แนวทางการปรับขนาดยาใน ผู้ป่วยโรคไต ปี 2560

กลุ่มงานเภสัชกรรม

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ภาพปกจาก : http://health.kapook.com/view64451.html

แนวทางการปรับขนาดยาในผู้ป่วยโรคไต

1.ที่มาและความสำคัญ

การทำงานของไตผิดปกติมีผลกระทบต่อการขับยาออกจากร่างกาย รวมถึงเภสัชจลนศาสตร์ในด้านอื่นๆ ทั้งการดูดซึม การกระจาย และการเปลี่ยนแปลงยา ทำให้ผู้ป่วยโรคไตเรื้อรังได้รับยาในขนาดที่ไม่เหมาะสมได้บ่อย ส่งผลต่อประสิทธิผลในการรักษา และโอกาสในการเกิดผลข้างเคียงจากยา

2.คำจำกัดความ[26]

ผู้ป่วยโรคไตเรื้อรัง จัดแบ่งเป็น 5 ระยะ ตาม National Kidney Foundation K/DOQI Staging System

ระยะ	Estimated GFR* (มล./นาที/1.73 ตารางเมตร)	คำจำกัดความ
1	≥ 90	อัตราการกรองของไตปกติ แต่พบมีความผิดปกติจากการตรวจปัสสาวะ เอกซเรย์ และ/หรือพยาธิสภาพของชิ้นเนื้อไต
2	60 – 89	อัตราการกรองของไตลดลงเล็กน้อย
3a	45 – 59	อัตราการกรองของไตลดลงปานกลาง
3b	30 – 44	
4	15 – 29	อัตราการกรองของไตลดลงมาก
5	< 15 (หรือรับการบำบัดทดแทนไต)	ภาวะไตวาย

Estimated Glomerular filtration rate (eGFR)

Estimated Glomerular filtration rate (eGFR) คือ อัตราการกรองของเลือดผ่านโกลเมอรูไลของไตทั้ง 2 ข้าง หน่วยเป็น มล./นาที/1.73 ตร.ม. คำนวณด้วยสูตรCKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) จากระดับครีอะตินีนในเลือด (serum creatinine, SCr) ที่วัดด้วย enzymatic method (หรือ modified kinetic Jaffe reaction) ค่านี้ขึ้นอยู่กับอายุ โดย GFR ในคนสูงอายุจะมีค่าลดลง

ค่า eGFR ใช้เป็นค่ามาตรฐานในการจำแนกระยะ และการกำหนดแนวทางการดูแลรักษาผู้ป่วยโรคไตเรื้อรังรวมทั้งสามารถนำไปใช้ในการคัดกรอง เพื่อลดปัจจัยเสี่ยง ทางระบบหัวใจและหลอดเลือด

การคำนวณหาค่า eGFR คำนวณจากสูตรต่อไปนี้

สูตร	เพศ	Serum creatinine	Estimated GFR(eGFR)
CKD-EPI	ชาย	<0.9มก./ดล.	$141 \times (SCr/0.7)^{-0.411} \times (0.993)^{Age}$
		>0.9มก./ดล.	$141 \times (SCr/0.7)^{-1.209} \times (0.993)^{Age}$
	หญิง	<0.7มก./ดล.	$144 \times (SCr/0.7)^{-0.329} \times (0.993)^{Age}$
		>0.7มก./ดล.	$144 \times (SCr/0.7)^{-1.209} \times (0.993)^{Age}$
C-G equation (Crockcoft-Gault)	ชาย	ไม่จำกัด	(140 – Age) x BW / 72 xSCr
	หญิง	ไม่จำกัด	(140 – Age) x 0.75 x BW / 72 xSCr

Creatinine clearance (CrCl)

ความสามารถของไตในการกำจัด creatinine ออกจากร่างกาย มีหน่วยเป็น มล./นาที สามารถคำนวณได้จาก อัตราการกรองสารผ่าน โกลเมอรูไล + อัตราการคัดหลั่ง – อัตราการดูดซึม

$$CrCl = \frac{creatinine\ excreted\ /\ unit\ time}{[Cr]_{serum}} = \frac{[Cr]_{urine} \times V}{[Cr]_{serum}}$$

3. คุณลักษณะของยาที่ส่งผลในการบริหารยาแก่ผู้ป่วยภาวะไตบกพร่อง

1. High renal clearance, wide therapeutic index: penicillins, cephalosporins

   ยาที่ขับออกจากไตเป็นหลัก แต่มีช่วงการรักษาที่กว้าง เมื่อการทำงานของไตลดลง จะพบว่ายาเหล่านี้อาจเกิดการสะสมอยู่ในร่างกายได้นานหรือมากขึ้น แต่บางชนิดไม่จำเป็นต้องลดขนาดยา

2. High renal clearance, narrow therapeutic index: ;lithium, aminoglycosides, digoxin, glycopeptide antibiotics, oral hypoglycemic agents, allopurinol

   ยาที่ขับออกจากไตเป็นหลัก และมีช่วงการรักษาแคบ เป็นยากลุ่มที่สามารถก่ออันตรายเมื่อระดับยาในเลือดสูงขึ้น เนื่องจากไตขับยาออกได้ลดลง

3. Low renal clearance, wide therapeutic index: Lansoprazole

   ยาที่ขับทางไตน้อย ไม่จำเป็นต้องปรับระดับยา

4. Low renal clearance, narrow therapeutic index: phenytoin, theophylline, carbamazepine

   ยาที่ขับทางไตน้อยแต่มีช่วงการรักษาแคบ ยากลุ่มนี้แม้ว่าจะมีช่วงการรักษาแคบ แต่เป็นยาที่ขับออกจากร่างกายโดยผ่านระบบอื่นที่ไม่ใช่ไต เช่น ขับทางตับ ดังนั้นจึงไม่จำเป็นต้องลดขนาดยาในกรณีที่ผู้ป่วยมีการทำงานของไตบกพร่อง

5. Drugs that are titrated against response or a physiological parameter: ACEIs, furosemide

   ยาที่ปรับขนาดโดยพิจารณาจากการตอบสนองต่อยา เช่น ยาลดความดันโลหิต ซึ่งมีทั้งชนิดที่ขับทางไต (atenolol, ACEIs) หรือทางตับเป็นหลัก (propanolol, calcium channel blockers, alpha blockers) ซึ่งในทางปฏิบัติการเลือกใช้ยาเหล่านี้อาจไม่จำเป็นต้องพิจารณาถึงความแตกต่างดังกล่าว เนื่องจากยาที่ถูกเลือกใช้เหล่านี้มักจะเริ่มต้นในขนาดต่ำและค่อยๆ เพิ่มขนาดขึ้นโดยดูจากการตอบสนองหรือผลข้างเคียงของยา

6. Single and initial doses: Fluconazole

   การให้ยาที่เป็น single dose โดยมากมักไม่ก่อให้เกิดปัญหาหรืออันตรายต่อผู้ป่วยโรคไต แม้ในกรณีของยาที่มีช่วงการรักษาแคบ เนื่องจากยาจะมีการสะสมในร่างกายที่น้อยมาก

7. Other drugs: opioids, NSAIDs

   Opioids และ benzodiazepines โดยมากจะถูกเมทาโบไลต์ผ่านตับ และไม่เกิดพิษต่อไต อย่างไร ก็ตาม metabolites ของสารเหล่านี้สามารถออกฤทธิ์เป็นรูป active form และทำให้เกิดพิษได้ ดังนั้นจึงควรใช้อย่างระวังในผู้ป่วยโรคไต NSAIDs ส่วนมากขับออกทางไตแต่สามารถก่อให้เกิด acute renal failure โดยเฉพาะอย่างยิ่งในผู้ที่มี pre-existing renal impairment ดังนั้นจึงควรใช้อย่างระวังในผู้ที่มี underlying renal problems เพราะอาจทำให้เกิดทั้งพิษต่อไตและเกิดผลข้างเคียงมีเลือดออกในทางเดินอาหาร

