

A dimly lit dialysis room with several dialysis machines and chairs. The machines are white with green accents and have various tubes and monitors. The chairs are blue and have white plastic stools in front of them. The room is filled with medical equipment and appears to be a clinical setting.

Dialysis Access and Complications for the Internist

Viktoriya Yanchuk DO
Nephrology and Hypertension

Disclosures

- None

Learning Objectives

- Review dialysis access types, indications and complications associated with dialysis access
- Review dialysis complications including mortality rates

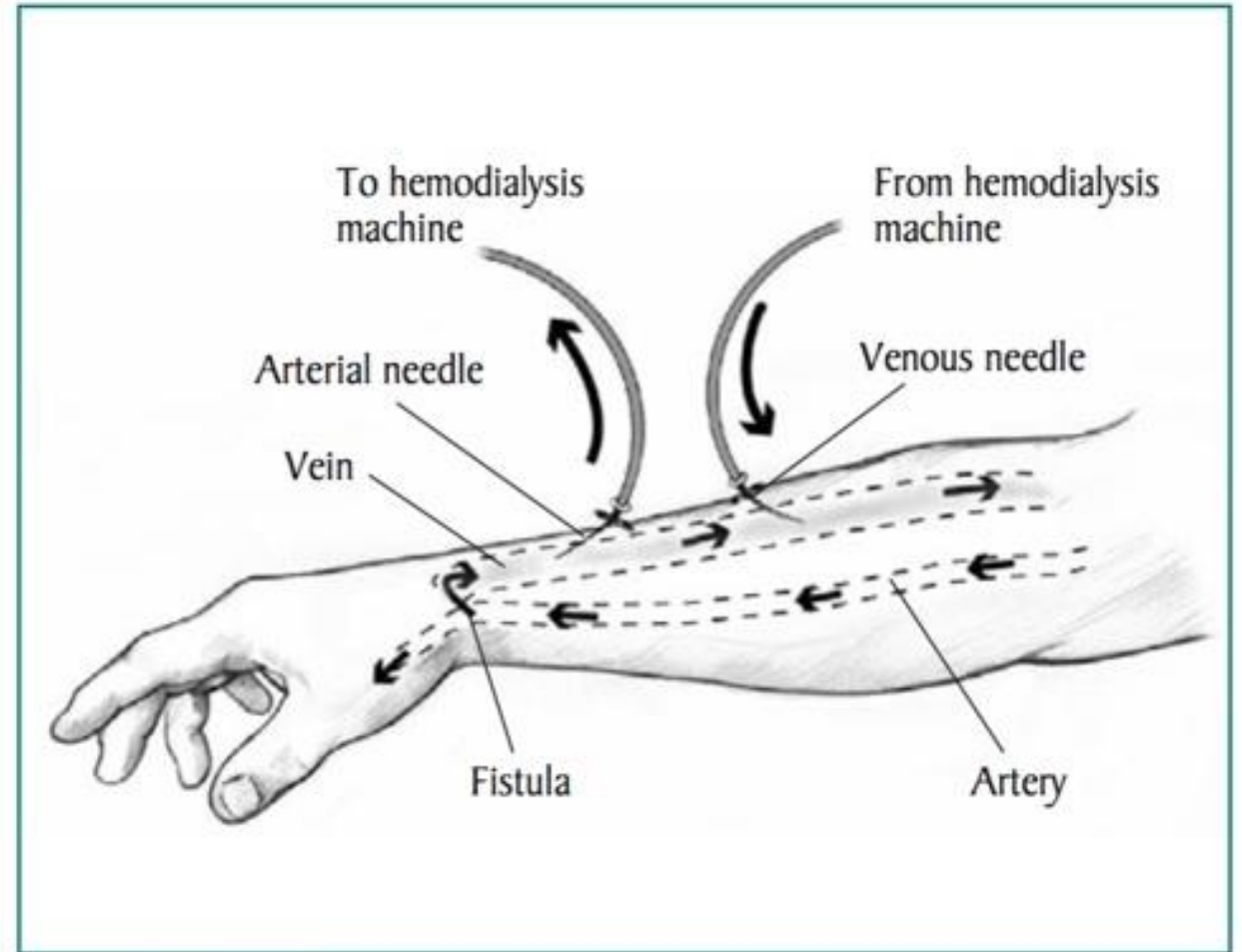
- Per CDC data, as of 2018 there are nearly 800,000 patients on dialysis in the US
- In 2018 127,000 people were started on dialysis
- ESRD incidence increased by 102% from 1990 to 2018
- Over 50 million HD treatments are performed in the US annually



Dialysis Access is Life!

Arteriovenous Fistula

- Gold standard of access
- Better blood flow and thus clearance
- Longer lasting
- Less chance of infection, hospitalization, and death
- Requires 2-3 months to mature for use
- Fistula First initiative launched by CMS in 2004, however in the last 10 years no change in primary AVF rate

