Cardiovascular disease

Oronce Finé, c. 1531

In this chapter from the USRDS Cardiovascular Special Studies Center we begin with updated data on causes of death in incident and prevalent dialysis patients, this year with additional categories. During 2009–2011, the overall mortality rate was considerably higher in incident patients, at 298 compared to 194 deaths per 1,000 patient years.

In both the incident and prevalent populations, cardiac death due to arrhythmic mechanisms continues to be the single largest cause of attributable mortality. Reflecting the unique nature of dialysis therapy, withdrawal is the second most common cause; this is somewhat misleading, however, as the occurrence of withdrawal is likely a surrogate for other underlying conditions such as advanced dementia, wasting, failure to thrive, etc.

The category of "other" causes of death raises a methodologic issue. On the CMS Death Notification form (2746), most of these deaths are categorized as "missing," with 25.3 and 21.3 percent of all mortality in incident and prevalent patients, respectively, receiving this designation. If one were to assume that there is no biasing of "non-ascertainment" of mortality in the missing group, one approach would be to recalibrate the estimates of attributable mortality by category, with a balanced proportional redistribution of the missing data.

We next provide a current view of the epidemiology of cardiovascular disease in ESRD patients, showing that transplant and hemodialysis patients, respectively, have the lowest rates for cardiovascular diagnoses, and that, reflecting the chronic nature of this condition, congestive heart failure and peripheral arterial disease are the two most common cardiovascular diseases (excluding hypertension) afflicting ESRD patients.

Data on two-year survival following selected cardiovascular diagnoses and interventions raise two key points: that transplant recipients have superior outcomes compared to those on dialysis, and that survival for these cardiovascular conditions is better for hemodialysis patients than for those on peritoneal dialysis (with the caveat that this comparison is not adjusted for potentially important characteristics such as vintage).

A broad overview of temporal trends in cardiovascular disease provides the impression that, in 1996–2002, there was an increase in the rate of AMI followed by a gradual decline, perhaps reflecting improvements in cardiac care of ESRD patients. In contrast, there does not seem be a reduction in either PAD or CHF rates. Whether this represents an actual increase in frequency or changes in ascertainment by claims is uncertain.

We next examine the use of medications for cardiovascular disease. We believe the CVSSC's tracking of medication use over time has provided an important insight into practice patterns in the care of cardiovascular disease in ESRD patients. As noted in prior ADRs, there has been a remarkable uptake in the use of beta blocker therapy. It is tempting to link the progressive decline in cardiovascular mortality in U.S. dialysis patients over the last decade to the use of cardioprotective agents. Other approved therapies (such as cilostazol for PAD), in contrast, are rarely used in ESRD patients.

You never enjoy the world aright, till the sea itself floweth in your veins, till you are clothed with the heavens, and crowned with the stars: and perceive yourself to be the sole heir of the whole world.

Thomas Traherne
Centuries of Meditations

On the following spread we update an analysis from the 2009 ADR. A practical clinical issue which bedevils potential renal transplant recipients is the presence of morbid obesity (often refractory to medical interventions) contra-indicating transplantation. One approach to this problem has been to offer selected dialysis patients bariatric surgery, but few data exist on related outcomes and long-term follow-up. We show that there has been a recent proliferation in the use of laparoscopic procedures and adjustable gastric bands, and a marked decline in the use of open gastric bypass. We then conclude the chapter by focusing on a topic new to the CVSSC: the epidemiology, survival, and medical treatment of patients with systolic and/or diastolic heart failure. ⬩ ***Figure 4.1;*** *see page 440 for analytical methods. Incident & prevalent dialysis patients, 2009–2011; from Reference Table H.12.*

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4.1 **Causes of death in incident & prevalent dialysis patients, 2009–2011**

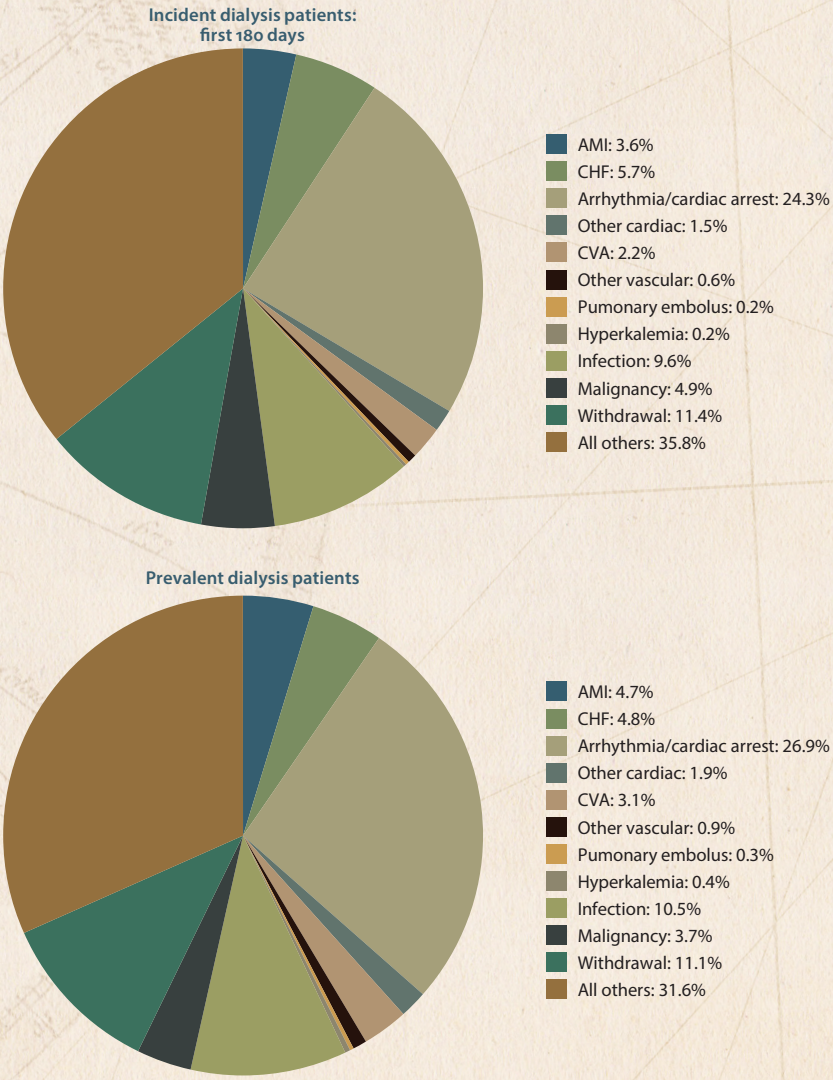


Table 4.a presents data on the adjusted relative risk of cardiovascular diseases, with respect to demographics and ESRD modality. Elderly patients are more likely to have these conditions, but less likely to undergo cardiac interventions. Data on the relationship of age and rate of selected cardiovascular diseases and procedures show that congestive heart failure is the most common cardiovascular diagnosis in elderly ESRD patients, with a rate of 620 per 1,000 patient years in patients 75 and older, followed by peripheral arterial disease, at 515 in the same age group.

• **Table 4.a & Figure 4.2;** see page 435 for analytical methods.