4. การปรับขนาดยาในผู้ป่วยภาวะไตบกพร่อง[25]

มีแนวทางภายใต้สมมติฐานต่อไปนี้

1. Bioavailability, Volume of distribution, plasma protein binding และ non-renal clearance ไม่มีการเปลี่ยนแปลง
2. การปรับขนาดยาไม่ต้องคำนึงถึง Metabolites
3. การตอบสนองทางเภสัชวิทยาไม่เปลี่ยนแปลง
4. ยามีคุณสมบัติเป็น linear pharmacokinetics
5. ไม่มีการเปลี่ยนแปลง target drug plasma concentration

ข้อแนะนำทางเวชปฏิบัติจึงทำได้โดยการปรับลดขนาดยา (Dose reduction) หรือเพิ่มช่วงระยะเวลาในการให้ยา (Interval extension) และให้เพิ่มเติมหลังการบำบัดทดแทนไตโดยเฉพาะการฟอกเลือด

ข้อมูลในคู่มือฉบับนี้ เป็นการรวบรวมจากฐานข้อมูล Micromedex, Drug Information Handbook , K/DOQI Clinical practice guidelines, Lexi-comp และ Guideline ของ American College of Physicians รวมทั้งข้อมูลจากบริษัทผู้ผลิต โดยประกอบด้วยข้อมูลดังต่อไปนี้

1. ขนาดยาปกติในข้อบ่งใช้ต่างๆ
2. ขนาดยาที่มีการปรับตาม CrCl และ/หรือ eGFR
3. ขนาดยาที่ต้องให้เพิ่มเติมหลังการบำบัดทดแทนไตโดยเฉพาะการฟอกเลือด

งานเภสัชสนเทศและนโยบายยา
สิงหาคม 2559

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
acyclovir[1, 2, 3, 5]	5-10 mg/kg IV q 8 hr	D&I	CrCl >50:100% q 8 hr	- CrCl 25-50: 100% q 12 hr - CrCl 10-25: 100% q 24 hr	CrCl<10:50% q 24 hr	- hemodialysis: 2.5-5 mg/kg q 24 hr - peritoneal dialysis: 50% of normal dose OD
	200-800 mg oral 5 times daily		- CrCl 10-25: normal dosing regimen 800 mg 5 times daily, administer 800 mg q 8 hr - CrCl < 10: • normal dosing regimen 200 mg 5 times daily or 400 mg q 12 hr: administer 200 mg q 12 hr • normal dosing regimen 800 mg 5 times daily: administer 800 mg q 12 hr			No Data
allopurinol[1, 2, 19]	100-600 mg/day oral single or 2-3 times daily (max 800 mg/day)	D&I	- CrCl 10-20: 200 mg daily - CrCl 3-10: ≤ 100 mg daily - CrCl < 3: ≤ 100 mg/dose at extended intervals			- hemodialysis: initial 100 mg alternate days given postdialysis, increase cautiously to 300 mg based on response.
	บางตำรา		- eGFR > 50: 75% หรือ eGFR 40-59 150 mg OD - eGFR 10-50: 50% eGFR 20-39 100 mg OD - eGFR < 10: 25% eGFR 10-19 100 mg วันเว้นวัน eGFR < 10 100 mg ทุก 3 วัน			
amikacin[1, 2, 5, 10, 22]	15 – 20 mg/kg q 24 hr	D&I	- CrCl> 60: 15 – 20 mg/kg q 24 hr - CrCl 40-59: 15 mg/kg q 36 hr - CrCl 30-39: 15 mg/kg q 48 hr - CrCl < 30: not recommended **บางตำรา** eGFR > 50 ขนาดยาปกติ q 12-24 hr eGFR 10 - 50 ขนาดยาปกติ q 24 - 48 hr eGFR < 10 ขนาดยาปกติ q 48 - 72 hr			- hemodialysis: 5-7.5 mg/kg q 48-72 hr follow levels, redose when pre-HD con. <10 mg/L, redose when post-HD con. < 6-8 mg/L. - peritoneal dialysis: • intermittent dosing: 2 mg/kg per exchange OD; allow to dwell ≥ 6 hr • continuous dosing (all exchanges): Loading dose: 25 mg/L, maintenance dose: 12 mg/L

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
amoxicillin + clavulanic[1, 2]	1.2 g IV q 6-8 hr	D&I	- CrCl > 30: no change in dosage - CrCl 10-30: 1.2 g IV stat followed by 600 mg IV q 12 hr - CrCl < 10: 1.2 g IV stat followed by 600 mg IV q 24 hr			- dialysis: additional 600 mg IV dose **may need to be supplemented at the end of dialysis**
	250 mg oral q 8 hr or 500 mg q 8-12 hror 875 mg q 12 hr or 2,000 mg q 12 hr		- CrCl ≥ 30: no dosage adjustment required. - CrCl 10-30 mL: 250 -500 mg q 12 hr, do not use 875 mg tablet or extended-release tablets - CrCl < 10: 250-500 mg q 24 hr; do not use 875 mg tablet or extended-release tablets			- hemodialysis: 250-500 mg amoxicillin q 24 hr, **administer dose both during and after dialysis**, do not use 875 mg tablet or extended-release tablets.
amphotericin B[2,3]	0.25-1 mg/kg IV q 24 hr	I	CrCl >50: q 24 hr	CrCl 10-50: q 24 hr	CrCl <10 :q 24-36 hr	- peritoneal dialysis: administration in dialysate; 1-2 mg/L of peritoneal dialysis fluid either with or without low-dose IV amphotericin B
ampicillin[2,3, 5]	1-2 g IV/IM q 4-6 hr (max12 g/day)	I	CrCl >50: q 6 hr	CrCl 10-50: q 6-12 hr	CrCl <10 : q 12-24 hr	- hemodialysis: 1-2 g q 12-24 hr, **administer after hemodialysis on dialysis days** - peritoneal dialysis: 250 mg q 12 hr
	บางตำรา[1]		- eGFR > 50: q 6 hr - eGFR 10-50: q 6-12 hr - eGFR < 10: q 12-16 hr			
ampicillin + salbactam[1, 2]	1.5-3 g IV q 6 hr	D&I	- CrCl ≥ 30: no dosage adjustment required. - CrCl 15-29: 1.5-3 g q 12 hr - CrCl 5-14: 1.5-3 g q 24 hr			- hemodialysis: 1.5-3 g q 12-24 hr
atenolol[1, 2]	25-100 mg oral OD	D	- CrCl > 35: no dosage adjustment required. - CrCl 15-35: max dose 50 mg daily - CrCl < 15: max 25 mg daily			- hemodialysis: **administer dose postdialysis or administer 25-50 mg supplemental dose**. - peritoneal dialysis: supplemental dose is not required.