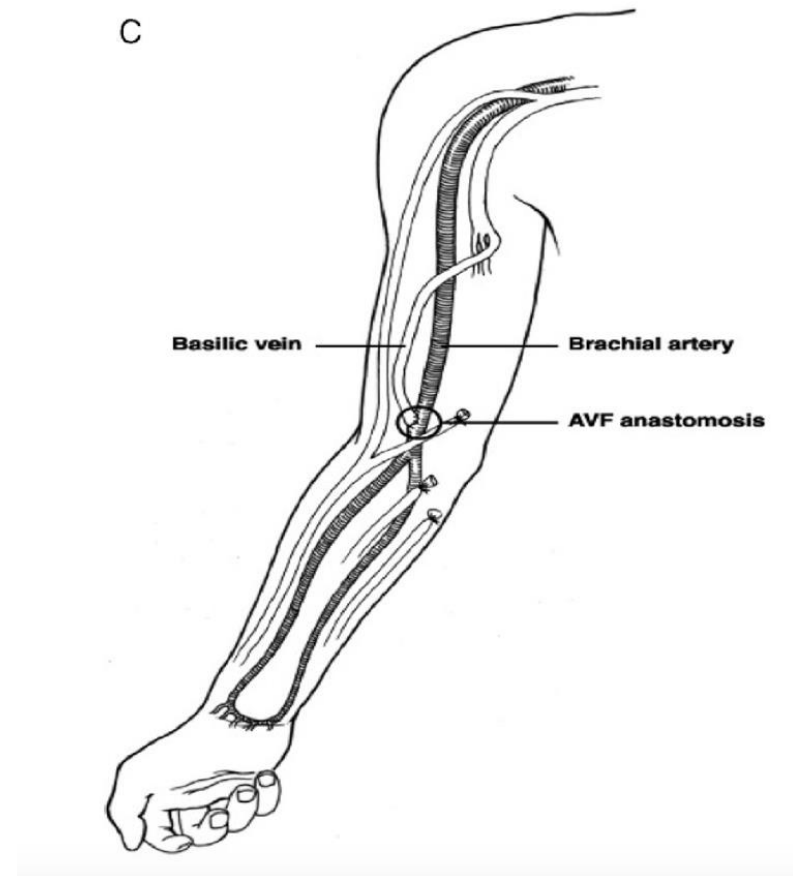


AV fistula in forearm

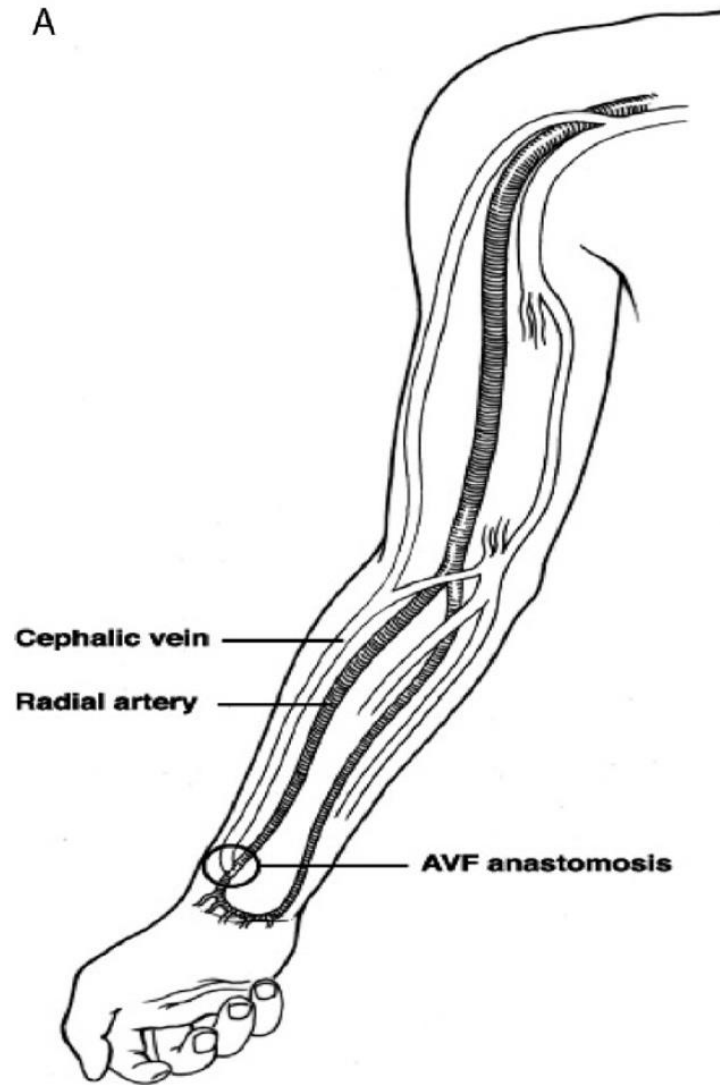
Image via NIDDK

Order of Preference of HD Access

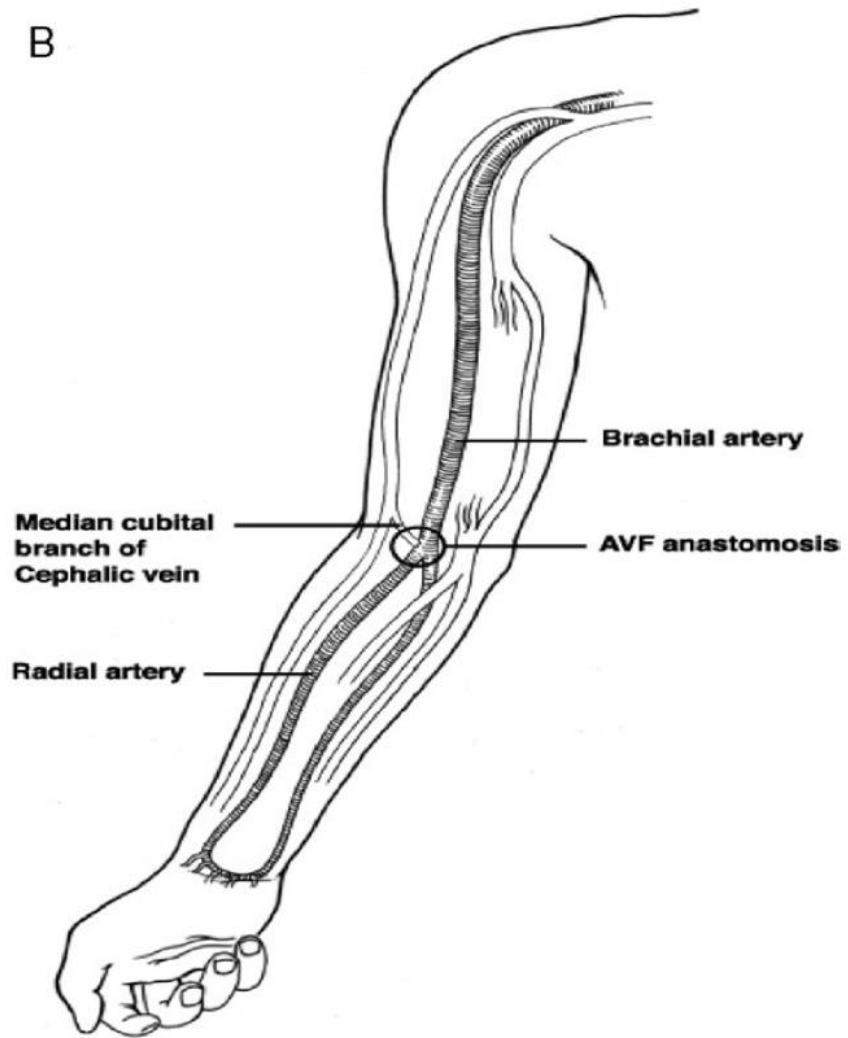
- Distal: Radiocephalic fistula
- Proximal: brachiocephalic fistula
- Proximal: transposed brachiobasilic fistula
- Upper-extremity graft
- Thigh graft
- Unusual grafts: necklace, unilateral chest wall