January 1, 2009 point prevalent ESRD patients with Medicare as primary payer; follow can occur up to three years.

vol 2 **4.a** **Relative risk of a cardiovascular diagnosis or procedure, by age, gender, race, ethnicity & modality, 2009–2011**

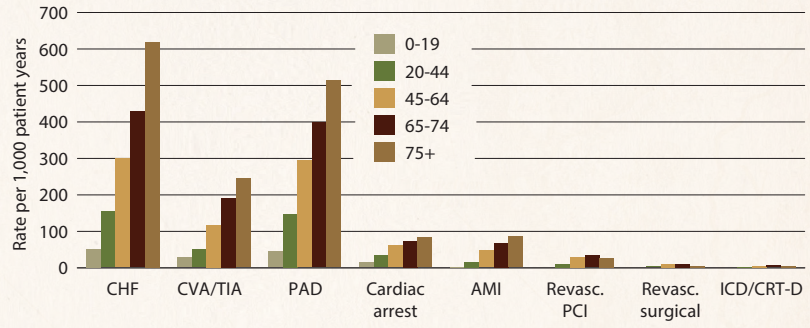
	CHF		CVA/TIA		PAD		Cardiac arrest		AMI		Revasc: PCI		Revasc: surgical:		ICD/CRT-D		
	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	RR	CI	
Age: 0–19	0.32	0.27-0.37	0.38	0.31-0.48	0.27	0.23-0.32	0.51	0.38-0.69	0.09	0.04-0.18	0.02	0.00-0.15	0.00	.	0.12	0.02-0.84	
20–44	0.68	0.67-0.70	0.53	0.51-0.54	0.65	0.64-0.66	0.74	0.72-0.77	0.47	0.45-0.50	0.47	0.44-0.50	0.40	0.36-0.45	0.54	0.47-0.63	
45–64 (reference)																	
65–74	1.17	1.16-1.19	1.42	1.40-1.45	1.17	1.15-1.18	1.06	1.03-1.09	1.20	1.17-1.23	1.00	0.97-1.04	0.96	0.90-1.02	1.05	0.97-1.14	
75+	1.28	1.26-1.29	1.55	1.52-1.58	1.24	1.22-1.25	0.99	0.97-1.02	1.27	1.23-1.31	0.71	0.68-0.75	0.47	0.43-0.52	0.60	0.54-0.66	
Male (reference)																	
Female	1.10	1.09-1.11	1.16	1.15-1.18	0.98	0.97-0.99	0.93	0.92-0.95	0.94	0.92-0.96	0.86	0.84-0.89	0.69	0.65-0.73	0.54	0.51-0.59	
White (reference)																	
Black/African Am	1.07	1.06-1.08	1.04	1.03-1.06	1.04	1.03-1.05	1.04	1.02-1.07	0.77	0.75-0.79	0.71	0.68-0.73	0.60	0.57-0.64	0.86	0.80-0.94	
Other	0.88	0.86-0.90	0.80	0.78-0.83	0.78	0.76-0.80	0.96	0.92-1.00	0.91	0.87-0.95	0.83	0.78-0.89	0.80	0.72-0.89	0.97	0.84-1.13	
Hispanic	1.04	1.02-1.05	1.05	1.03-1.08	1.12	1.11-1.14	0.92	0.89-0.95	0.87	0.84-0.90	0.89	0.85-0.93	0.87	0.81-0.94	0.81	0.73-0.90	
Non-Hispanic (reference)																	
Hemodialysis (reference)																	
Peritoneal dialysis	0.66	0.64-0.68	0.85	0.82-0.89	0.67	0.65-0.69	0.88	0.84-0.93	1.18	1.12-1.24	1.25	1.16-1.34	1.36	1.22-1.52	0.95	0.79-1.14	
Transplant	0.37	0.36-0.37	0.48	0.47-0.49	0.42	0.42-0.43	0.19	0.18-0.20	0.32	0.31-0.33	0.43	0.41-0.45	0.35	0.32-0.38	0.31	0.27-0.35	

In Figure 4.3, reported rates for CHF and PAD may be artifactually increased by the claims definition (i.e., due to an increase in the number of diagnostic fields) used to define these conditions. Due to differences in follow-up times and patient selection, rates in Figure 4.3 and Table 4.b are not comparable. Although the absolute rates may be subject to error, the overall importance of these conditions should not be underestimated. In particular, there remains a striking knowledge gap in the prevention and treatment of PAD in ESRD patients (Garimella et al., 2012). Although the majority of sudden cardiac death in the general population is attributed to coronary heart disease, one of the main lessons of statin trials in dialysis patients has been the failure of cholesterol-lowering medications to reduce rates of sudden death. Even in the SHARP study, which showed a benefit of lipid lowering in the occurrence of atherosclerotic events in CKD patients, the overall effect was attenuated in dialysis patients, likely reflecting the contribution of non-atherosclerotic mechanisms to sudden death and mortality in these patients.

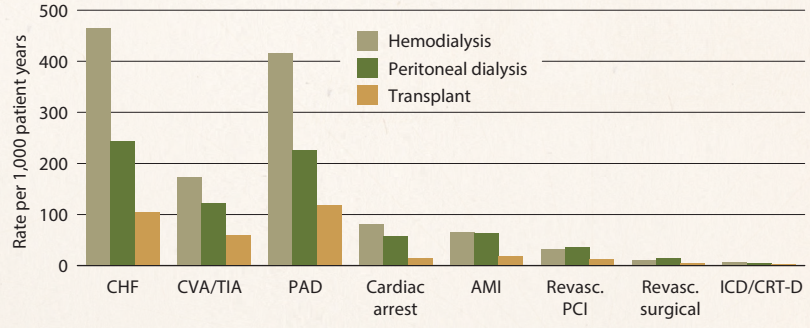
• **Figure 4.3;** see page 435 for analytical methods.

Jan. 1, 2009 point prevalent ESRD pts with Medicare as primary payer; follow-up can occur up to three years.

vol 2 **4.2** **Rates of cardiovascular diagnoses & procedures, by age, 2009–2011**



vol 2 **4.3** **Rates of cardiovascular diagnoses & procedures, by modality, 2009–2011**



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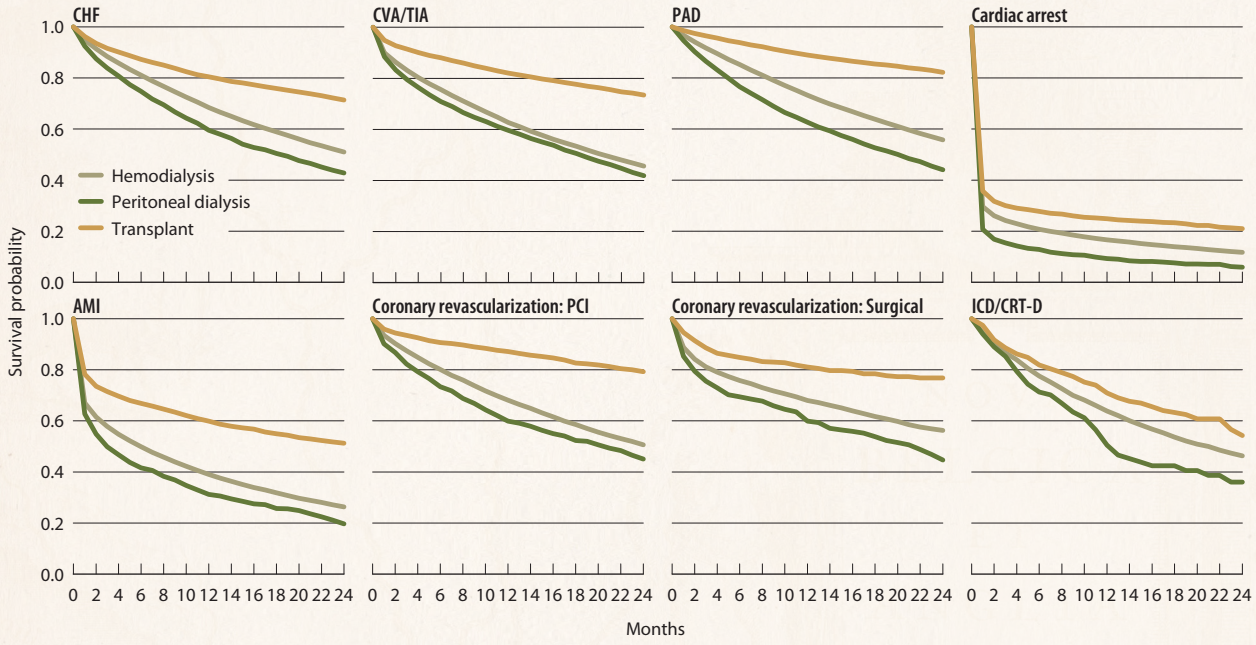
4.4

Survival of patients with cardiovascular diagnoses & procedures, by modality, 2009–2011



Although the event rate for cardiovascular disease is lower in peritoneal dialysis patients than in their counterparts on hemodialysis, the unadjusted mortality associated with these conditions is higher in peritoneal dialysis patients, and lowest in transplant recipients. Although the CVSSC has reported a small steady improvement in cardiovascular mortality over the past decade, the data presented in this figure are still not acceptable. The two-year mortality of dialysis patients after AMI from 2009–2011, for example, remains similar to that reported by Herzog et al. 15 years ago (N Engl J Med). In that paper, which reported on patients from 1977–1995, overall two-year mortality was 73 percent. Updated data show a rate of 74 percent for hemodialysis patients and 80 percent for those on peritoneal dialysis.