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
azathioprine[2]	rheumatoid arthritis - initial: 1 mg/kg/day oral as single dose or divided twice daily (max dose is 2.5 mg/kg/day) - maintenance may lower dose 0.5 mg/kg/day q 4 wk		no specific dosage adjustments provided in the manufacturer's labeling			No Data
	บางตำรา[2]	D	100%	75%	50%	- hemodialysis: 50%, supplement: 0.25 mg/kg
benzathine + benzylpenicillin[1] (Penicillin G Benzathine)	1.2-2.4 million units IM at 1-week intervals	D	- eGFR > 50: 100% - eGFR 10-50: 75% - eGFR < 10: 20-50%			- CAPD: is 20-50% q 6 hr
benzylpenicillin (penicillin G sodium)[1, 2, 5]	1-24 million units/day IV/IM divided doses q 4-6 hr	D&I	- CrCl > 10 and uremia: full loading dose IV/IM, followed 50% loading dose q 4-5 hr		- CrCl < 10 and uremia: full loading dose IV/IM, followed 1/2 loading dose q 8-10 hr	- hemodialysis: normal dose followed by either 25-50% of normal dose q 4-6 hr or 50-100% of normal dose q 8-12 hr
	บางตำรา[10]		- eGFR > 50: 100% - eGFR 10-50: 75% - eGFR < 10: 20-50%			

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR					Remark
cefazolin[1, 2, 5]	1-1.5 g IV/IM q 8 hr (max12 g/day)	D&I	- CrCl ≥ 55: usual dose and interval - CrCl 35-54: 100% q 8 hr - CrCl 11-34: 50% q 12 hr - CrCl ≤ 10: 50% q 18-24 hr; - eGFR > 50: q 8 hr - eGFR 10-50: q 12 hr - eGFR < 10: q 24-48 hr					- hemodialysis: 500-1000 mg q 24 hr or use 1-2 g q 48-72 hr or 15-20 mg/kg (max dose 2 g) IV after dialysis 3 times weekly or 2 g after dialysis if next dialysis expected in 48 hr or 3 g after dialysis if next dialysis is expected in 72 hr - peritoneal dialysis: 0.5 g q 12 hr follow peritoneal dialysis
cefdinir[1, 2]	300 mg oral q 12 hr (100 mg oral q 8 hr; mims Thailand)[23]	I	- CrCl ≥ 30: no dosage adjustment required. - CrCl < 30: 300 mg OD					- hemodialysis: • **initial dose: 300 mg (or 7 mg/kg/dose) every other day.** • **postdialysis, 300 mg (or 7 mg/kg/dose) should be given**. • subsequent doses (300 mg or 7 mg/kg/dose) should be administered every other day.
cefepime[1, 2]	1-2 g q 12 hr	D&I	normal renal function	500 mg q 12 hr	1 g q 12 hr	2 g q 12 hr	2 g q 8 hr	
			- CrCl 30-60: - CrCl 11-29: - CrCl < 11:	500 mg q 24 hr 500 mg q 24 hr 250 mg q 24 hr	1 g q 24 hr 500 mg q 24 hr 250 mg q 24 hr	2 g q 24 hr 1 g q 24 hr 500 mg q 24 hr	2 g q 12 hr 2 g q 24 hr 1 g q 24 hr	
			- hemodialysis: 1 g on day 1 maintenance 0.5-1 g q 24 hr or 1-2 g q 48-72 hr or 2 g 3 times weekly after dialysis - peritoneal dialysis: give recommended dose q 48 hr					

<table>
<tr><th>Drug</th><th>Normal dose /interval</th><th>Method</th><th colspan="3">CrCl (ml/min) or eGFR</th><th>Remark</th></tr>
<tr><td rowspan="7">cefixime[1, 2]</td><td rowspan="7">400 mg oral OD or 200 mg q 12 hr (100 mg/capsule)</td><td rowspan="7">D</td><td rowspan="2">CrCl (mL/min)</td><td>capsule</td><td>chewable Tablet</td><td rowspan="7">- hemodialysis
• chewable tablet, tablet: not recommended
• suspension: 260 mg OD
- CAPD (not significantly removed by peritoneal dialysis):
• chewable tablet, tablet: 200 mg OD
• 100 mg/5 mL suspension: 172 mg OD
• 200 mg/5 mL suspension: 176 mg OD
• 500 mg/5 mL suspension: 180 mg OD</td></tr>
<tr><td>100 mg</td><td>200 mg</td></tr>
<tr><td>≥ 60</td><td colspan="2">normal dose</td></tr>
<tr><td>21-59</td><td colspan="2">not recommended</td></tr>
<tr><td>≤ 20</td><td>4 cap OD</td><td>1 tab OD</td></tr>
<tr><td colspan="3">Canadian labeling:
- CrCl ≥ 40: no dosage adjustment required.
- CrCl 20-40: 75%
- CrCl < 20: 50%</td></tr>
<tr><td>cefoperazone + sulbactam[1, 14] (ปรับขนาด Sulbactam)</td><td>1-2 g q 12 hr</td><td>D</td><td colspan="3">- CrCl 15-30: max 1 g of sulbactam administered q 12 hr (max daily dosage 2 g sulbactam)
- CrCl < 15: max 500 mg of sulbactam q 12 hr (max daily dosage of 1 g sulbactam)</td><td>หลังทำ Hemodialysis ให้ Supplement 1 g</td></tr>
<tr><td rowspan="2">cefotaxime[1, 2,3]</td><td>- uncomplicated infections: 1 g IM/IV q 12 hr
- moderate-to-severe infections: 1-2 g IM/IV q 8 hr
- life-threatening infections: 2 g IV q 4 hr</td><td>D&I</td><td colspan="3">- eGFR > 50: q 6 hr
- eGFR 10-50: q 6-12 hr
- eGFR < 10: q 24 hr or 50%</td><td rowspan="2">- hemodialysis: 1-2 g IV q 24 hr (on dialysis days, administer after hemodialysis)
- peritoneal dialysis: 1 g IV q 24 hr</td></tr>
<tr><td>บางตำรา[13]</td><td>D</td><td colspan="3">- CrCl < 20: 50%.</td></tr>
</table>

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
ceftazidime[1, 2]	0.5-2 g IV q 8 hr	D&I	- dose recommended is lower than that recommended for patients with renal insufficiency as outlined below, **the lower dose should be used** - severe infections, (6 g/day in patients without renal impairment) consider increasing the doses below by 50% or increase the dosing frequency - CrCl 31-50: 1 g q 12 hr - CrCl 16-30: 1 g q 24 hr - CrCl 6-15: 500 mg q 24 hr - CrCl < 5: 500 mg q 48 hr			- **hemodialysis: 0.5-1 g q 24 hr or 1-2 g q 48-72 hr** - Peritoneal dialysis: • intermittent: Loading dose 1 g followed by 500 mg q 24 hr • continuous: Loading dose of 1 g followed by 500 mg q 24 hr
ceftriaxone[1, 2]			no dosage adjustments provided in the manufacturer's labeling, in patients with concurrent renal and hepatic impairment, **max daily dose should not exceed 2 g**			dialysis: poorly dialyzed; no supplemental dose or dosage adjustment necessary
cephalexin[1, 3]	250-1000 mg oral q 6 hr or 500 mg q 12 hr (max 4 g/day)	D&I	- CrCl ≥ 60: no dosage adjustment required. - CrCl 30-59: no dosage adjustment necessary, do not exceed 1,000 mg/day. - CrCl 15-29: 250 mg q 8-12 hr - CrCl 5-14: 250 q 24 hr - CrCl 1-4: 250 mg q 48-60 hr			- hemodialysis: the following guidelines have been used by some clinicians: 250-500 mg oral q 12-24 hr, give dose after dialysis session. - peritoneal dialysis: the following guidelines have been used by some clinicians: 250-500 mg oral q 12-24 hr
	บางตำรา[2]		no dosage adjustment required.	500 mg q 8-12 hr	250-500 mg q 12-24 hr	- hemodialysis: 250 mg q 12-24 hr, **give dose after dialysis sesion**
cetirizine[1]	5-10 mg OD, (max dose 10 mg daily)		no dosage adjustments provided in the manufacturer's labeling			
	บางตำรา[3]		- eGFR > 50: no dosage adjustment required. - eGFR ≤ 50: 5 mg OD			- hemodialysis: 5 mg OD, 5 mg 3 times per week may also be effective. - peritoneal dialysis: 5 mg OD