Radiocephalic Fistula

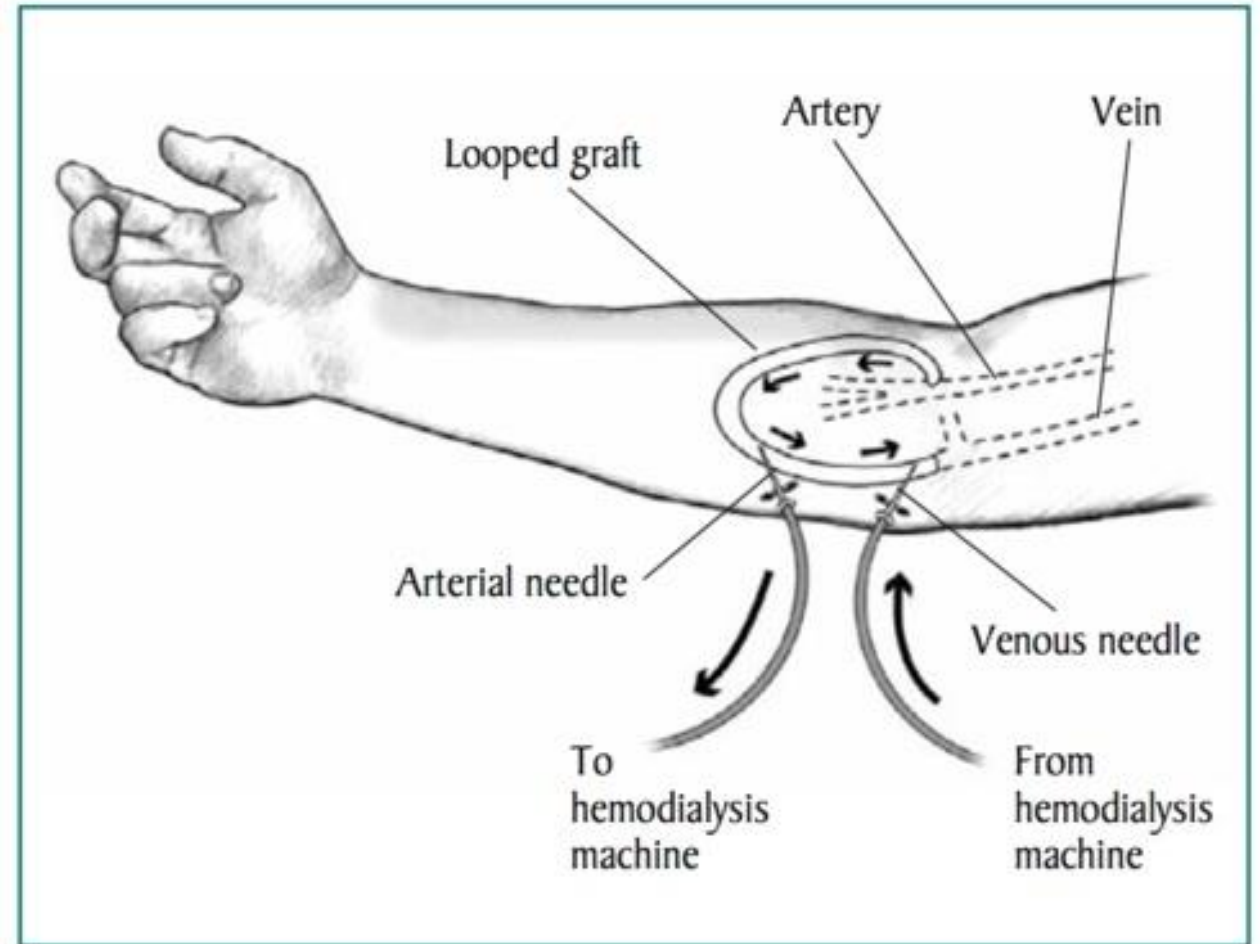


Brachiocephalic Fistula



Arteriovenous Graft

- Most commonly uses PTFE tubing
- Can be used in 2-3 weeks
- More likely to clot and have infections
- Sometimes only choice in patients with small veins

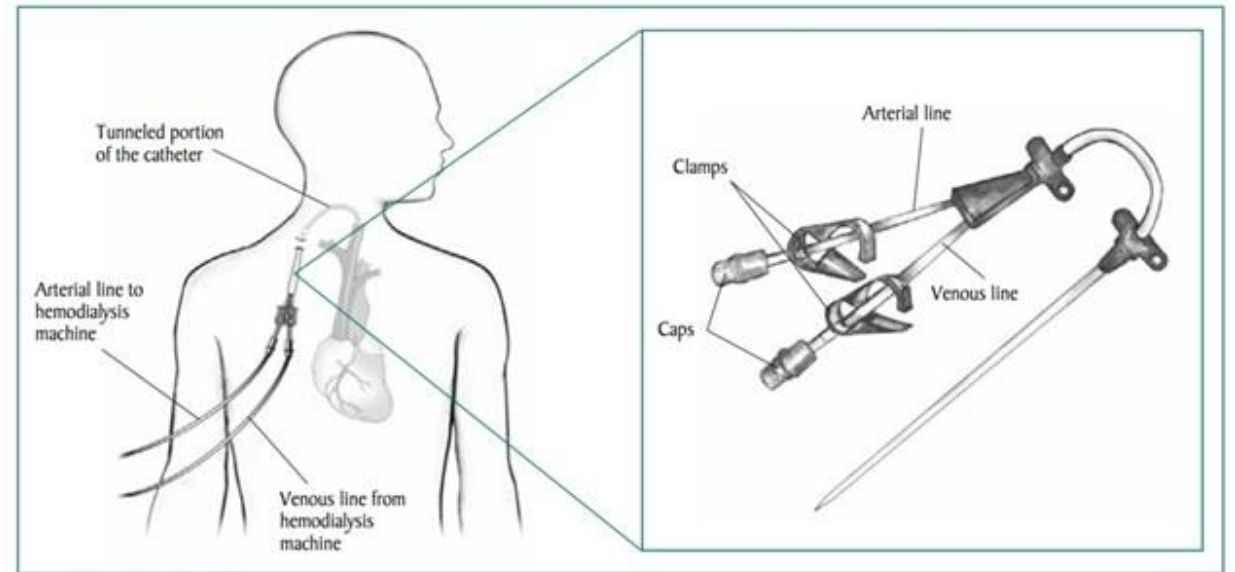


AV graft in forearm

Image via NIDDK

Tunneled Dialysis Catheter

- Right internal jugular vein
- Left internal jugular vein
- Subclavian vein
- Femoral vein
- Translumbar, transhepatic (high mortality, last resort)



Tunneled venous catheter

HD Access Complications

- Clotting
- Stenosis
- Infection, localized and systemic
- Bleeding

Table 1. Comparison of Vascular Access Types

Feature	Fistula	Graft	Catheter
Primary failure rate (%)	20-50	10-20	<5
Time to first use (wk)	6-12	2-3	Immediate
Frequency of intervention	Very low	Moderate	High
Dialysis blood flow	Excellent	Excellent	Moderate
Frequency of thrombosis (after use for hemodialysis)	Very low	Moderate	High
Frequency of infection	Very low	Moderate (~8/100 patient-years)	Very high (~2 times/y/patient)
Longevity (after in use)	Longest (~5 y)	Intermediate (~2 y)	Shortest (<1 y)

An Exam Everyone Can Do

- No need to fear!
- Evaluate AVF for thrill (feel) and bruit (listen)
- Evaluate extremity for distal edema, color change, finger ischemia and ulceration
- Evaluate access for erythema, drainage, ulceration