As we reported last year, one outcome that has improved is the 30-day mortality rate for patients with ST-segment elevation MI. There has, however, been little change in mortality after 30 days, and no difference in non-ST-segment MI patients. Consistent with a CVSSC paper by Banerjee et al, (2007), the two-year mortality rate remains high for dialysis patients with CHF, at 49 percent for hemodialysis patients and 57 percent for those on peritoneal dialysis. • **Figure 4.4;** see page 436 for analytical methods. *January 1 point prevalent ESRD patients, 2009, with a first cardiovascular diagnosis or procedure in 2009–2011.*

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4.b Rates (per 1,000 patient years) of cardiovascular diagnoses & procedures, by modality

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AMI																
Hemodialysis	53.7	56.5	61.9	70.1	73.6	77.5	80.8	80.6	76.3	73.8	70.1	70.9	74.7	72.2	74.5	73.1
Peritoneal dialysis	64.6	66.6	71.1	73.3	76.5	77.5	78.5	75.2	70.6	66.8	64.4	66.9	66.1	66.6	68.5	66.9
Transplant	19.4	19.6	21.0	21.2	22.0	22.6	23.0	22.9	20.9	18.6	16.2	16.6	17.9	17.2	19.0	19.3
CVA/TIA																
Hemodialysis	174.3	179.4	181.1	178.5	185.7	192.2	200.3	201.3	212.0	205.4	201.2	199.7	206.1	201.5	204.8	207.9
Peritoneal dialysis	155.1	159.6	158.0	149.7	148.0	154.6	153.3	142.4	149.8	139.8	137.8	127.9	136.5	135.6	137.5	147.5
Transplant	45.4	50.0	50.8	48.6	50.7	52.1	55.7	22.5	58.9	59.8	57.7	57.3	65.4	64.1	69.8	73.7
Peripheral arterial disease																
Hemodialysis	472.7	456.1	457.1	448.6	455.2	469.7	478.4	475.5	498.1	498.7	488.2	486.9	511.5	507.5	521.9	557.9
Peritoneal dialysis	309.1	303.7	299.7	290.4	296.1	296.4	295.8	287.1	303.3	294.8	280.2	276.0	274.6	275.5	280.0	315.0
Transplant	114.6	118.8	119.4	118.5	126.2	128.7	136.8	70.2	141.6	143.1	138.2	138.6	150.1	147.7	159.9	175.0
Congestive heart failure																
Hemodialysis	513.7	527.1	527.7	516.5	520.4	542.5	566.6	582.0	621.8	628.1	618.2	622.9	620.3	614.0	632.9	655.5
Peritoneal dialysis	357.9	345.9	349.6	334.4	340.7	338.1	335.9	338.7	360.8	346.8	352.7	332.3	312.2	298.3	311.7	337.1
Transplant	90.9	98.6	108.9	111.9	117.6	121.5	126.9	57.0	133.3	134.6	126.0	123.5	131.8	130.4	141.9	149.7
Revascularization: PCI																
Hemodialysis	16.2	17.6	19.8	22.2	23.8	27.1	29.5	31.3	34.5	35.6	35.6	32.3	33.4	34.5	36.4	36.1
Peritoneal dialysis	16.1	17.7	20.2	22.8	24.9	27.2	30.1	33.3	37.1	36.3	38.0	35.4	35.9	39.0	39.2	39.6
Transplant	9.6	10.3	11.4	10.8	11.8	12.2	13.1	13.2	14.4	13.3	12.6	11.4	12.1	11.6	12.7	11.7
Revascularization: CABG																
Hemodialysis	11.9	12.8	12.5	13.3	13.6	12.7	13.3	12.6	12.0	11.5	10.7	10.9	10.5	10.6	10.7	10.0
Peritoneal dialysis	14.9	15.1	14.8	13.4	15.9	15.5	16.3	14.7	14.3	15.9	14.1	13.0	13.9	14.4	14.6	14.4
Transplant	6.9	6.7	7.5	6.9	6.3	6.6	6.1	5.7	5.1	5.0	4.3	3.9	3.9	3.5	3.9	3.4

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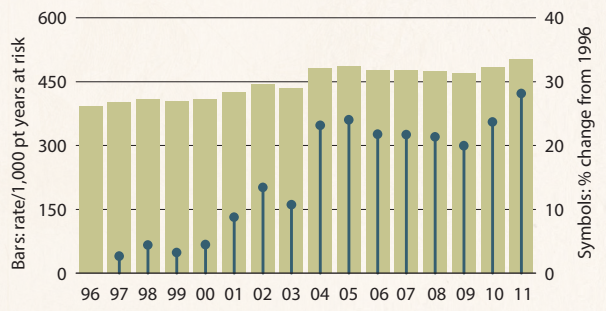
4.5 Rates of a CHF diagnosis in ESRD patients



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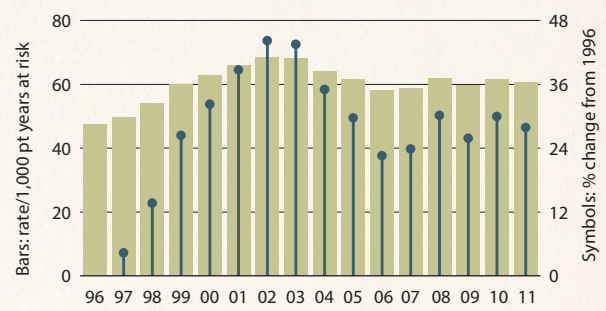
4.6 Rates of an AMI event in ESRD patients



The message of Table 4.b with respect to cardiovascular disease burden is decidedly mixed. On the positive side, rates of AMI, which had been increasing from 1996 to 2002, stabilized in the early part of the last decade and have since declined. It is tempting to attribute this to improvements in AMI care, including the use of antiplatelet agents, statin therapy (which has shown to be of benefit for atherosclerotic events in CKD patients), beta blockers, and increased use of coronary revascularization post-AMI. While overall use of coronary revascularization has changed little over the last ten years, preliminary CVSSC data indicate there has been an increase in the use of early PCI following ST-segment elevation MI, consistent with practice patterns in the general population. We suspect that the decline in AMI rate is more a reflection of better medical therapy than of coronary intervention.

Event rates for CVA/TIA, PAD, and CHF are less encouraging. Although a prevalent dialysis population lives longer, it may be more likely to live with an increasing cardiovascular disease burden. Nevertheless, estimated CHF rates of 656 per 1,000 patient years in hemodialysis patients, and of 558 for PAD and 208 for CVA/TIA, would not be viewed favorably by most clinicians. As pointed out by KDIGO (Herzog et al., 2011), there are major gaps in knowledge related to the prevention and treatment of cerebrovascular disease, PAD, and CHF. • **Table 4.b & Figures 4.5–6;** see page 436 for analytical methods. *Point prevalent ESRD patients on January 1 of each year; unadjusted. Cardiovascular event rates could be elevated in 2010 & 2011 due to availability of additional inpatient diagnosis code fields beginning in 2010; follow-up can occur up to one year.*

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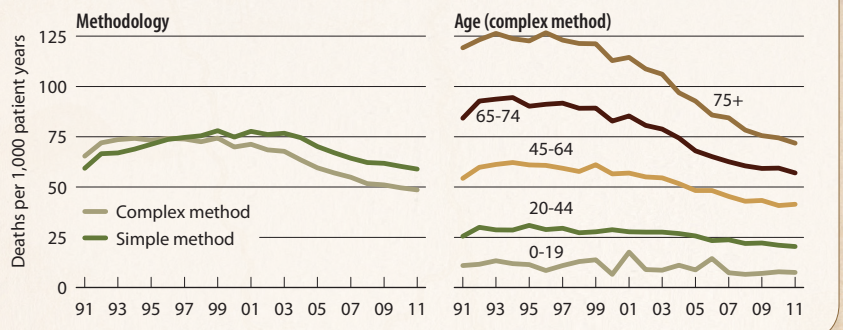
4.7 **Rates of sudden cardiac death in prevalent dialysis patients, by method of estimation**