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
ciprofloxacin[1, 2]	400 mg IV q 12 hr	D&I	- CrCl ≥ 30: no dosage adjustment required. - CrCl 5-29: 200-400 mg q 18-24 hr			- hemodialysis: 200-400 mg q 24 hr
	บางตำรา[3]	D	no dosage adjustment required.	50-75% q 12 hr	50% q 12 hr	
	500-750 mg oral q 12 hr	D&I	- CrCl ≥ 50: no dosage adjustment required. - CrCl 30-50: 250-500 mg oral q 12 hr - CrCl 5-29: 250-500 mg oral q 18 hr			- hemodialysis: 250-500 mg q 24 hr ให้ยาหลังทำ
clarithromycin[1, 2, 3]	250-500 mg oral q 12 hr or 1000 mg (two 500 mg extended-release tablets) OD	D	- CrCl ≥ 30: no dosage adjustment required. - CrCl < 30: 50%			- hemodialysis: administer after HD session is completed
colistimethate (colistin) [1, 2]	2.5-5 mg/kg per day of colistin IM/IV in 2 to 4 divided doses (max 5 mg/kg/day)	D&I	- CrCl ≥ 80: no dosage adjustment required. - CrCl 50-79: 2.5-3.8 mg/kg/day in 2 divided doses - CrCl 30-49: 2.5 mg/kg/day once daily or in 2 divided doses - CrCl 10-29: 1.5 mg/kg every 36 hr			- hemodialysis: 1.5 mg/kg q 24-48 hr
cyclophosphamide[1, 2]	1-5 mg/kg/dayoral	D&I	- eGFR > 50: 100% q 12 hr - eGFR 10-50: 75% q 12hr - eGFR < 10: 50% q 18-24 hr			- hemodialysis: **50% of normal dose administer after hemodialysis** - peritoneal dialysis: 75% of normal dose
	บางตำรา[3]	D	- CrCl ≥ 10: no dosage adjustment required. - CrCl < 10: 75%			

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR	Remark
colchicine[1, 2,25]	- **gout prophylaxis**: 0.6 mg oral once or twice daily (max 1.2 mg/day) - **gout flare** treatment: 1.2 mg oral at the first sign of a flare followed by 0.6 mg one hr later (max 1.8 mg over 1 hr) - **familial mediterranean fever**: 1.2-2.4 mg oral daily, increase or decrease in increments of 0.3 mg/day	D&I	**gout prophylaxis**: - CrCl 30-80: no adjustment required, but monitor closely for toxicity - CrCl < 30: initiate therapy with 0.3 mg/day, adequately monitor with any dose increase **gout flare treatment**: - CrCl 30-80: no dosage adjustment required. - CrCl < 30: no dosage adjustment require., but do not repeat treatment course more often than once q 2 weeks **familial mediterranean fever**: - CrCl 30-80: adjustment may be necessary. - CrCl < 30: initiate therapy with 0.3 mg/day. adequately monitor any dose increase GFR 10-50 : 50%-100% ของขนาดปกติ GFR < 10 : 25% ของขนาดปกติ	- dialysis • gout flare treatment: 0.6 mg as a single dose; treatment course should not be repeated more frequently than q 14 days. • familial mediterranean fever: 0.3 mg as a single dose, use caution if dose titrated
dapsone[2]	25-100 mg oral OD		no dosage adjustment required.	- hemodialysis: pneumocystis prophylaxis; 50 mcg twice daily, at least one of the doses should be given after dialysis
diclofenac[1, 2]	37.5 mg IV q 6 hr as needed (max 150 mg daily)		- CrCl 10-49: IV formulation not recommended - CrCl 10-49 and at risk for volume depletion in postoperative period: IV formulation contraindicated	
	50 mg oral 3 times daily		no dosage adjustments provided in the manufacturer's labeling; not recommended in patients with advanced renal disease or significant renal impairment	

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
digoxin[1, 2, 3]	loading dose: 0.25 mg IV q 2 hr up to 1.5 mg,	D	ESRD: reduce dose by 50%			- **hemodialysis: 0.0625 mg q 48 hr 10-25% of the usual dose q 48 hr)** - CAPD: 0.0625 mg q 48 hr (10- 25% of the usual dose q 48 hr)
	maintenance dose: 0.125-0.375 mg IV daily (guideline dosing)	D&I	- eGFR > 50: no dosage adjustment required. - eGFR 10- 50: 0.0625 mg q 24-36 hr (25-75% q 24-36 hr) - eGFR < 10: 0.0625 mg q 48 hr (10-25% q 48 hr)			
enalapril[2]	- **heart failure**: initial, 2.5 mg oral twice daily; maintenance, 2.5 -20 mg twice daily, (max 40 mg) - **hypertension**: initial, 5 mg orally OD, maintenance, 10-40 mg oral OD or in 2 divided doses (max 40 mg/day)	D	- CrCl > 30: no dosage adjustment required. - CrCl ≤ 30: 2.5 mg/day; titrated upward until blood pressure is controlled.			- hemodialysis: Initial: 2.5 mg on dialysis days, adjust dose on nondialysis days depending on blood pressure response.
	บางตำรา[3]	D	100%	75-100%	50%	- peritoneal dialysis: supplemental dose is not necessary.

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
enoxaparin[1, 2]			- CrCl ≥ 30: no dosage adjustment required. - CrCl < 30: • DVT prophylaxis: SC 30 mg OD • DVT treatment: SC 1 mg/kg OD • STEMI: Initial: <75 years 30 mg IV single dose, ≥75 years Omit IV bolus Maintenance: SC 1 mg/kg OD (the first dose of the SC maintenance regimen administered at the same time as the IV bolus) • unstable angina, NSTEMI: SC 1 mg/kg OD			- dialysis: Enoxaparin has not been FDA approved for use in dialysis patients
ertapenem[1,2, 4]	1 g IV/IM OD	D	- CrCl >30: no dosage adjustment required. - CrCl ≤30 and ESRD: 500 mg/day			- hemodialysis: 500 mg IV every 24 hours; **supplemental dose of 150 mg after hemodialysis if last dose administered within 6 hours prior to hemodialysis** - CAPD: 500 mg IV OD
fenofibrate (supralip®NT)[21]	145 mg once daily		• dosage reduction is required in patients with renal impairment. • contraindications in serious renal insufficiency.			No Data
fentanyl[2]			no dosage adjustment provided in manufacturer's labeling; use with caution.			No Data
	บางตำรา[3]	D	100%	75%	50%	
fluconazole[1, 2, 5]	150 mg oral/IV once or loading dose 200-800 mg, maintenance: 200-800 mg OD	D	- no adjustment for vaginal candidiasis single-dose therapy - multiple dosing in adults, administer loading dose of 50-400 mg, then adjust daily doses as follows • CrCl > 50: 100% • CrCl ≤ 50: 50%			- hemodialysis: • manufacturer's 100% after each dialysis session; on nondialysis days, patient should receive a reduced dose according to their CrCl. • alternate recommendations: doses of 200 -400 mg q 48-72 hr or 100-200 mg q 24 hr