Thrombosed fistula requires
thrombectomy within 48 hours

AVF Aneurysm



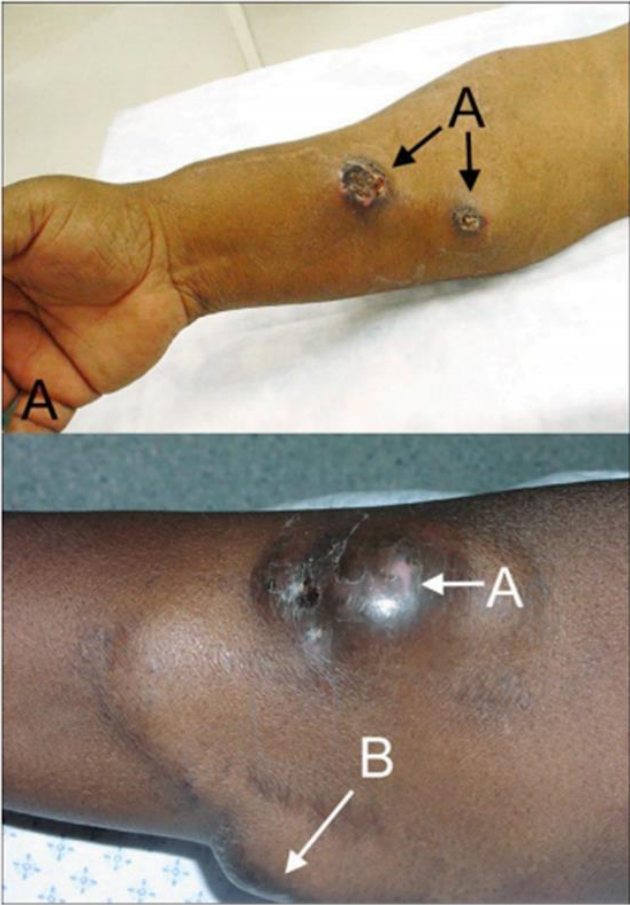
AVF Aneurysm



High Output Heart Failure

- Underappreciated complication for AVF
- Large portion of blood shifting from left-sided circulation to right-sided circulation
- Increased preload => increased cardiac output => cardiac hypertrophy => eventually heart failure
- Signs: tachycardiac, JVD, elevated pulse pressure
- While monitored gently compress AVF and watch for drop in HR
- Usually seen on large fistulas, proximal location
- Obtain ECHO, consider RHC
- Requires surgical intervention: banding or ligation

AVF Ulceration



Steal Syndrome



TDC complications

- 25% will develop symptomatic ipsilateral deep vein thrombosis with femoral catheter
- Can lead to limb ischemia and limb loss
- May cause central vein stenosis (most common with subclavian)
 - Ipsilateral upper-extremity edema
 - Prominent chest wall collateral veins

Catheter Related Bloodstream Infections

- 5 episodes per 1000 catheter days
- Await long enough and infection is inevitable
- 10% of catheter infections will lead to serious complications
- 70% caused by gram positives, 30% by gram negatives
- Biofilm major cause of bacteremia

