. Stop apixaban and switch patient to warfarin dosed by pharmacy

4. Three months later, the nephrologist saw the patient and noted an increase in serum creatinine to 1.61 mg/dL. The nephrologist consulted you for appropriate rosuvastatin dosing. Which of the following dosing strategies is most appropriate?

   A. Rosuvastatin 40 mg daily
   B. Rosuvastatin 20 mg daily
   C. **Rosuvastatin 10 mg daily**
   D. Switch to atorvastatin 10 mg daily

VIGNETTE 7 – ANSWERS & RATIONALE

1. B. Cefepime 2 g IV every 12 hours

The KDIGO recommendations, and consensus from nephrology experts advocate for using race-agnostic eGFR equations with BSA adjustment instead of Cockroft-Gault eCrCL for medication-related decisions.

The patient's baseline serum creatinine is 1.40 mg/dL, and her standardized eGFRcr is reported as 39 mL/min/1.73 m^2 using the 2021 CKD-EPIcr equation. Her BSA is 1.49 m^2, meaning that using the indexed eGFR of 39 mL/min/1.73 m^2 slightly overestimates her kidney function. The patient's BSA-adjusted eGFR ($eGFR_{BSAadj}$) calculated using both creatinine and cystatin C—given the patient's frailty—is 35 mL/min, placing her within the range where medication dose adjustments may be necessary.

Cefepime is primarily eliminated by the kidneys, requiring dose adjustments in patients with impaired kidney function to prevent drug accumulation and associated toxicities (e.g. seizures, encephalopathy) while ensuring effective infection clearance and minimizing antimicrobial resistance. Cefepime dosing guidelines recommend a dose of 2 g IV every 12 hours for patients with an eGFR between 30-60 mL/min.

According to kidney function-based dosing guidelines, the regular dosing of cefepime 2 g IV every 8 hours is appropriate only for patients with eGFR > 60 mL/min. Since the patient's $eGFR_{BSAadj}$ is 35 mL/min, administering 2 g IV every 8 hours could lead to excessive drug accumulation, increasing the risk of toxicity, particularly neurotoxicity (seizures, encephalopathy). Reducing the dose unnecessarily (either to 1g IV every 12 hours for $eGFR_{BSAadj}$ 11-29 mL/min or 1g IV every 24 hours for $eGFR_{BSAadj}$ <11 mL/min) could result in subtherapeutic levels, undertreatment of her infection, and development of antimicrobial resistance.

2. A. Initiate enoxaparin 50 mg SubQ q12h

Cockcroft-Gault estimated creatinine clearance (eCrCl) is no longer the preferred method for medication dosing due to its limitations and lack of accuracy in diverse populations. The KDIGO recommendations and consensus from nephrology experts advocate for using race-agnostic eGFR equations with BSA adjustment instead of eCrCl for medication-related decisions.

The patient's BSA-adjusted eGFRcr-cys ($eGFRcr\text{-}cys_{BSAadj}$) is 35 mL/min, calculated using the 2021 CKD-EPIcr-cys eGFR race-agnostic equation, which incorporates both serum creatinine and cystatin C, providing the best estimate of kidney function.

Therapeutic enoxaparin dosing is adjusted based on kidney function because it is predominantly cleared by the kidneys. In patients with kidney impairment, careful dose adjustments are necessary to balance thrombotic risk and bleeding risk. Since therapeutic enoxaparin dosing is 1 mg/kg every 12 hours for $eGFR_{BSAadj}$ > 30 mL/min, the appropriate dose for this patient weighing 115 pounds (~52 kg) is 50 mg SQ every 12 hours. This dose maintains effective anticoagulation while minimizing the risk of drug accumulation and associated bleeding complications. Although the patient's Cockcroft-Gault estimated creatinine clearance (eCrCl) is 29 mL/min, this method is no longer recommended for drug dosing because it does not provide the most accurate assessment of kidney function. Adjusting the dose based on eCrCl to 50 mg SQ every 24 hours would likely result in a subtherapeutic dose for a hospitalized patient with atrial fibrillation. Since the patient remains at an increased risk of stroke and thromboembolic events, inadequate anticoagulation could lead to serious complications. Answers C and D are based on prophylactic doses to prevent venous thromboembolism (VTE) in hospitalized patients at low thrombotic risk. Using a prophylactic dose in a patient requiring therapeutic anticoagulation would increase the risk of stroke and systemic embolism.

3. B. Continue with apixaban home dose of 5 mg twice daily

The standard dose of apixaban for stroke prevention in atrial fibrillation is 5 mg twice daily. Per package insert recommendations, dose adjustment to 2.5 mg twice daily is required only if the patient meets at least two of the following criteria: age ≥80 years, body weight ≤60 kg, or serum creatinine ≥1.5 mg/dL. In this case, the patient meets only one criterion (weight 52 kg) but does not meet the serum creatinine (SCr 1.40 mg/dL) or age (75 years) thresholds for dose reduction. Therefore, the appropriate dose remains 5 mg twice daily. The dosing in Answer A, 10 mg twice daily for 7 days then 5 mg twice daily, is incorrect because this dosing regimen is used for the treatment of venous thromboembolism (VTE), not atrial fibrillation. Apixaban remains an appropriate and effective anticoagulant for atrial fibrillation in this patient. There is no clinical indication to switch to warfarin.

Patient Summary: Based on the information available about your kidney function and overall health, the dose of 5 mg twice daily balances your overall risks of stroke and bleeding, so the medicine remains safe and effective for you.

4. C. Rosuvastatin 10 mg daily

The KDIGO recommendations and consensus from nephrology experts advocate for using race-agnostic eGFR equations with BSA adjustment instead of eCrCl for medication-related decisions. The patient's BSA-adjusted eGFRcr (eGFR-cr_{BSAadj}) is now 29 mL/min, calculated using the 2021 CKD-EPI race-agnostic equation and her new baseline creatinine of 1.61 mg/dL.

Rosuvastatin is eliminated by the kidneys, and dose adjustments are required in patients with chronic kidney disease (CKD) to minimize the risk of adverse effects. For $eGFR_{BSAadj}$ < 30 mL/min, the maximum recommended dose of rosuvastatin is 10 mg daily. Given the patient's $eGFR_{BSAadj}$ below the 30 mL/min threshold, a dose reduction to 10 mg is necessary to reduce the risk of myopathy and rhabdomyolysis. While atorvastatin is a viable alternative, there is no compelling reason to switch statins in this case. A dose-adjusted regimen of rosuvastatin 10 mg daily provides adequate lipid-lowering effects while maintaining safety in patients with CKD who require statin therapy.

Patient Summary: This lower dose of 10 mg daily still protects your health very well, while also being safer for your kidneys.