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
Fexofenadine[25]	60 mg BID	I	eGFR <80 : 60 mg OD			No Data
fosfomycin[15]		D	normal renal function	2 g q 12 hr	4 g q 12 hr	4 g q 8 hr
			- CrCl 80-100:	2 g q 12 hr	4 g q 12 hr	4 g q 8 hr
			- CrCl 40-50:	1 g q 12 hr	2 g q 12 hr	2 g q 8 hr
			- CrCl 20-30:	500 mg q 12 hr	1 g q 12 hr	1 g q 8 hr
flupentixol decanoate			renal insufficiency is contraindicated however the labeling also suggests that dosage adjustments are not required in renal impairment			
furosemide[1]	max 1500-2000 mg IV		- up to 3200 mg/day (Large doses should be administered at a rate < 500 mg/hr) have been used in patients with severe renal failure. - Scr > 5: administration rate < 4 mg/min when using high dose - avoid use in oliguric states			- hemodialysis and peritoneal dialysis: supplemental dose is not necessary.
gabapentin[1, 2]	Neuropathic pain, Postherpetic neuralgia : 300-3,600 (Titrated as need for pain)	D&I	- CrCl ≥ 60: 300-1,200 mg 3 times daily - CrCl 30-59: 200-700 mg twice daily - CrCl 15-29: 200-700 mg OD - CrCl 15: 100-300 mg OD - CrCl < 15: reduce daily dose in proportion to CrCl based on dose for creatinine clearance of 15 mL/min (eg, reduce dose by one-half [range: 50 to 150 mg/day] for CrCl 7.5 mL/minute)			- hemodialysis: dose based on CrCl plus a single supplemental dose of 125-350 mg (given after each 4 hr of hemodialysis)
ganciclovir[1, 2]	- induction: 5 mg/kg IV q 12 hr for 14-21 days - maintenance: 5 mg/kg/day IV OD for 7 days/week or 6 mg/kg/day for 5 days/week	D&I	induction: - CrCl 50-69: 2.5 mg/kg/dose q 12 hr - CrCl 25-49: 2.5 mg/kg/dose q 24 hr - CrCl 10-24: 1.25 mg/kg/dose q 24 hr - CrCl < 10: 1.25 mg/kg/dose 3 times/week following hemodialysis. maintenance: - CrCl 50-69: 2.5 mg/kg/dose q 24 hr - CrCl 25-49: 1.25 mg/kg/dose q 24 hr - CrCl 10-24: 0.625 mg/kg/dose q 24 hr - CrCl < 10: 0.625 mg/kg/dose 3 times/week following hemodialysis.			- hemodialysis (administer after hemodialysis on dialysis days): • CMV Infection: IV: induction: 1.25 mg/kg q 48-72 hr, maintenance: 0.625 mg/kg q 48-72 hr • peritoneal dialysis: dose as for CrCl < 10

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR	Remark
gemfibrozil[1, 2]	600 mg oral twice daily 30 min before meals	D	manufacturer's labeling: - CrCl 31-80: no dosage adjustments provided in the manufacturer's labeling; use with caution - CrCl < 30: use is contraindicated	- hemodialysis: supplemental dose not necessary. - peritoneal dialysis: 50% supplement for dialysis
	บางตำรา		- eGFR > 50: no dosage adjustment required. - eGFR 10-50: 75% - eGFR < 10: 50%	
gentamicin[1, 22]	4–7 mg/kg q 24 hr	D&I	- CrCl> 60: 4–7 mg/kg q 24 hr - CrCl 40-59: 4–7 mg/kg q 36 hr - CrCl 30-39: 4–7 mg/kg q 48 hr - CrCl < 30: not recommended	- hemodialysis: loading dose of 2-3 mg/kg loading dose followed by: • mild UTI or synergy: 1 mg/kg q 48-72 hr • moderate-severe UTI: 1-1.5 mg/kg q 48-72 hr • systemic gram-negative rod infection:
hydralazine[1, 2]	25-50 mg บางตำรา[3]	I	no dosage adjustments provided in the manufacturer's labeling;	
			adjusted dose recommendations are based on doses of 25-50 mg q 8 hr - eGFR ≥ 10: q 8 hr - eGFR <10: q 8-16 hr	- hemodialysis: dose after dialysis - peritoneal dialysis: q 8-16 hr

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark	
		Clcr/BW (kg)	≥70	60	50	40	30
imipenem + cilastatin[1, 2]	1 g/day IV	CrCl ≥ 71	250 mg q 6 hr	250 mg q 8 hr	125 mg q 6 hr	125 mg q 6 hr	125 mg q 8 hr
		CrCl 41-70	250 mg q 8 hr	125 mg q 6 hr	125 mg q 6 hr	125 mg q 8 hr	125 mg q 8 hr
		CrCl 21-40	250 mg q 12 hr	250 mg q 12 hr	125 mg q 8 hr	125 mg q 12 hr	125 mg q 12 hr
		CrCl 6-20	250 mg q 12 hr	125 mg q 12 hr	125 mg q 12 hr	125 mg q 12 hr	125 mg q 12 hr
	1.5 g/day IV	CrCl ≥ 71	500 mg q 8 hr	250 mg q 6 hr	250 mg q 6 hr	250 mg q 8 hr	125 mg q 6 hr
		CrCl 41-70	250 mg q 6 hr	250 mg q 8 hr	250 mg q 8 hr	125 mg q 6 hr	125 mg q 8 hr
		CrCl 21-40	250 mg q 8 hr	250 mg q 8 hr	250 mg q 12 hr	125 mg q 8 hr	125 mg q 8 hr
		CrCl 6-20	250 mg q 12 hr	250 mg q 12 hr	250 mg q 12 hr	125 mg q 12 hr	125 mg q 12 hr
	2 g/day IV	CrCl ≥ 71	500 mg q 6 hr	500 mg q8 hr	250 mg q 6 hr	250 mg q 6 hr	250 mg q 8 hr
		CrCl 41-70	500 mg q 8 hr	250 mg q6 hr	250 mg q 6 hr	250 mg q 8 hr	125 mg q 6 hr
		CrCl 21-40	250 mg q 6 hr	250 mg q8 hr	250 mg q 8 hr	250 mg q 12 hr	125 mg q 8 hr
		CrCl 6-20	250 mg q 12 hr	250 mg q12 hr	250 mg q 12 hr	250 mg q 12 hr	125 mg q 12 hr
	3 g/day IV 3 g/day IV (ต่อ)	CrCl ≥ 71	1000 mg q 8 hr	750 mg q 8 hr	500 mg q 6 hr	500 mg q 8 hr	250 mg q 6 hr
		CrCl 41-70	500 mg q 6 hr	500 mg q 8 hr	500 mg q 8 hr	250 mg q 6 hr	250 mg q 8 hr
		CrCl 21-40	500 mg q 8 hr	500 mg q 8 hr	250 mg q 6 hr	250 mg q 8 hr	250 mg q 8 hr
		CrCl 6-20	500 mg q 12 hr	500 mg q 12 hr	250 mg q 12 hr	250 mg q 12 hr	250 mg q 12 hr
	4 g/day IV	CrCl ≥ 71	1000 mg q 6 hr	1000 mg q 8 hr	750 mg q 8 hr	500 mg q 6 hr	500 mg q 8 hr
		CrCl 41-70	750 mg q 8 hr	750 mg q 8 hr	500 mg q 6 hr	500 mg q 8 hr	250 mg q 6 hr
		CrCl 21-40	500 mg q 6 hr	500 mg q 8 hr	500 mg q 8 hr	250 mg q 6 hr	250 mg q 8 hr
		CrCl 6-20	500 mg q 12 hr	500 mg q 12 hr	500 mg q 12 hr	250 mg q 12 hr	250 mg q 12 hr
kanamycin[1, 2,24]	15 mg/kg OD	D&I	- CrCl > 80: 15 mg/kg/day - CrCl 60-80: 12 mg/kg/day - CrCl 40-60:7.5 mg/kg/day - CrCl 30-40: 4 mg/kg/day - CrCl 20-30: 7.5 mg/kg q 48 hr - CrCl 10-20 :4 mg/kg q 48 hr - CrCl < 10 : 3 mg/kg q 72 hr			- hemodialysis**: 50% after hemodialysis on dialysis days.** - peritoneal dialysis: administration via PD fluid: 15-20 mg/L/day of PD fluid	