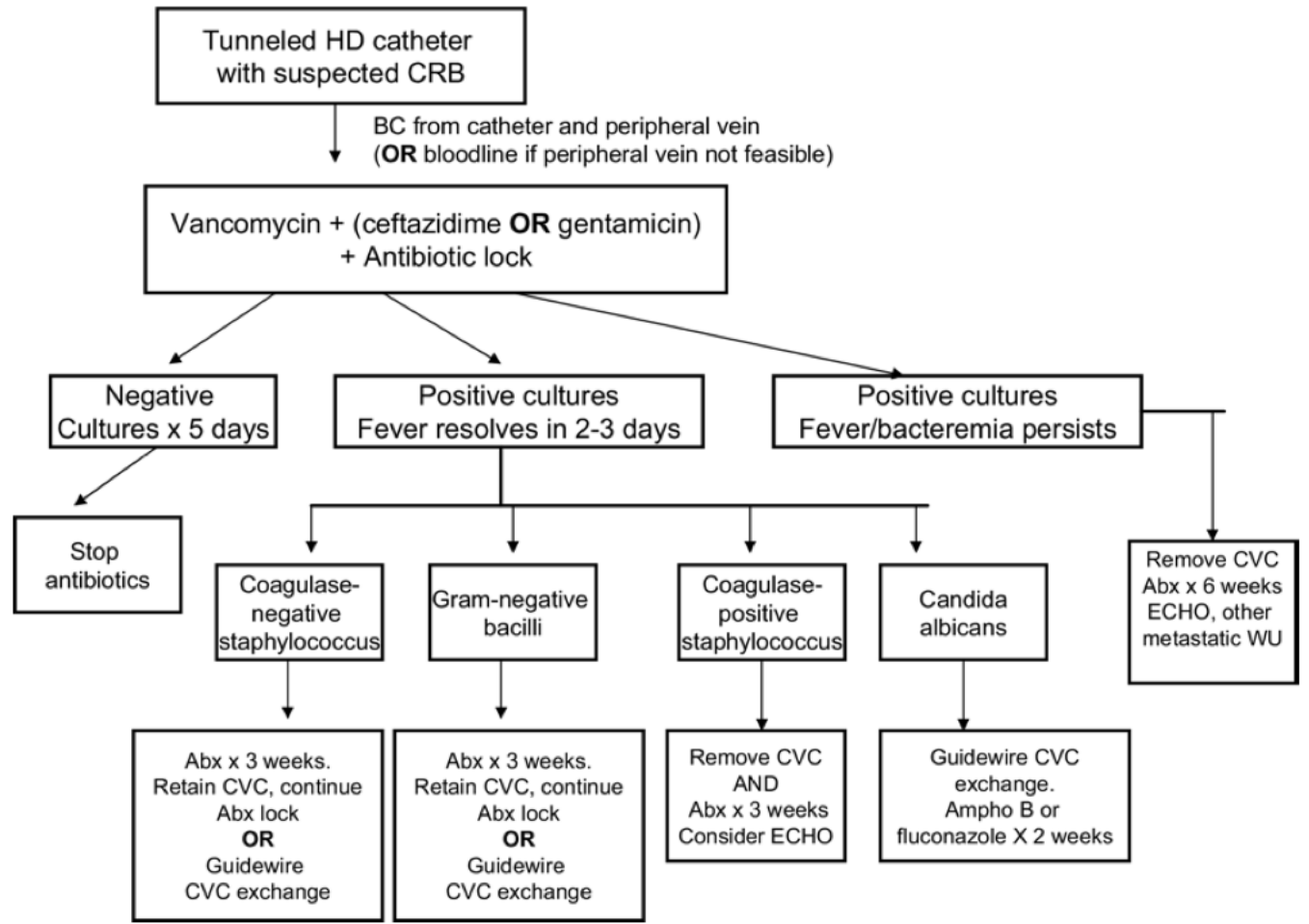


Catheter Removal

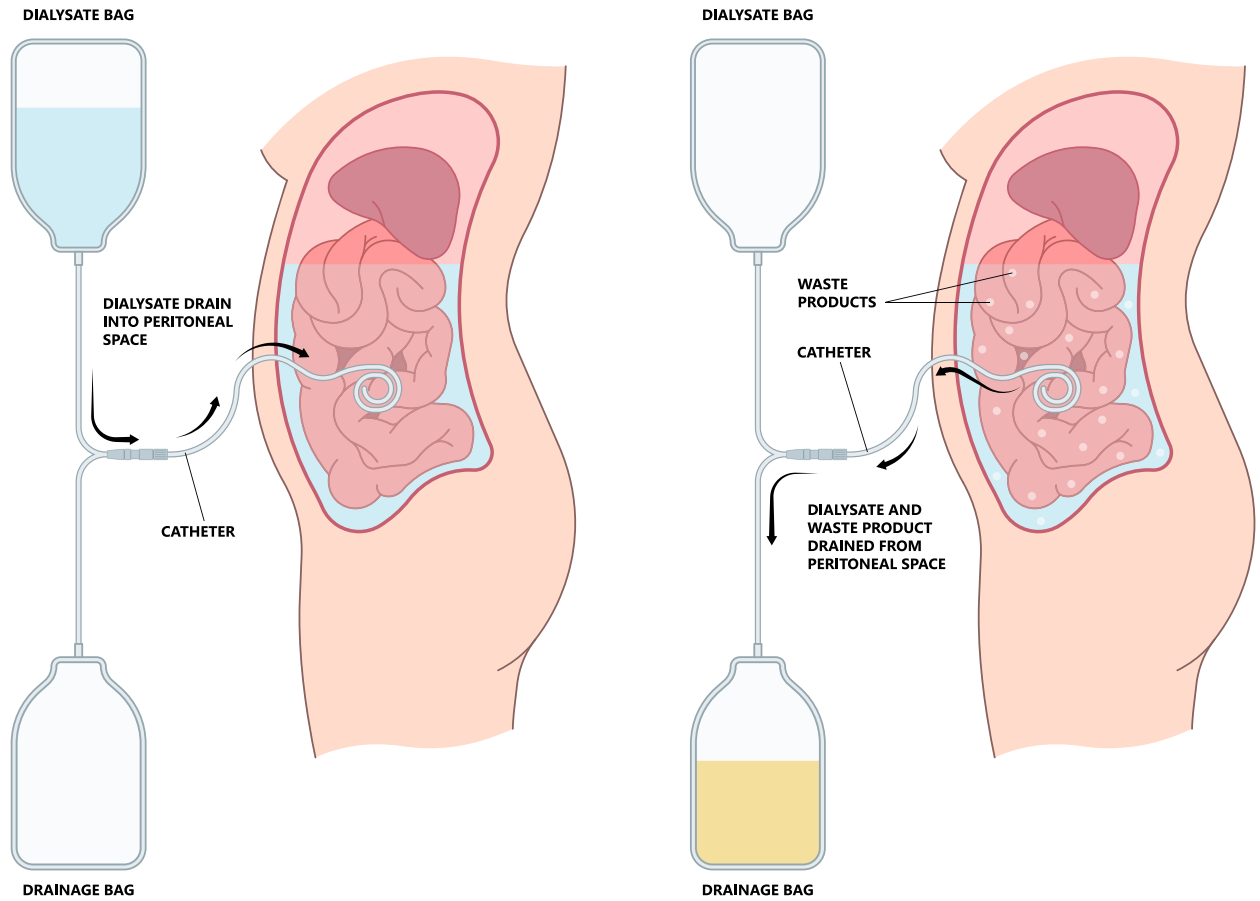
- One option: immediate catheter removal, line holiday
- Indications:
 - Septic shock
 - Fever or bacteremia > 48 hours after initiation of antibiotics
 - Metastatic infection
 - Tunnel infection
- Recommend removal for CRBSIs due to *S aureus*, *Pseudomonas*, and fungal organisms

Catheter Salvage

- Catheter salvage should not be used in the following situations:
 - *S aureus*, pseudomonas, and fungal infections
 - Unresolved infection symptoms 48 to 72 hours after initiation of antibiotics
 - Metastatic complications
 - Concomitant tunnel infection.