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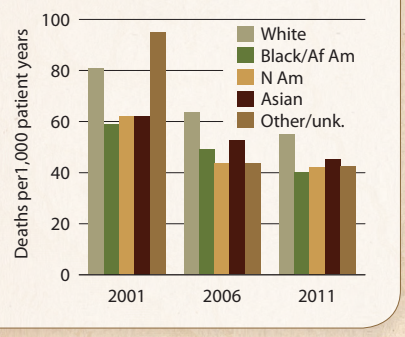
4.8 **Rates of sudden cardiac death in prevalent dialysis patients, by race**



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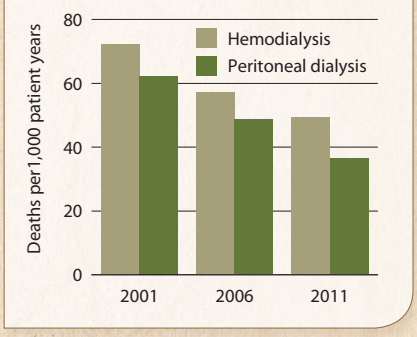
4.9 **Rates of sudden cardiac death in prevalent dialysis patients, by modality**



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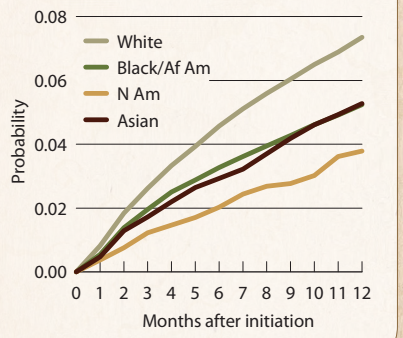
4.10 **Probability of sudden cardiac death in 2010 incident dialysis patients, by race**



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4.11 **Probability of sudden cardiac death in 2010 incident dialysis pts, by modality**

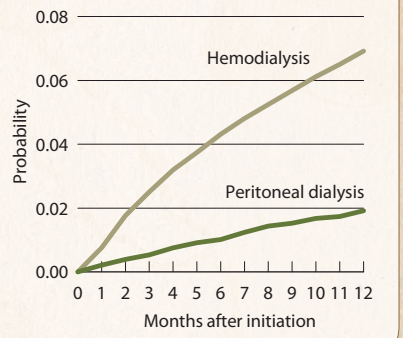

Figure 4.7 compares estimates of sudden cardiac death (SCD) using the "simple" method (using data from the Death Notification forms) and the "complex" CVSSC method (first published in the 2006 ADR). A study by Pun et al. found that the complex method is more accurate in the classification of sudden death in dialysis clinics.

Rates have decreased across races and modalities since 2001, falling, for example, from 72 to 49 per 1,000 patient years in the hemodialysis population, and from 62 to 36 among patients on peritoneal dialysis.

At 12 months after the initiation of dialysis, the probability of SCD reaches 7 percent in whites and 5 percent in blacks/African Americans. There is a striking difference in the occurrence of SCD in incident hemodialysis versus peritoneal dialysis patients, at 7 percent compared to only 2 percent, respectively, at the end of the first year. ✦ **Figures 4.7–11;** see page 437 for analytical methods. *Period prevalent dialysis patients (4.7). Period prevalent dialysis patients: unadjusted & using the complex method (4.8–9). Incident dialysis patients; simple method (4.10–11).*

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4.c **Cardiovascular disease & pharmacological interventions (row percent), by diagnosis & modality, 2011**

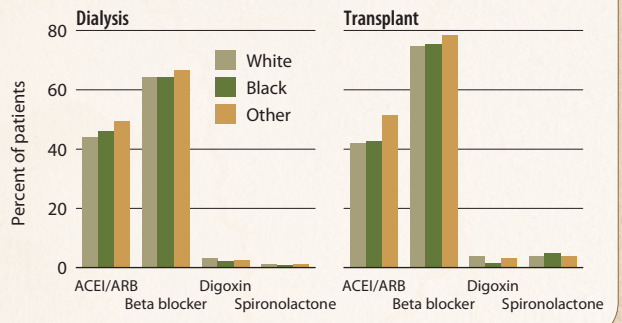
	N	ACEI/ ARBs	Beta Blocker	DHP CCB	NDHP CCB	Digoxin	Spirono-lactone	Epler-enone	Clopid-ogrel	War farin	Dabi-gatran	Cilos-tazol	Pentoxi-fylline	Dipyrid-amole	Statins	Amio-darone
CHF																
Hemodialysis	64,168	44.2	66.0	39.6	6.1	4.6	1.2	0.0	21.3	14.1	0.1	1.1	0.6	1.0	44.6	6.5
Peritoneal dialysis	2,260	44.7	69.7	34.3	6.4	5.2	3.1	0.0	20.9	14.2	0.0	0.9	0.4	0.4	48.1	6.8
Transplant	5,277	41.3	75.9	43.0	9.0	4.3	5.1	0.2	15.9	19.4	0.7	1.1	0.7	0.8	58.5	4.5
AMI																
Hemodialysis	5,428	54.1	77.7	41.5	6.0	4.4	1.2	0.0	49.5	12.3	0.1	1.6	0.8	0.8	64.1	7.2
Peritoneal dialysis	227	47.6	81.1	34.4	4.8	4.0	2.2	0.0	54.2	11.9	0.0	2.2	1.3	0.4	69.2	6.6
Transplant	386	46.6	85.0	44.3	6.2	4.4	3.6	0.0	51.6	15.0	1.0	0.3	0.8	0.5	74.4	4.1
PAD																
Hemodialysis	55,076	39.5	60.0	37.5	5.2	3.2	0.7	0.0	23.9	13.4	0.1	2.0	0.9	1.1	45.4	5.2
Peritoneal dialysis	1,881	38.4	60.5	31.8	5.5	2.9	1.7	0.1	25.9	12.6	0.1	3.1	1.2	0.6	52.5	4.0
Transplant	5,913	39.3	67.1	43.6	7.0	2.2	2.9	0.2	19.4	14.2	0.5	3.0	1.2	1.0	59.5	2.4
CVA/TIA																
Hemodialysis	21,895	43.2	63.0	42.2	5.7	3.2	0.8	0.0	26.9	13.7	0.1	1.5	0.7	2.5	49.9	5.4
Peritoneal dialysis	884	43.9	60.9	38.0	7.5	2.4	1.4	0.1	27.3	13.3	0.0	1.4	0.7	2.1	53.7	4.1
Transplant	2,384	39.1	66.9	44.9	6.8	2.4	3.1	0.2	23.3	17.5	0.6	1.5	0.6	2.6	63.5	2.7
AFIB																
Hemodialysis	25,759	35.3	64.2	28.7	12.6	10.3	1.0	0.0	18.6	38.2	0.2	1.1	0.6	0.7	45.4	17.6
Peritoneal dialysis	987	31.9	64.6	27.2	12.0	10.7	2.1	0.2	15.7	42.7	0.2	1.0	0.4	0.4	50.6	19.4
Transplant	3,369	40.7	74.5	36.1	13.8	10.2	4.1	0.3	10.8	52.2	2.1	0.9	0.4	0.3	56.8	10.7
ICDs/CRT-D																
Hemodialysis	541	56.4	79.9	27.9	3.7	9.6	1.8	0.2	30.5	20.9	0.6	0.7	0.2	0.7	51.9	18.3
Peritoneal dialysis	31	54.8	83.9	35.5	3.2	6.5	3.2	0.0	29.0	25.8	0.0	0.0	0.0	0.0	45.2	3.2
Transplant	29	65.5	96.6	31.0	3.4	17.2	13.8	0.0	41.4	41.4	6.9	0.0	3.4	0.0	65.5	20.7
Revascularization: PCI																
Hemodialysis	4,467	54.2	78.4	43.9	5.1	3.2	1.2	0.0	81.9	9.4	0.1	1.9	0.5	1.1	69.6	6.1
Peritoneal dialysis	264	48.5	79.5	35.6	7.6	2.3	2.7	0.0	79.9	9.8	0.0	2.3	0.8	0.8	75.0	6.1
Transplant	395	50.9	85.6	41.5	6.8	4.8	3.0	0.0	80.0	11.9	1.3	0.8	1.0	1.0	77.5	3.0
Revascularization: CABG																
Hemodialysis	699	50.5	81.7	42.2	7.2	2.7	0.6	0.0	38.8	14.4	0.0	1.0	0.4	1.3	71.7	18.0
Peritoneal dialysis	51	47.1	84.3	41.2	2.0	2.0	2.0	0.0	35.3	7.8	0.0	0.0	0.0	2.0	82.4	17.6
Transplant	82	50.0	87.8	48.8	6.1	7.3	2.4	0.0	36.6	15.9	4.9	0.0	0.0	0.0	85.4	19.5
No cardiac event																
Hemodialysis	66,233	44.1	58.2	46.6	4.4	0.8	0.6	0.0	8.9	5.9	0.0	0.3	0.3	0.6	34.4	1.0
Peritoneal dialysis	7,417	47.9	56.3	42.9	5.4	0.6	1.5	0.0	6.0	4.0	0.0	0.4	0.3	0.3	40.4	0.6
Transplant	32,914	40.3	59.0	44.2	6.6	0.4	1.7	0.1	4.4	4.6	0.0	0.2	0.2	0.4	50.9	0.2