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR	Remark
ketorolac[1,2]	- IM: 60 mg as a single dose or 30 mg q 6 hr (max: 120 mg/day) - IV: 30 mg as a single dose or 30 mg q 6 hr (max: 120 mg/day)	D	CrCl > 30: - IM: 30 mg as a single dose or 15 mg q 6 hr (max 60 mg/day) - IV: 15 mg as a single dose or 15 mg q 6 hr (max 60 mg/day) Canadia labeling - Scr 1.9-5: 50% IM, max 60 mg/day - Scr > 5: contraindicated.	- advanced impairment or patients at risk for renal failure due to volume depletion: use is contraindicated.
lamivudine[1,2]	- HIV-1 infection: 150 mg twice daily or 300 mg OD - Type B viral hepatitis: 100 mg OD	D&I	HIV-1 infection: - CrCl ≥ 50: no dosage adjustment required. - CrCl 30-49: 150 mg OD - CrCl 15-29: 150 mg first dose, then 100 mg OD - CrCl 5-14: 150 mg first dose, then 50 mg OD - CrCl < 5: 50 mg first dose, then 25 mg OD treatment of hepatitis B patients: - CrCl ≥ 50: no dosage adjustment required. - CrCl 30-49: 100 mg first dose, then 50 mg OD - CrCl 15-29: 100 mg first dose, then 25 mg OD - CrCl 5-14: 35 mg first dose, then 15 mg OD - CrCl < 5: 35 mg first dose, then 10 mg OD	- hemodialysis and peritoneal dialysis: supplemental dosing not required.
levetiracetam[1,2]	- 500 mg oral/IV immediate release twice daily; may increase q 2 wk by 500 mg/dose to the recommended dose of 1,500 mg twice daily.	D	immediate release and IV formulations: - CrCl > 80: 500-1,500 mg q 12 hr - CrCl 50-80: 500-1,000 mg q 12 hr - CrCl 30-50: 250-750 mg q 12 hr - CrCl < 30: 250-500 mg q 12 hr	immediate release and IV formulations: - hemodialysis: 500-1000 mg q 24 hr, **supplemental dose of 250-500 mg is recommended posthemodialysis** - peritoneal dialysis: 500-1,000 mg q 24 hr

Drug	Normal dose /interval	Method	CrCl (ml/min) or e GFR			Remark	
levofloxacin[1, 2]	250-750 mg IV OD (กรณีผู้ป่วยมี Plan รับยาเป็น 3-day therapy ไม่จำเป็นต้องปรับขนาดยา)	D&I		250 mg daily	500 mg daily	750 mg daily	750 or 1000 mg daily (treatment of tuberculosis only)
			CrCl 20-49	no dosage adjustment required.	initial dose 500 mg, followed by 250 mg q 24 hr	750 mg q 48 hr	- CrCl < 30: administer 750 or 1000 mg 3 times per week - hemodialysis patients dose CrCl < 30 aminister after dialysis on dialysis days
			CrCl 10-19	250 mg q 48 hr	initial dose 500 mg, followed by 250 mg q 48 hr	initial dose 750 mg, followed by 500 mg q 48 hr	
			hemodialysis/CAPD	no information available	dose 500 mg, followed by 250 mg q 48 hr	initial dose 750 mg, followed by 500 mg q 48 hr	
Lincomycin[1]	600-1000 mg IV q 8-12 hr	D	Severe renal impairment : 25%-30% normal dose			No Data	
lithium carbonate[1, 2, 3]	600-1800 mg/d divided 2-3 doses	D	100%	50-75%	25-50%	- hemodialysis: 100% after dialysis	
loratadine[1, 2]	10 mg oral OD or 5 mg twice daily		no dosage adjustment provided in manufacturer's labeling				
	บางตำรา	I	q 24 hr	q 24-48 hr	q 48 hr	- dialysis: q 48 hr	
magnesium sulfate[1, 2]	.1-4 g IV.administer at ≤1 g/hr	D	- severe impairment: max dose of magnesium sulfate is 20 g/48 hr (2 g/48 hr elemental magnesium) - hypomagnesemia: renal dysfunction: reduce dose by 50% Use with caution, close monitoring is required. - Pre-eclampsia/eclampsia: severe renal impairment: do not exceed 20 g during a 48 hour period.				
meropenem[1, 2, 3, 5]	1.5-6 g daily divided q 8 hr	D&I	100%.	- CrCl 26-50: 100% q 12 hr - CrCl 10-25: 50% q 12 hr	50% q 24 hr	- hemodialysis: 500 mg q 24 hr - peritoneal dialysis (off-label dose): 100% q 24 hr	

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
metoclopramide[1, 2]	10-20 mg IV q 4-6 hr	D	- CrCl < 40: administer 50% of normal dose			No Data
	บางตำรา		- eGFR > 50: 100% - eGFR 10-50: 75% - eGFR < 10: 50%			
metronidazole[1, 2]	500 mg q 6-8 hr (max: 4 g/day)		- renal impairment: no dosage adjustments provided in the manufacturer's labeling - end-stage renal disease requiring dialysis: metabolites may accumulate; monitor for adverse events. - hemodialysis: If administration cannot be separated from hemodialysis, consider supplemental dose following hemodialysis. - peritoneal dialysis: no dosage adjustment required.			
midazolam[1, 2]		D	- CrCl < 10: 50%			No Data
	บางตำรา		no dosage adjustments provided in manufacturer's labeling			
mitomycin C[1, 2, 3]		D	100%	100%	75%	- Scr > 1.7: avoid use - CAPD: 75%
morphine sulfate[1, 2,25]	- opioid naive: 2.5-5 mg IV q 3-4 hr	D	- no specific dosage adjustments, recommend starting cautiously with lower doses, titrating slowly while carefully monitoring for side effects บางตำรา แนะนำว่า eGFR 25-50 : 75% ของขนาดปกติ eGFR 10-20 : 50% ของขนาดปกติ			
neostigmine[1, 2, 3]			no dosage adjustments provided in manufacturer's labeling			No Data
		D	100%	50%	25%	
octreotide[1, 2]	bleeding esophageal varices: 50 mcg IV bolus, then 50 mcg/hr IV continuously for 2-5 days		- CrCl > 10: no dosage adjustments provided in the manufacturer's labeling.			- dialysis-dependent impairment: no specific dosage adjustments provided in the manufacturer's labeling, dosage adjustment may be needed since clearance is reduced by ~50%.
oxytetracycline[1]	250-500 mg IV q12 hr	I	- should be avoided in patients with impaired renal function. - eGFR > 50: q 8-12 hr - eGFR 10-50: q 12-24 hr - eGFR < 10: q 24 hr (It is best avoided in these patients)			No Data