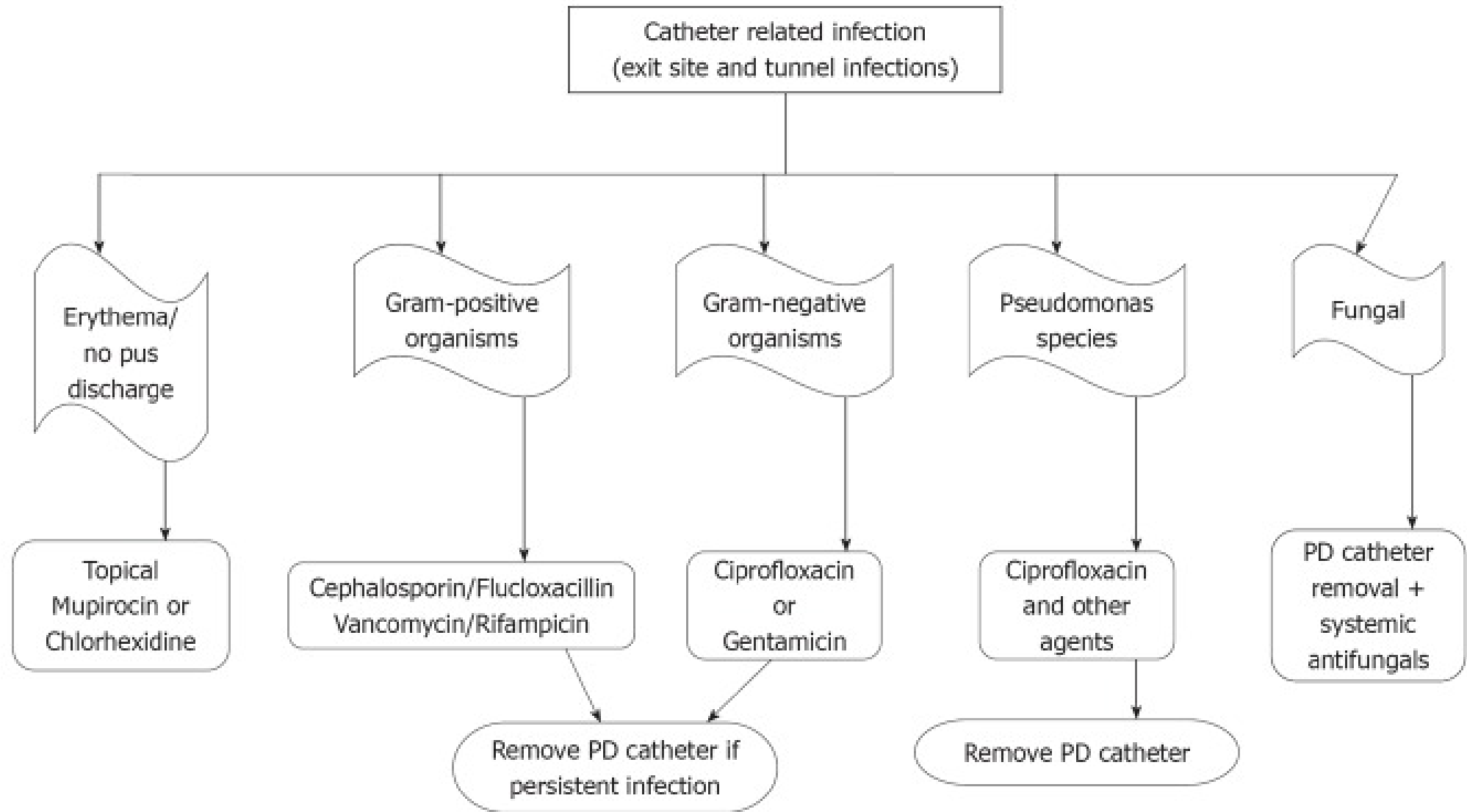


PERITONEAL DIALYSIS



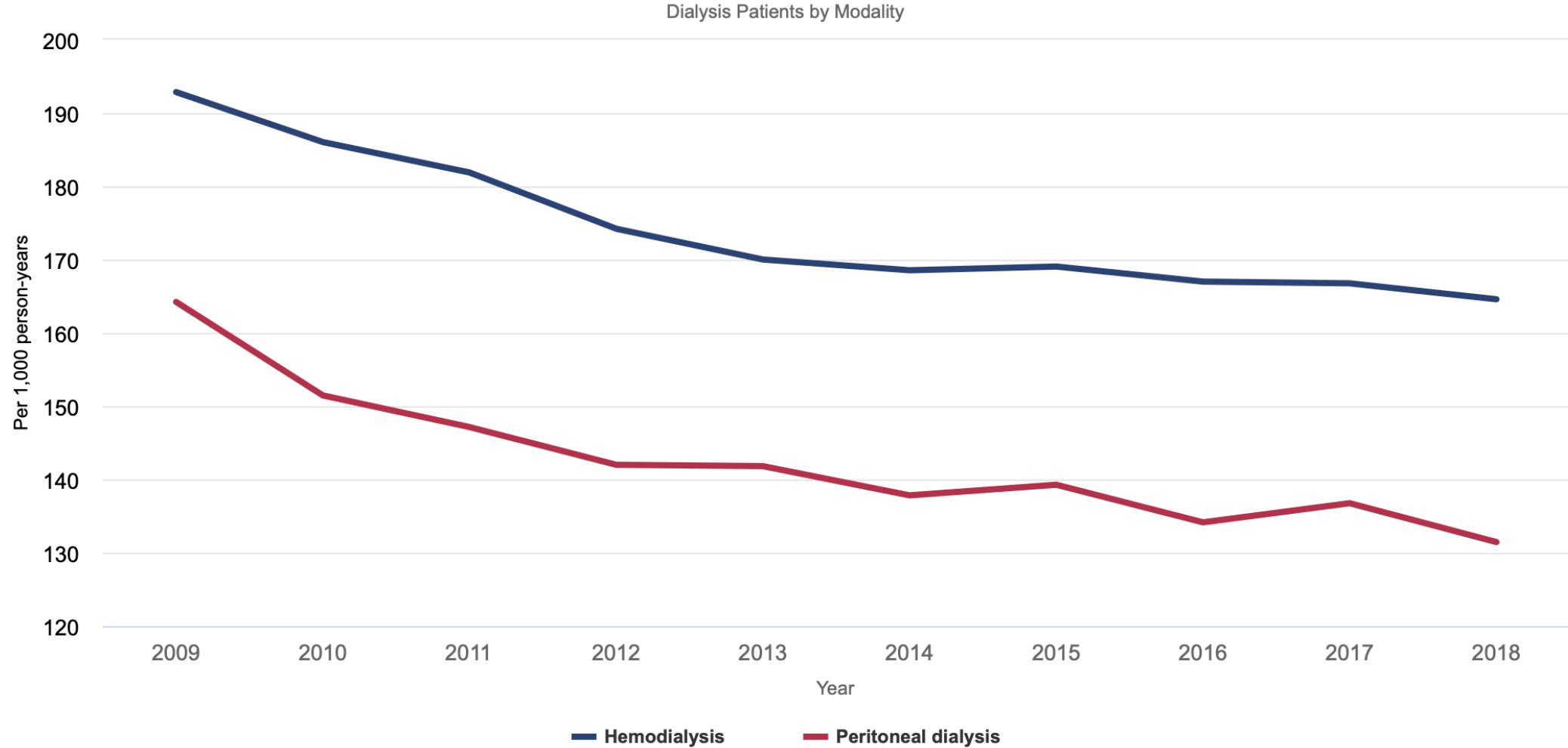
Peritoneal Dialysis Access Complications

- Exit cite and tunnel infections
- Can lead to peritonitis and systemic infection
- Most often due to poor patient technique
- When examining look for tenderness, erythema, drainage
- Always wear a mask!
- If suspect peritonitis call nephrologist ASAP to obtain PD fluid sample prior to antibiotics if possible



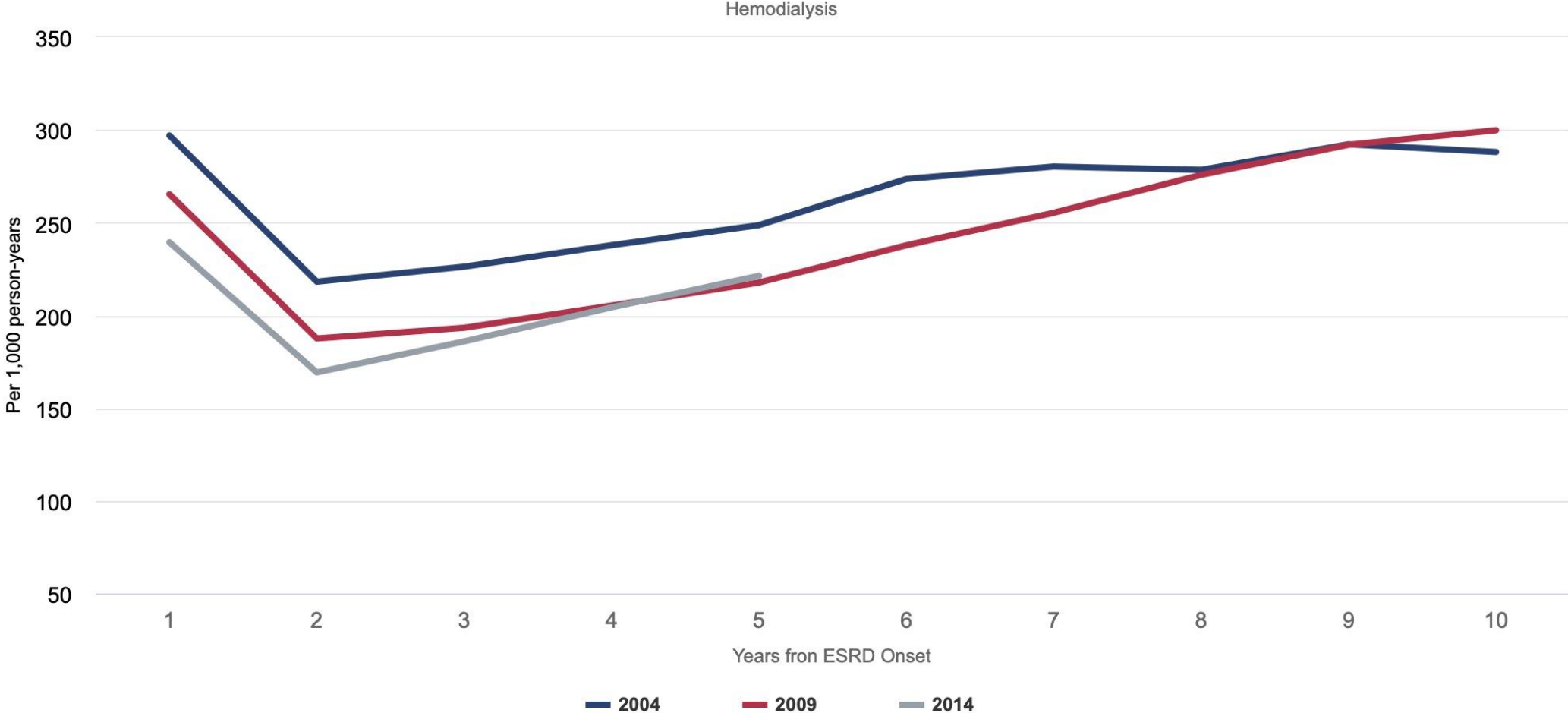
Dialysis Complications

Figure 5.1 Adjusted all-cause mortality for patients with prevalent ESRD, by treatment modality, 2009-2018