Data on practice patterns in the medical treatment of cardiovascular disease in prevalent 2011 ESRD patients show a widespread use of beta blocker therapy. Presumably, most patients identified as receiving beta blockers and ACEI/ARBs for "no cardiac event" were in reality receiving these agents for antihypertensive therapy. More than three quarters of hemodialysis patients received beta blockers for AMI, a two-fold increase compared to an earlier era (Berger et al., 2003). Cilostazol, a drug approved for the treatment of symptomatic PAD, was prescribed in only 2 percent. Despite the "negative" trials of statin therapy in dialysis patients, there has been no apparent reduction in statin use. Even among patients with "no cardiac event," one-third of hemodialysis patients, and 40 percent of those on peritoneal dialysis, received statin therapy, as did two-thirds of dialysis patients with an AMI.

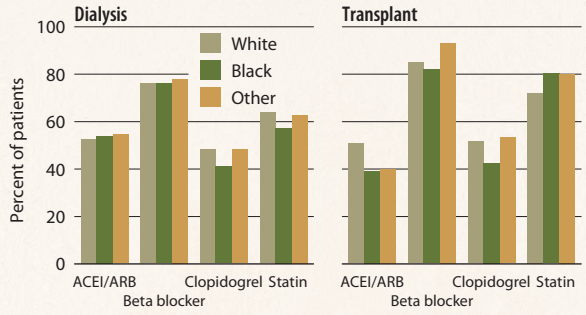
The medical treatment of atrial fibrillation presents special problems in dialysis patients. Consistent with the clinical uncertainty regarding the benefit of primary prevention of stroke with warfarin anticoagulation in dialysis patients, the most recent KDIGO recommendation (Herzog et al., 2011) neither supports nor rejects the use of warfarin therapy. Reflecting this clinical uncertainty, warfarin therapy was identified in only 38 percent of 2011 hemodialysis patients with atrial fibrillation, and in 43 percent of their peritoneal dialysis patients counterparts. And despite the lack of safety data on its use in dialysis patients, amiodarone is received by 18–19 percent of dialysis patients with atrial fibrillation.

In 2010, the first of the "novel" oral anticoagulants, dabigatran, was approved for use in the U.S. It is not approved for use in dialysis patients. Based on Part D data, a few dialysis patients have already been prescribed this agent. This trend needs to be followed closely, as there are significant safety concerns related to hemorrhagic risk. The use of Part D Medicare data to examine medication use in dialysis patients may provide a means of performing pharmacovigilance — including the tracking of off-label medication use — in this special, high-risk population. ✦ **Table 4.c;** see page 437 for analytical methods. *January 1 point prevalent patients with Medicare Parts A, B, & D enrollment & with a cardiovascular diagnosis or procedure in 2011.*

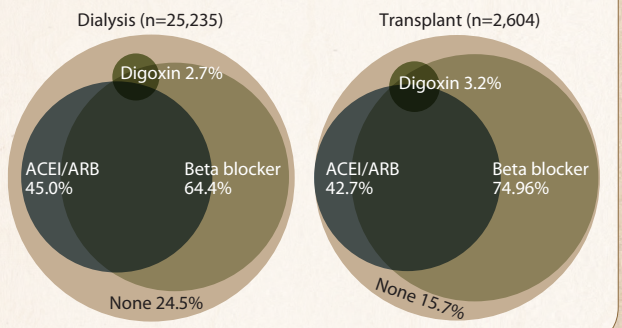
vol 2
4.12 **Prescription drug therapy in prevalent ESRD patients with CHF, by modality & race, 2011**



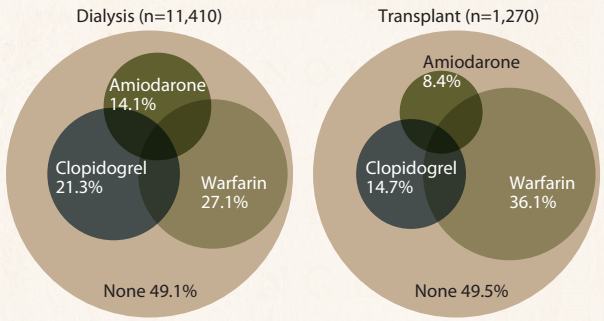
vol 2
4.13 **Prescription drug therapy in prevalent ESRD patients with AMI, by modality & race, 2011**



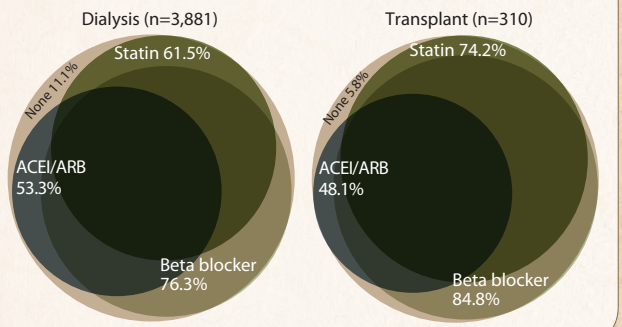
vol 2
4.14 **Patients treated for CHF, by type of medication & modality, 2011**



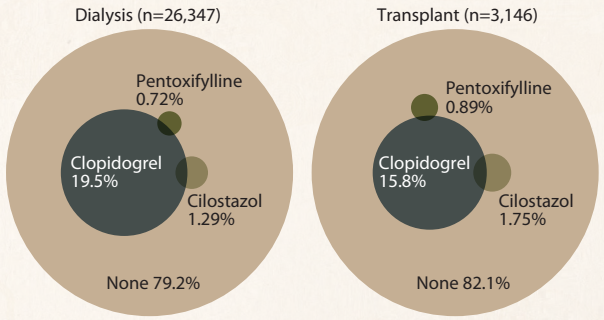
vol 2
4.15 **Patients treated for atrial fibrillation, by type of medication modality, 2011**



vol 2
4.16 **Patients treated for AMI, by type of medication & modality, 2011**



vol 2
4.17 **Patients treated for PAD, by type of medication & modality, 2011**



For CHF treatment, there is no suggestion of the underuse of ACEIs/ARBs or beta blockers related to race. Forty-five and 43 percent of dialysis and transplant patients with CHF, respectively, received an ACI/ARB in 2011, while 64 and 75 percent received a beta blocker; in both populations, one-third of patients received both.

The contrasts between AMI and PAD treatment are striking. Nearly all AMI patients receive an ACEI/ARB, beta blocker, or statin, with a considerable portion receiving all three. Data on PAD treatment, in contrast, show one of the remaining "islands of nihilism" characterizing the treatment of one cardiovascular disease in ESRD patients. About 80 percent of dialysis patients with PAD received neither clopidogrel, cilastozol, nor pentoxifylline. These figures, of course, do not include the nonprescription use of aspirin. ⬩ **Figures 4.12–17;** see page 437 for analytical methods. *January 1 point prevalent ESRD patients with Medicare Parts A, B, & D enrollment & with a first cardiovascular diagnosis or procedure in 2011.*

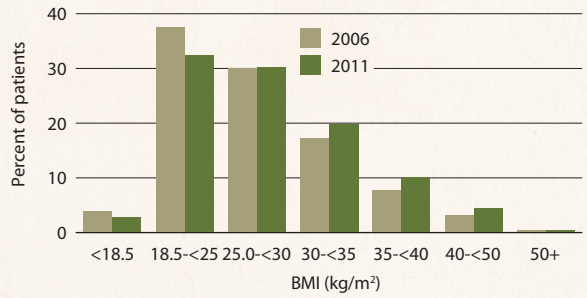
Among prevalent dialysis patients with a first cardiovascular diagnosis or procedure in 2011, the mean BMI was 28.5 kg/m²; one in six had a BMI of 35 or greater. No levels of obesity were associated with an increased risk of cardiovascular death.