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR	Remark
oseltamivir (oral)[1, 2]	- treatment of influenza: 75 mg oral twice daily for 5 days; higher doses	D&I	**treatment of influenza** - CrCl > 60: no dosage adjustment required. - CrCl 30-60: 30 mg twice daily for 5 days - CrCl 10-30: 30 mg once daily for 5 days - CrCl < 10: use not recommended - CAPD: single 30-mg dose immediately after a dialysis exchange - ESRD on dialysis: may initiate immediately if symptomatic during the 48 hr between sessions; then give 30 mg after every hemodialysis cycle, not to exceed 5 days independently from the time of the initial dose	
	- prophylaxis of influenza: 75 mg oral OD for 7-10 days		**prophylaxis of influenza** - CrCl > 60:no dosage adjustment required. - CrCl 30-60: 30 mg OD - CrCl 10-30: 30 mg every other day - CrCl < 10: use not recommended - CAPD: 30 mg once weekly for the recommended prophylaxis duration. administer immediately after a dialysis exchange - ESRD on dialysis: may initiate prior to the start of dialysis; then give 30 mg after alternate hemodialysis cycles	
paracetamol[1, 2]	- BW < 50: 15 mg/kg q 6 hr or 12.5 mg/kg q 4 hr; max single dose: 15 mg/kg/dose; max daily dose: 75 mg/kg/day - BW ≥50: 650 mg q 4 hr or 1000 mg q 6 hr; max single dose: 1000 mg/dose (max daily dose: 4 g daily)	D&I	- CrCl ≤ 30: use with caution, consider decreasing daily dose and extending dosing interval	

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
pethidine[1, 6, 7]			avoid use in renal impairment			No Data
	บางตำรา	D	100%	75%	50%	
phenobarbital[1, 2, 3]		I	no dosage adjustment required.		q 12-16 hr	
	บางตำรา		- eGFR > 10: no dosage adjustment required. - eGFR < 10: q 12-16 hr			- hemodialysis: **administer dose before dialysis and 50% of dose after dialysis**. - peritoneal dialysis: 50% of normal dose.
phenytoin[1, 2]	loading dose 10-15 mg/kg IV, maintenance doses of 100 mg oral/IV q 6-8 hr		- no dosage adjustments provided in the manufacturer's labeling, - serum conc. may be difficult to interpret in renal failure. monitoring of free (unbound) conc. or adjustment to allow interpretation is recommended.			
piperacillin + tazobactam[1, 2]	3.375 g IV q 6 hr or 4.5 g IV q 6 to 8 hr (max 18 g daily)	D&I	- CrCl > 40: no dosage adjustment required. - CrCl 20-40: 2.25 g q 6 hr (3.375 g q 6 hr for nosocomial pneumonia) - CrCl < 20: 2.25 g q 8 hr (2.25 g q 6 hr for nosocomial pneumonia)			• 2.25 g q 12 hr (2.25 g q 8 hr for nosocomial pneumonia), scheduled doses after hemodialysis on dialysis days • if not due right after dialysis: administer an additional dose of 0.75 g after the dialysis session. - peritoneal dialysis: 2.25 g q 12 hr (2.25 g q 8 hr for nosocomial pneumonia)
Propranolol[25]	Hypertension 80-240 mg/day Angina 80-320 mg/day Arrhythmia 30-160 mg/day		eGFR 10-40 : 50% หรือขนาดปกติ ทุก 24-36 ชม. eGFR <10 : 25% หรือขนาดปกติ ทุก 40-60 ชม.			

<table>
<tr><th>Drug</th><th>Normal dose /interval</th><th>Method</th><th colspan="5">CrCl (ml/min) or eGFR</th><th colspan="2">Remark</th></tr>
<tr><td rowspan="7">pregabalin[1, 2]</td><td rowspan="7"></td><td rowspan="7">D&I</td><td>CrCl (mL/min)</td><td colspan="3">total pregabalin daily dose (mg/day)</td><td colspan="2">dose regimen</td></tr>
<tr><td>> 60</td><td>150</td><td>300</td><td>450</td><td>600</td><td>tid, bid</td></tr>
<tr><td>30-60</td><td>75</td><td>150</td><td>225</td><td>300</td><td>tid, bid</td></tr>
<tr><td>15-30</td><td>25-50</td><td>75</td><td>100-150</td><td>150</td><td>bid, OD</td></tr>
<tr><td>< 15</td><td>25</td><td>25-50</td><td>50-75</td><td>75</td><td>OD</td></tr>
<tr><td colspan="6">posthemodialysis supplementary dosage (as a single additional dose):
- 25 mg/day: single supplementary dose of 25 mg or 50 mg
- 25-50 mg/day: single supplementary dose of 50 mg or 75 mg
- 50-75 mg/day schedule: single supplementary dose of 75 mg or 100 mg
- 75 mg/day: single supplementary dose of 100 mg or 150 mg</td></tr>
<tr><td>quinine[8]</td><td>initial dose 16.4 mg (equivalent to 20 mg of dihydrochloride)/kg infused over 4 hr followed by 8.2 mg/kg
q 8 hr in adults and q 12 hr in children</td><td>D</td><td colspan="6">maintenance doses should be reduced threefold in patients with impaired renal function.</td></tr>
<tr><td>ranitidine[2]</td><td>- intermittent bolus or infusion: 50 mg q 6-8 hr max 400 mg/day)
- continuous IV infusion: 6.25 mg/hr
Oral:150mg BID</td><td>D&I</td><td colspan="5">IV
CrCl < 50 50 mg IV q 18-24 hr, adjust dose cautiously if needed
Oral
CrCl < 50 150 mg q 18-24 hr, adjust dose cautiously if needed</td><td>hemodialysis: administer dose after dialysis</td></tr>
</table>

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR			Remark
risperidone[1, 2]		D	- CrCl ≥ 30: no dosage adjustments provided in the manufacturer's labeling, may be decreased and doses should be reduced in patients with renal disease - CrCl < 30: 0.5 mg twice daily; titrate slowly in increments of no more than 0.5 mg twice daily; increases to dosages > 1.5 mg twice daily should occur at intervals of ≥ 1 week			- limiting initial dose to 1 mg daily (in 2 divided doses) may reduce the risk of orthostatic hypotension/syncope.
rosuvastatin[1, 2]	5-40 mg OD (max 40 mg/day)	D	- CrCl ≥ 30: no dosage adjustment required. - CrCl < 30: initial: 5 mg OD (max: 10 mg/day)			No Data
simvastatin[1, 2]	5-40 mg oral daily	D	- CrCl 30-80: no dosage adjustment required. - CrCl < 30: initial 5 mg/day with close monitoring.			No Data
sitagliptin[1, 2]	100 mg oral OD	D	no dosage adjustment required.	- CrCl 30-50: 50 mg OD - CrCl < 30: 25 mg OD		- hemodialysis or peritoneal dialysis: 25 mg OD, administer without regard to timing of hemodialysis
streptomycin[1, 2]	1-2 g IM q 6-12 hr	I	no dosage adjustment required.	q 24-72 hr	q 72-96 hr	- hemodialysis: **50% the recommended dose administered after hemodialysis on dialysis days** - peritoneal dialysis: administration via PD fluid: 20-40 mg/L of PD fluid
	บางตำรา		- eGFR > 50: q 24 hr - eGFR 10-50: q 24-72 hr - eGFR < 10: 72-96 hr			
sulfamethoxazole + trimethoprim[1, 2, 3]	8-20 mg TMP/kg/day IV divided q 6-12 hr	D	- CrCl > 30: 100% - CrCl 15-30: 50% - CrCl < 15: use is not recommended			- hemodialysis: **2.5-10 mg/kg trimethoprim q 24 hr or 5-20 mg/kg trimethoprim 3 times weekly after IHD.**
	บางตำรา[2]	D&I	- CrCl 15-30: • treatment: 100% (divided q 12 hr) for 24-48 hr, then decrease daily dose by 50% and administer q 24 hr (note: for serious infections including *Pneumocystis jirovecii* pneumonia (PCP), full daily dose is given in divided doses q 6-8 hr for 2 days, followed by reduction to 50% daily dose divided q 12 h) - CrCl <15: • treatment: 100% q 48 hr			