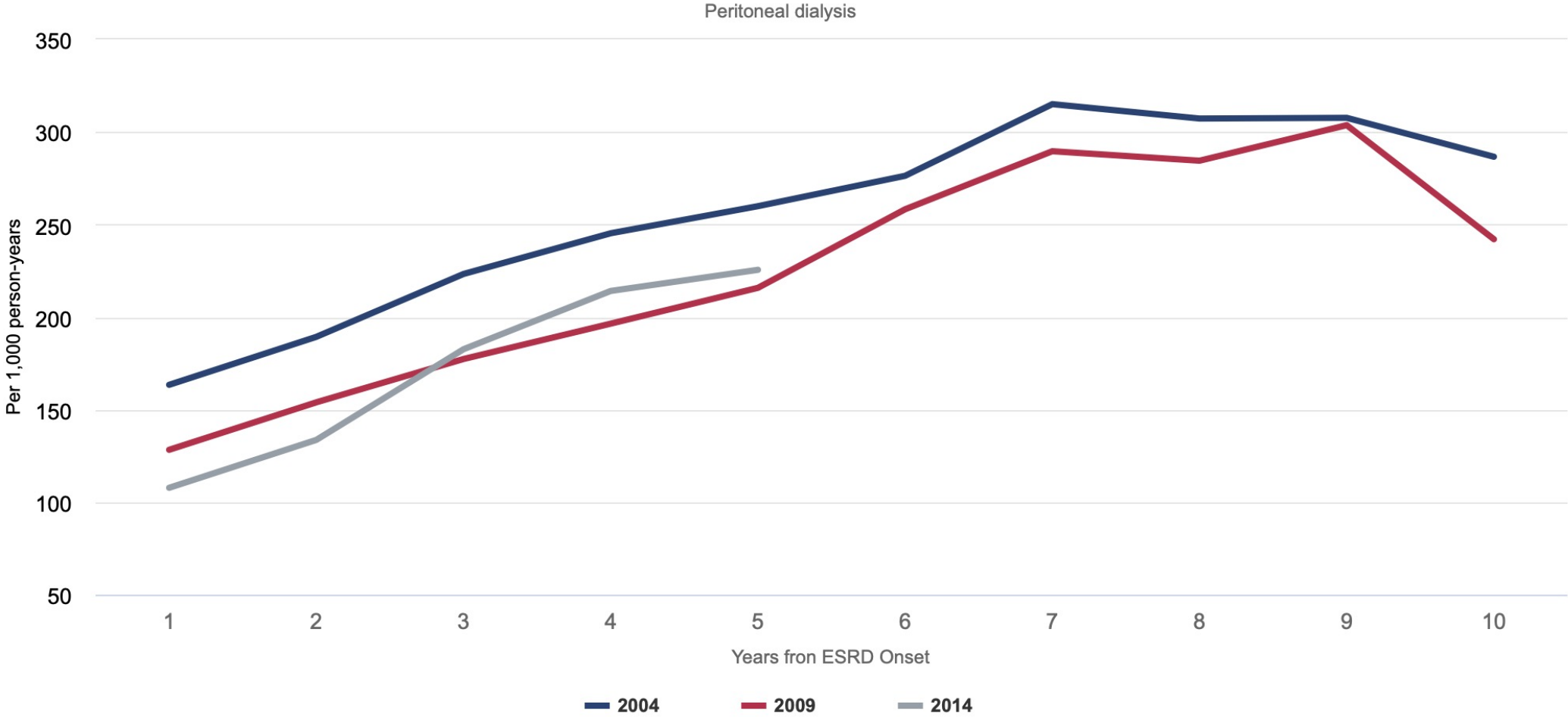
Data Source: 2020 United States Renal Data System Annual Data Report

Figure 5.4a Adjusted all-cause mortality rate after initiation of dialysis for ESRD, censored at transplant, by modality, 2004, 2009, and 2014