Very obese patients are typically excluded from renal transplantation. Between 2006 and 2011, there was an increase in the percentage of patients with higher BMIs being wait-listed for transplant. In 2011, approximately two-thirds of wait-listed patients had a BMI less than 30; only 5 percent had a BMI of 40 or greater. ✦ **Table 4.d & Figures 4.18–21;** see page 438 for analytical methods. *January 1 point prevalent dialysis patients age 20 & older with a first cardiovascular diagnosis or procedure in 2011 (4.d). January 1 point prevalent hemodialysis & peritoneal dialysis patients on the transplant wait list (4.18). January 1 point prevalent dialysis patients age 20 & older (4.19–20); January 1 point prevalent dialysis patients age 20 & older with a first cardiovascular diagnosis or procedure in 2010 (4.21).*

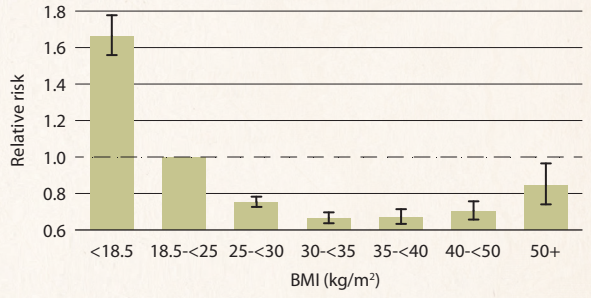
vol 2 **4.d** **Distribution of patients with cardiovascular disease (row percent), by body mass index (BMI), 2011**

			BMI (kg/m²)						
	N	Mean	<18.5	18.5–<25	25–<30	30–<35	35–<40	40-<50	50+
All	100,080	28.5	3.5	33.0	29.4	17.6	9.0	6.1	1.4
Age: 20–44	8,839	29.0	4.0	35.5	24.6	15.4	10.1	7.8	2.7
45–64	39,164	29.7	3.0	28.7	27.2	19.0	11.1	8.7	2.2
65-74	26,369	28.7	2.9	29.7	31.1	19.9	9.9	5.7	0.9
75+	25,708	26.2	4.5	42.3	32.4	14.0	4.7	1.9	0.2
Male	47,496	29.1	4.5	30.1	26.5	18.4	10.6	8.0	1.9
Female	52,584	27.9	2.5	35.7	31.9	17.0	7.6	4.3	1.0
White	56,519	28.6	3.1	31.8	30.6	18.0	9.1	6.0	1.3
Black/Af Am	37,769	28.6	3.7	33.2	27.6	17.7	9.5	6.6	1.7
Other race	5,792	26.4	5.4	43.4	28.4	13.4	5.8	2.9	0.7
Hispanic	14,449	28.5	2.3	30.7	34.2	18.2	8.6	4.9	1.1
Non-Hispanic	85,631	28.5	3.7	33.4	28.5	17.5	9.1	6.3	1.5
Non-diabetes	27,351	26.0	6.1	46.1	27.6	11.7	4.9	2.9	0.7
Diabetes	72,729	29.4	2.5	28.1	30.0	19.9	10.6	7.3	1.7
Hemodialysis	95,216	28.4	3.6	33.4	29.2	17.4	8.9	6.1	1.4
Peritoneal dialysis	4,864	29.5	1.9	24.9	32.4	22.1	11.7	6.0	1.2
CHF	31,102	28.7	3.3	32.6	29.0	17.6	9.3	6.6	1.6
AMI	9,879	27.9	3.9	35.4	29.6	16.6	8.3	5.0	1.1
PAD	21,936	28.7	3.4	32.5	28.6	17.6	9.4	6.7	1.7
CVA/TIA	13,588	27.8	3.8	35.3	30.1	17.4	7.9	4.6	0.9
AFIB	20,170	28.5	3.6	32.6	29.6	17.5	9.0	6.2	1.5
PCI/CABG	3,405	29.2	1.7	26.8	31.8	22.6	10.9	5.3	1.0

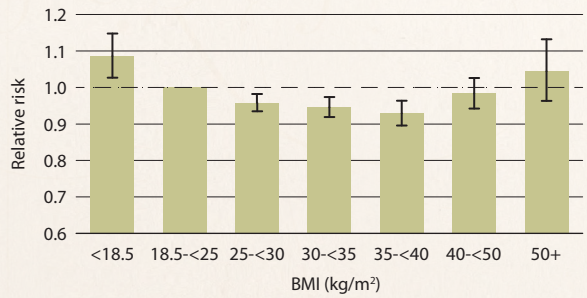
vol 2 **4.18** **Distribution of dialysis patients on the transplant wait list, by body mass index (BMI)**



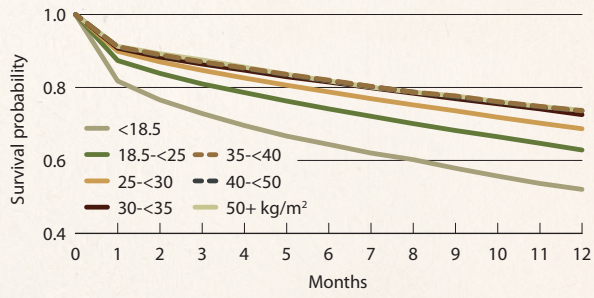
vol 2 **4.19** **Adjusted relative risk of a cardiovascular death, by body mass index (BMI), 2011**



vol 2 **4.20** **Adjusted relative risk of incident CHF, by body mass index (BMI), 2011**



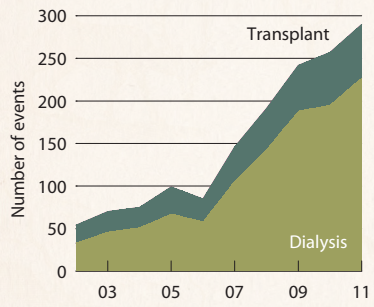
vol 2 **4.21** **Unadjusted survival in patients with cardiovascular disease, by body mass index (BMI), 2011**



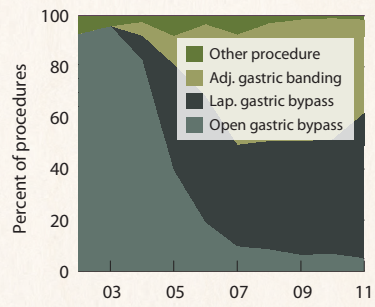
vol 2
4.e **Patient distribution (row percent) by BMI at ESRD incidence in patients who undergo bariatric surgery, 2002–2011**

	N	Mean	BMI (kg/m²) <30	30–<35	35–<40	40–<45	45–<50	50+
All	1,509	42.1	8.6	12.2	20.1	22.5	18.2	18.4
Age: 20–44	654	41.8	11.8	10.5	17.4	21.4	19.2	19.6
45–64	779	42.4	6.4	13.9	20.8	23.3	17.0	18.6
65+	76	41.2	4.2	8.5	33.8	23.9	22.5	7.0
Male	922	42.7	8.7	11.8	19.0	21.1	17.3	22.1
Female	587	41.1	8.3	12.9	21.9	25.0	19.8	12.1
White	854	41.1	8.3	13.8	24.7	21.2	17.9	14.0
Black/Af Am	619	43.5	9.1	9.7	13.1	24.7	18.7	24.7
Other race	36	41.9	6.1	15.2	24.2	18.2	18.2	18.2
Non-diabetes	720	41.9	10.4	12.7	16.1	22.8	19.1	18.9
Diabetes	789	42.2	7.1	11.8	23.2	22.4	17.6	18.0
Dialysis	1,114	44.0	6.7	6.4	17.2	23.9	22.4	23.3
Transplant	395	36.1	14.4	30.4	29.1	18.2	5.1	2.9

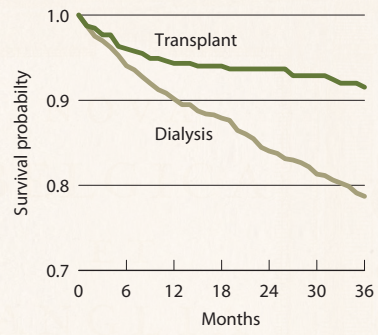
vol 2
4.22 **Number of bariatric surgery events, by modality**