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR	Remark
terbutaline[1]	0.25 mg SC once; may repeat in 15-30 min, max 0.5 mg/4 hr	D	- eGFR > 50: 100% - eGFR 10-50: 50% - eGFR < 10: should be avoided	No Data
tenofovir[1, 2, 18]	300 mg oral OD	I	manufacturer's labeling: - CrCl ≥ 50: no dosage adjustment required. - CrCl 30-49: 300 mg q 48 hr - CrCl 10-29: 300 mg q 72-96 hr - CrCl < 10: no dosage adjustment provided in manufacturer's labeling; has not been studied. IDSA recommendations: - CrCl < 50 or GFR < 60: avoid use	- hemodialysis: **300 mg following dialysis q 7 days or after a total of ~12 hr of dialysis** - peritoneal dialysis: use with caution, dose reduction recommended.
topiramate[1, 2]	begin 25-50 mg/day oral, may increase dosage by 25-50 mg/day at 1-week intervals to the usual maintenance dose of 200-400 mg/day in 2 divided doses	D	- CrCl < 70: administer 50% and titrate more slowly.	- hemodialysis: supplemental dose may be needed during hemodialysis
Tramadol[1,2,9]	50 -100 mg IV q 4-6 hr	D	CrCl < 30 mL/min (immediate-release, orally-disintegrating tablets), increase dosing interval to 12 hours; MAX 200 mg/day	hemodialysis: (immediate-release tablets), **increase dosing interval to 12 hours**; MAX 200 mg/day; no supplemental dose required

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR						Remark			
tranexamic acid[1, 2]	IV: Canadian labeling (regardless of indication)	I	- Scr 1.4-2.8: 10 mg/kg IV twice daily - Scr 2.8- 5.7: 10 mg/kg IV q 24 hr - Scr ≥ 5.7: 10 mg/kg IV q 48 hr						No Data			
	IV: Cardiac surgery	D	- Scr 1.6-3.3: reduce maintenance infusion to 1.5 mg/kg/hr (based on a 25% reduction from 2 mg/kg/hr) - Scr 3.3-6.6: reduce maintenance infusion to 1 mg/kg/hr (based on a 50% reduction from 2 mg/kg/hr) - Scr > 6.6: reduce maintenance infusion to 0.5 mg/kg/hr (based on a 75% reduction from 2 mg/kg/hr)									
	oral: cyclic heavy menstrual bleeding		- Scr 1.4-2.8: 1300 mg twice daily (2600 mg daily) for up to 5 days - Scr 2.9- 5.7: 1300 mg once daily for up to 5 days - Scr ≥ 5.7: 650 mg once daily for up to 5 days									
	oral: Canadian labeling (regardless of indication)		- Scr 1.4-2.8: 15 mg//kg twice daily - Scr 2.8- 5.7: 15 mg/kg q 24 hr - Scr ≥ 5.7: 15 mg/kg q 48 hr									
vancomycin[2]	500 mg q 6 hr or 1,000 mg q 12 hr	D&I	- CrCl > 50: start with 15 to 20 mg/kg/dose (usual: 750-1,500 mg) q 8-12 hr - CrCl 20-49: start with 15- 20 mg/kg/dose (usual: 750- 1,500 mg) q 24 hr - CrCl < 20: wiill need longer intervals; determine by serum concentration monitoring						- hemodialysis (administer after hemodialysis on dialysis days): following loading dose of 15-25 mg/kg, give either 500-1,000 mg or 5-10 mg/kg after each dialysis session - peritoneal dialysis (PD): loading dose of 1,000 mg, followed by 500- 1,000 mg q 48-72 hr with close monitoring of levels			
	บางตำรา[10]		- eGFR > 50: 500 mg IV q 6-12 hr - eGFR: 10-50: 500 mg IV q 24-48 hr - eGFR < 10: 500 mg q 48-96 hr						- hemodialysis: 500 mg IV q 48-96 hr			
	บางตำรา[11]	CrCl	10	20	30	40	50	60	70	80	90	100
		dose (mg/24 hr)	155	310	465	620	770	925	1080	1235	1390	1545

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR	Remark
valacyclovir[1, 2]	- **Herpes zoster, Shingles**: 1 g oral 3 times daily for 7 days - **genital herpes simplex:** • initial episode: 1 g oral twice daily for 10 days • recurrent episode: 500 mg oral twice daily for 3 days - **Herpes labialis**: 2 g oral twice daily for 1 day; separate doses by 12 hr	I	**Herpes zoster:** - CrCl 30-49: 1 g q 12 hr - CrCl 10-29: 1 g q 24 hr - CrCl < 10: 500 mg q 24 hr **genital herpes:** - initial episode: • CrCl 10-29: 1 g q 24 hr • CrCl < 10: 500 mg q 24 hr - recurrent episode: • CrCl < 29: 500 mg q 24 hr - suppressive therapy: • CrCl < 29: - usual dose of 1 g q 24 hr, decrease dose to 500 mg q 24 hr - usual dose of 500 mg q 24 hr, decrease dose to 500 mg q 48 hr - HIV-infected patients: 500 mg q 24 hr **Herpes labialis:** - CrCl 30-49: 1 g q 12 hr for 2 doses - CrCl 10-29: 500 mg q 12 hr for 2 doses - CrCl < 10: 500 mg as a single dose	- hemodialysis: dialyzable: administer dose postdialysis

Drug	Normal dose /interval	Method	CrCl (ml/min) or eGFR		Remark
voriconazole[1, 2, 16, 17]	- initial: 6 mg/kg IV q 12 hr for 2 doses - maintenance dose: 4 mg/kg IV q 12 hr		no dosage adjustments provided in the manufacturer's labeling	• no specific dosage adjustments provided in the manufacturer's labeling. • due to accumulation of the intravenous vehicle (cyclodextrin), recommends the use of oral voriconazole in these patients unless an assessment of the benefit:risk justifies the use of IV voriconazole • if IV therapy is used, closely monitor Scr and change to oral voriconazole when possible. IV therapy has been used in select patients with CrCl < 50 using varying doses	
	- oral: maintenance dose: titrate in 50 mg/dose increments for weight < 40 kg and 100 mg/dose increments for weight ≥40 kg. • weight < 40 kg: 100 mg q 12 hr • weight ≥40 kg: 200 mg q 12 hr		- CrCl > 30: no dosage adjustment required.		- hemodialysis and peritoneal dialysis: no supplemental dose or dosage adjustment required.

<table>
<tr><th>Drug</th><th>Normal dose /interval</th><th>Method</th><th colspan="6">CrCl (ml/min) or eGFR</th><th>Remark</th></tr>
<tr><td rowspan="4">zoledronic acid[1, 2]</td><td>nononcology uses</td><td></td><td colspan="6">- CrCl ≥ 35: no dosage adjustment required.
- CrCl < 35: use is contraindicated</td><td>- paracetamol administration after the infusion may reduce symptoms of acute-phase reactions.</td></tr>
<tr><td rowspan="2">oncology uses</td><td rowspan="2">multiple myeloma and bone metastases</td><td>CrCl</td><td>>60</td><td>50-60</td><td colspan="2">40-49</td><td>30-39</td><td>< 30</td></tr>
<tr><td>dose (mg)</td><td>4</td><td>3.5</td><td colspan="2">3.3</td><td>3</td><td>use is not recommended</td></tr>
<tr><td>hypercalcemia of malignancy</td><td colspan="7">- mild-moderate impairment: no dosage adjustment is required.
- severe impairment (serum creatinine >4.5 mg/dL):
• U.S. labeling: evaluate risk versus benefit
• Canadian labeling: use is not recommended.</td></tr>
</table>

หมายเหตุ: D = dose reduction, I = interval extension, hemodialysis = intermittent hemodialysis

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