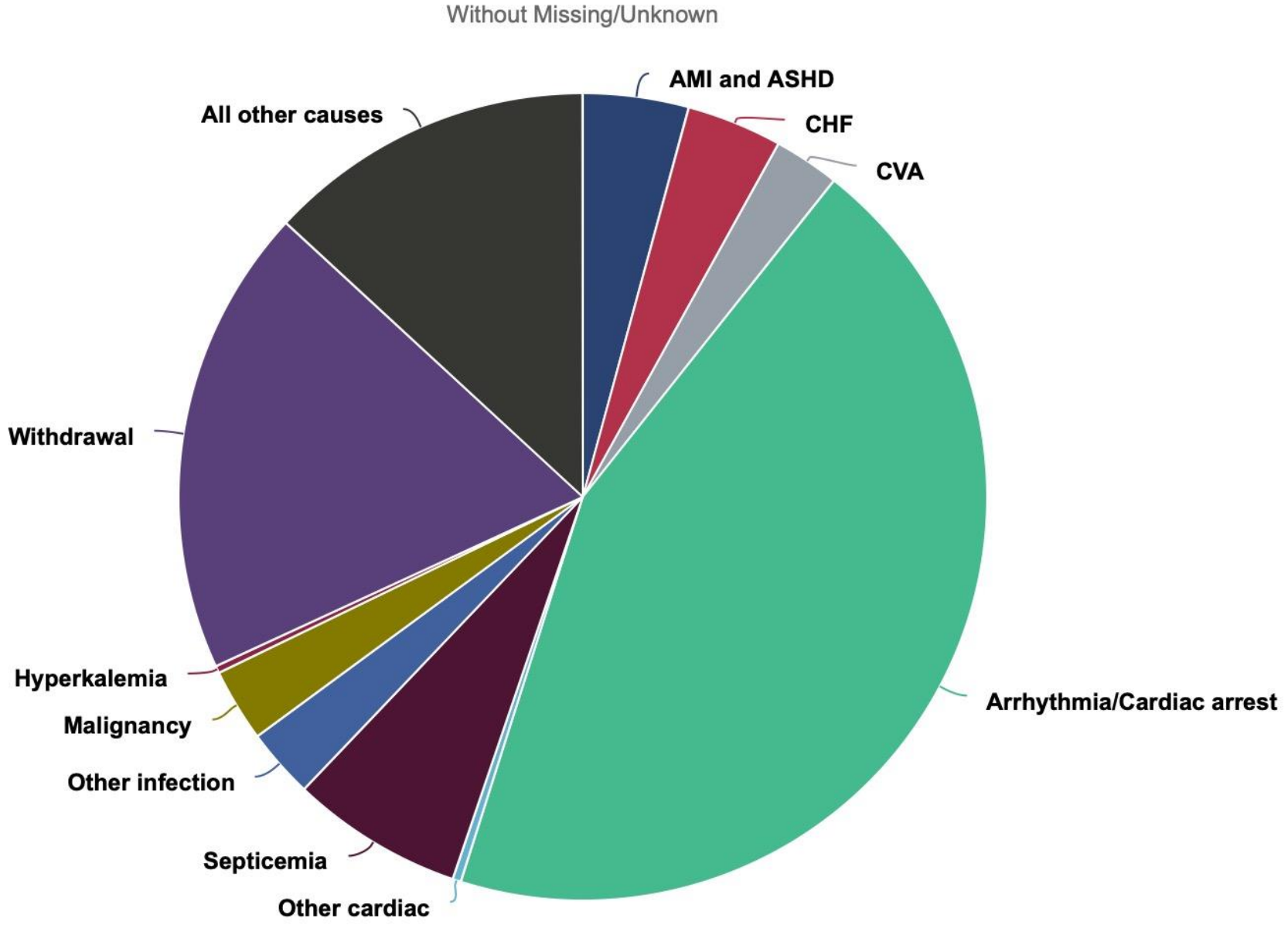
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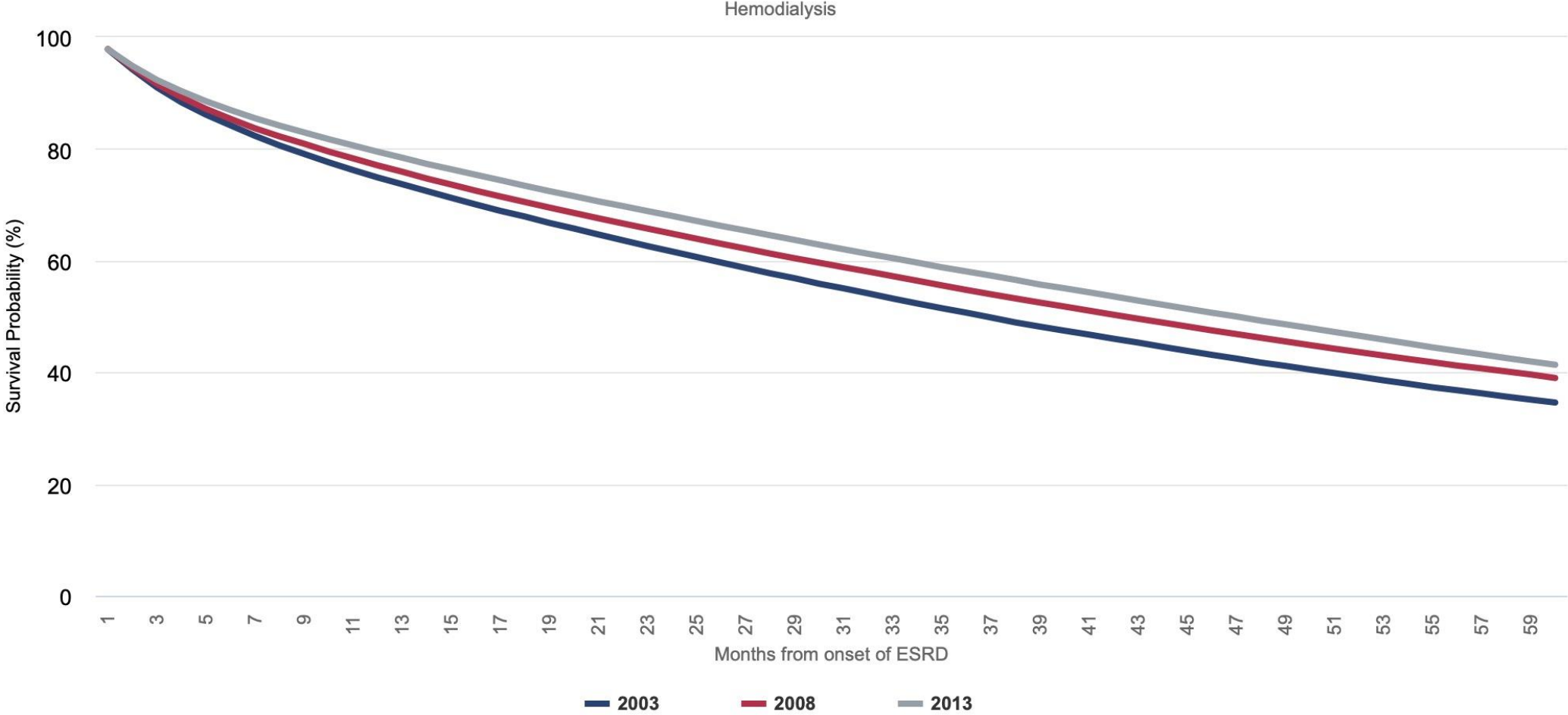
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Figure 5.6a Unadjusted percentages of cause-specific mortality, with and without inclusion of missing and unknown causes of death, in patients with ESRD receiving hemodialysis, who died in 2018



Data Source: 2020 United States Renal Data System Annual Data Report

Figure 5.7 Adjusted survival of incident ESRD patients over the first 5 years after onset of ESRD, by treatment modality and year of ESRD onset, 2003, 2008, and 2013



Data Source: 2020 United States Renal Data System Annual Data Report

Hypotension

- Most common acute complication, 30%
- Patient and dialytic factors influence
- More common in women and elderly
- During HD, while UF is removed SVR goes up
- During clearance, due to catabolic effects heat is generated with vasodilation, increases blood flow to the skin
- CO and BP has to be maintained, increase HR, increase contractility
- Many patients have underlying heart disease, autonomic dysregulation, baroreceptor reflex blunted

Ultrafiltration

- Fluid removal rate correlated to hypotension
- Fluid removal of >13 mL/kg/hr associated with increased mortality
- Eg 60 kg patient: >790 mL/hour needing 4 L removed
- More than 1.5L/hr removal, when going below dry weight, likely to lead to hypotension

Medications

- Often use antihypertensives
- Beta-blockers and verapamil reduce myocardial contractility
- Generally, BP medications should be held prior to HD unless patient has exceedingly high BP

Arrhythmias

- High prevalence of coronary artery disease, structural heart disease
- Sudden cardiac death worse during longer intradialytic periods
- Use of lower K bath associated with higher risk for SCD
- Bradycardia more common, especially in the last 12 hours prior to HD session
- Higher potassium shifts => more likely dysrhythmia
- Seen with worse K restriction compliance

Cramps!

- Estimated 20% of HD treatments
- More frequent with high fluid removal rate and overall UF
- No treatment with strong evidence
- Quinine has been used but FDA has **black box warning**



Hemorrhage

- Due to use of anticoagulation during HD predisposed to variety of bleeding
- Most commonly GI bleeding
- High prevalence of GI tract AV malformations
- Worse if uremic
- Lose 5-10 mL of blood in the tubing each HD session
- If cannulation difficulty or oozing even further blood loss

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