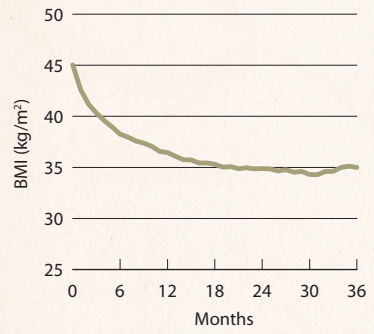
vol 2
4.23 **Distribution of bariatric surgical procedures**



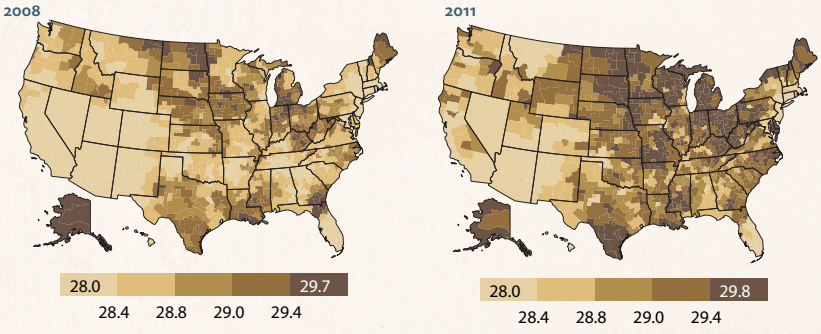
vol 2
4.24 **Survival following bariatric surgery, by modality, 2002–2011**



vol 2
4.25 **BMI following bariatric surgery in dialysis patients, 2005–2011**



vol 2
4.26 **Geographic variations in BMI (kg/m²), by HSA**



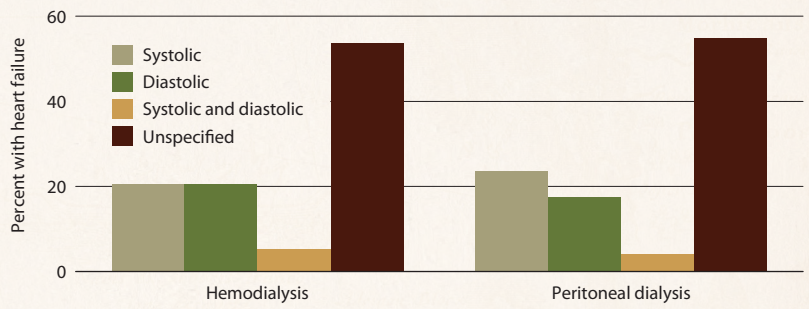
Data here document the proliferation of bariatric surgery in ESRD patients, the predominant use of either adjustable gastric banding or laparoscopic gastric bypass, and outcomes. These data provide the most complete picture of the overall utilization and outcomes with bariatric surgery in U.S. ESRD patients, with 1,114 dialysis and 395 transplant patients over a decade.

Three-year mortality following bariatric surgery is 21 percent in dialysis patients and 8 percent among transplant recipients. Thirty-day mortality is an impressively low 1.3 percent, attesting to the safety of the procedure (even allowing for selection bias). Equally impressive is the apparent sustained weight loss after surgery. The mean BMI in dialysis patients undergoing bariatric surgery was 45 at the time of surgery, 37 at one year, and 35 at year three. These data suggest that bariatric surgery is a potentially viable strategy in dialysis patients wishing to be considered for renal transplantation, but who have been excluded due to morbid obesity. • **Table 4.e & Figures 4.22–26;** see page 438 for analytical methods. *ESRD patients age 20 & older with Medicare coverage at time of surgery (4.e & 4.22–24); dialysis patients age 20 & older with Medicare as primary payer at time of surgery (4.25); January 1 point prevalent dialysis patients receiving dialysis for the entire year (4.26).*

vol 2 **4.f** **Percent of incident dialysis patients receiving first echocardiograms, 2011**

	Total	First 90 days		Day 90–1 yr	
	N	N	%	N	%
Age 65+	32,226	9,651	29.9	6,384	19.8
0-19	359		0.0	99	27.6
20-39	3,892		0.0	989	25.4
40-64	22,147		0.0	5,904	26.7
Age 65+					
White	23,617	7,087	30.0	4,720	20.0
Black/Af Am	6,974	2,090	30.0	1,359	19.5
N Am	286	76	26.6	42	14.7
Asian	1,322	388	29.3	258	19.5

vol 2 **4.27** **Heart failure in prevalent dialysis patients, by modality, 2011**



vol 2 **4.g** **Characteristics of dialysis patients with heart failure**

	Systolic heart failure				Diastolic heart failure				Systolic & diastolic heart failure				Unspecified heart failure			
	HD		PD		HD		PD		HD		PD		HD		PD	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Age: 0–19	*	*	*	*	*	*	.	.	*	*	.	.	17	0	*	*
20–44	1,179	10	49	14	1,111	9	42	16	262	9	*	*	3,612	12	138	17
45–64	5,115	44	162	46	5,027	43	121	47	1,263	43	30	50	13,132	43	321	40
65–74	3,156	27	88	25	3,114	26	62	24	791	27	15	25	7,801	25	207	26
75+	2,278	19	50	14	2,524	21	33	13	632	21	*	*	6,137	20	135	17
Male	6,514	56	208	59	4,966	42	109	42	1,478	50	34	57	14,901	49	402	50
Female	5,221	44	142	41	6,815	58	149	58	1,471	50	26	43	15,798	51	409	50
White	6,155	52	225	64	5,732	49	146	57	1,597	54	31	52	15,427	50	537	66
Black/Af Am	4,941	42	116	33	5,405	46	96	37	1,171	40	24	40	13,526	44	230	28
Other race	639	5	*	*	644	5	16	6	181	6	*	*	1,746	6	44	5
Non-diabetes	5,895	50	212	61	5,834	50	141	55	1,429	48	37	62	15,053	49	466	57
Diabetes	5,840	50	138	39	5,947	50	117	45	1,520	52	23	38	15,646	51	345	43
ACEI/ARB	7,639	65.1	224	64.0	7,049	59.8	157	60.9	1,861	63.1	42	70.0	16,157	52.6	471	58.1
Beta blocker	10,094	86.0	309	88.3	9,604	81.5	222	86.0	2,452	83.1	57	95.0	22,668	73.8	635	78.3
Digoxin	1,048	8.9	30	8.6	520	4.4	*	*	189	6.4	*	*	1,474	4.8	44	5.4

The differentiation of systolic and diastolic heart failure (HF) depends on the measurement of left ventricular ejection fraction (EF), typically performed by echocardiography. Without an EF measurement it is clinically impossible to distinguish between these two entities. Based on clinical trials in the general population, beta blockers and ACEI/ARBs should be used in patients with systolic HF; the issue is still unsettled, however, in regard to patients with preserved systolic function.

Half of all dialysis patients age 65 and older receive an echocardiogram within a year of initiating dialysis. Based on KDOQI guidelines (AJKD, 2005), all dialysis patients should receive an echocardiogram, as there is an evidence-based therapy (carvedilol) for treatment of dialysis patients with systolic HF (Cice et al., 2003).

ICD-9 codes for differentiation between systolic and diastolic HF have now existed for a decade, but, unfortunately, they are currently used to identify only a minority of patients with CHF. Nevertheless, for the distinct categories of systolic and diastolic HF in prevalent 2011 dialysis patients, more than 11,000 were coded as having systolic HF while comparable numbers had "pure" diastolic HF. Nearly two-thirds of dialysis patients received an ACEI/ARB, while an impressive 86–88 percent received a beta blocker, attesting to the acceptance of this evidence-based therapy by nephrologists for the treatment of systolic HF. Digoxin therapy was used in 9 percent of patients with systolic HF.

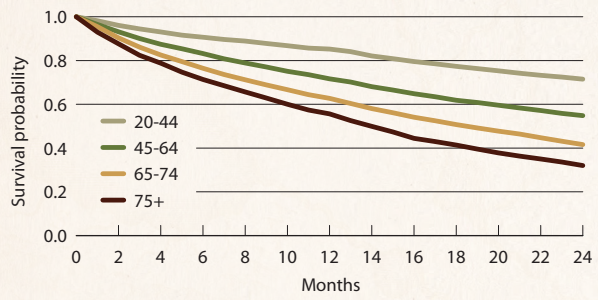
Few data exist on the optimal treatment of diastolic HF; 60 percent of hemodialysis patients with diastolic HF receive ACEIs/ARBs, and 82 percent receive beta blockers. ✦ **Tables 4.f–g & Figure 4.27;** see page 438 for analytical methods. *Incident dialysis patients, 2011 (4.f). Figure 4.27 & Table 4.g: January 1, 2011 point prevalent ESRD dialysis patients with Medicare Parts A, B, & D coverage, diagnosed with heart failure in 2011, & surviving & staying on the same modality for all of 2011. "." Zero values in this cell. *Values for cells with ten or fewer patients are suppressed.*

vol 2
4.h **Adjusted hazard ratios of all-cause death in patients with heart failure, by modality, 2010–2011**

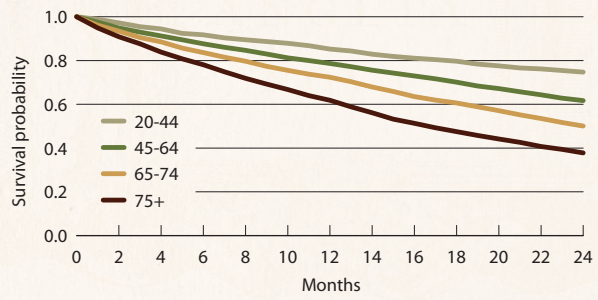
	Hemodialysis			Peritoneal dialysis		
	Hazard ratio	CI	p-value	Hazard ratio	CI	p-value
Age: 0-19	0.32	0.17-0.61	0.0006	0.30	0.11-0.81	0.0178
20-44	0.62	0.60-0.65	<.0001	0.55	0.47-0.65	<.0001
45-65	reference					
65-74	1.44	1.41-1.47	<.0001	1.56	1.41-1.72	<.0001
75+	2.06	2.02-2.11	<.0001	2.28	2.05-2.53	<.0001
Male	reference					
Female	0.93	0.92-0.95	<.0001	0.96	0.89-1.04	0.3038
White	reference					
Black/African American	0.75	0.73-0.76	<.0001	0.78	0.70-0.87	<.0001
Other	0.77	0.74-0.80	<.0001	0.76	0.64-0.89	0.0007
Diabetes	1.29	1.26-1.32	<.0001	1.50	1.35-1.66	<.0001
Hypertension	1.12	1.09-1.15	<.0001	1.07	0.95-1.19	0.2662
Other cause	reference					
Heart failure: none	reference					
Systolic	1.90	1.85-1.96	<.0001	2.03	1.75-2.36	<.0001
Diastolic	1.59	1.54-1.64	<.0001	1.66	1.35-2.03	<.0001
Both	1.69	1.60-1.78	<.0001	1.61	1.14-2.26	0.0068
Unspecifed	1.49	1.46-1.52	<.0001	1.53	1.38-1.70	<.0001

Data on the mortality hazard associated with types of heart failure (HF) show a 90 percent increased death risk for systolic HF and a 59 percent increased risk for diastolic HF. Of patients age 75 and older with systolic HF, approximately two-thirds die within two years. The outcome is slightly better for patients with diastolic HF, with a two-year survival of 38 percent. These findings mirror those in the general population, in which diastolic and systolic HF are both noted to have adverse outcomes. • **Table 4.h & Figures 4.28–31;** see page 439 for analytical methods. *January 1, 2009 point prevalent dialysis patients, surviving & staying on the same modality for all of 2009. Figures 4.28–31: subset of these patients, with a heart failure diagnosis in 2009.*

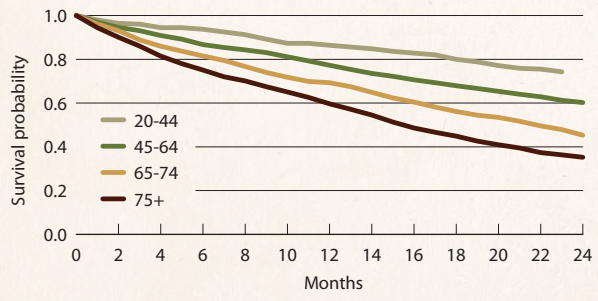
vol 2
4.28 **Unadjusted survival in patients with systolic heart failure, by age, 2010–2011**



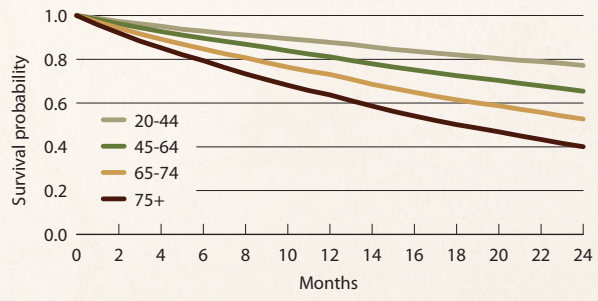
vol 2
4.29 **Unadjusted survival in patients with diastolic heart failure, by age, 2010–2011**



vol 2
4.30 **Unadjusted survival in patients with systolic & diastolic heart failure, by age, 2010–2011**



vol 2
4.31 **Unadjusted survival in patients with unspecified heart failure, by age, 2010–2011**



causes of death

CAUSES OF DEATH IN INCIDENT & PREVALENT DIALYSIS PATIENTS 2009–2011 (FIGURE 4.1)

	incident patients	prevalent patients
overall mortality (per 1,000 patient years)	298	194
percent cardiovascular mortality:		
AMI	3.6%	4.7%
CHF	5.7%	4.8%
arrhythmia/cardiac arrest	24.3%	26.9%
CVA	2.2%	3.1%
other cardiac	1.5%	1.9%

diagnosis of cardiovascular disease

RATES OF CARDIOVASCULAR DIAGNOSES & PROCEDURES, 2009–2011 (RATE PER 1,000 PATIENT YEARS; FIGURE 4.3)

	hemodialysis	peritoneal dialysis	transplant
CHF	464	243	105
CVA/TIA	173	123	59
PAD	415	227	119
cardiac arrest	81	58	14

sudden cardiac death

RATES OF SUDDEN CARDIAC DEATH IN PREVALENT DIALYSIS PATIENTS, 2011 (DEATHS PER 1,000 PATIENT YEARS; FIGURES 4.8–9)

white: 55; black/African American: 40: other: 44

hemodialysis: 49; peritoneal dialysis: 36

PROBABILITY OF SUDDEN CARDIAC DEATH IN 2010 INCIDENT DIALYSIS PATIENTS AT 12 MONTHS AFTER INITIATION (FIGURES 4.10–11)

white: 0.07; black/African American: 0.05: other: 0.05

hemodialysis: 0.07; peritoneal dialysis: 0.02

pharmacological interventions

PHARMOCOLOGICAL INTERVENTION FOLLOWING A DIAGNOSIS OF CHF, 2011 (PERCENT OF PATIENTS ON MEDICATION; TABLE 4.C)

	ACEI/ARB	beta blocker	clopidogrel	statin
hemodialysis	44%	66%	21%	45%
peritoneal dialysis	45%	70%	21%	48%
transplant	41%	76%	16%	59%

PHARMOCOLOGICAL INTERVENTION FOLLOWING A DIAGNOSIS OF AMI, 2011 (PERCENT OF PATIENTS ON MEDICATION; TABLE 4.C)

	ACEI/ARB	beta blocker	clopidogrel	statin
hemodialysis	54%	78%	50%	64%
peritoneal dialysis	48%	81%	54%	69%
transplant	47%	85%	52%	74%

body mass index and cardiac death

ADJUSTED RELATIVE RISK OF A CARDIOVASCULAR DEATH, BY BMI (FIGURE 4.19)

<18.5: 1.7; 18.5–<25: reference; 25–<30: 0.8; 30–<35: 0.7;
35–<40: 0.7; 40–<50: 0.7; 50+: 0.8

heart failure

HEART FAILURE IN PREVALENT DIALYSIS PATIENTS, 2011 (FIGURE 4.27)

	systolic	diastolic	systolic & diastolic	unspecified
hemodialysis	21%	21%	5%	54%
peritoneal dialysis	24%	17%	4%	55%