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Authors

Pun, Patrick H
Sheng, Shubin
Sanders, Gillian
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Prescription of Guideline-Recommended Implantable Cardioverter Defibrillator and Cardiac Resynchronization Therapy Among Patients Hospitalized with Heart Failure and Varying Degrees of Renal Function

Patrick H. Pun, MD MHS[a,b], **Shubin Sheng, PhD**[a], **Gillian Sanders, PhD**[a], **Adam D. DeVore, MD**[a,c], **Daniel Friedman, MD**[a,c], **Gregg C. Fonarow, MD**[d], **Paul A. Heidenreich, MD, MS**[e], **Clyde W. Yancy, MD, MSc**[f], **Adrian F. Hernandez, MD**[a,c], and **Sana M. Al-Khatib, MD MHS**[a,c]

[a]Duke Clinical Research Institute, Durham, NC

[b]Department of Medicine, Division of Nephrology, Duke University School of Medicine, Los Angeles, CA

[c]Department of Medicine, Division of Cardiology, Duke University School of Medicine, Los Angeles, CA

[d]Ahmanson-UCLA Cardiomyopathy Center, Ronald Reagan-UCLA Medical Center, Los Angeles, CA

[e]W, Palo Alto, CA

[f]Division of Cardiology, Northwestern University, Feinberg School of Medicine, Chicago, IL

Abstract

Implantable cardioverter defibrillators(ICD) and cardiac resynchronization therapy (CRT) reduce mortality in many patients with heart failure(HF), but the current use and effectiveness of ICD/CRT in patients with chronic kidney disease(CKD) are uncertain. We examined associations between kidney function and guideline-recommended prescription of ICD/CRT in the Get With The Guidelines-Heart Failure registry, a performance improvement program for hospitalized HF patients. We compared differences in ICD and CRT prescription between the following categories of estimated glomerular filtration rate(eGFR) (mL/min/1.73 m^2): ≥60, 59–30, <30, and dialysis-dependent. From 2008 through 2014, 26,286 patients were eligible for ICD or CRT, and 16,123(61%) had an eGFR<60. De novo ICD and CRT prescription in this group was low at 45% and 30.5%, respectively. Compared to patients with eGFR≥60, patients with eGFR30–59 were more likely to receive an ICD (adjusted odds ratio[aOR]=1.08, 95% confidence intervals[CI]1.01–1.14), while dialysis patients were less likely (aOR=0.61, 95%CI 0.5–0.76). Worse kidney function was associated with a decreased likelihood of CRT prescription (aOR=0.97 per 10

Corresponding Author: Patrick Pun, MD MHS; PO Box 17696 Durham, NC, 27715 Patrick.Pun@dm.duke.edu; Tel: 919-668-8993; Fax 919-668-7032.

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mL/min eGFR decrease, p=0.03). During the study period, the likelihood of both ICD and CRT prescription increased over time among CKD patients (ICD aOR=1.12(95%CI 1.07–1.18), CRT aOR=1.14(95%CI 1.06–1.23) per year). Prescription of an ICT/CRT was associated with greater one-year survival in all eGFR groups. In conclusion, there are significant CKD-based differences in prescription of ICD and CRT in HF. However, given the current state of evidence, it is unclear whether or not improved prescription of ICD and CRT in the CKD population will result in improvement in outcomes.

Keywords

chronic kidney disease; congestive heart failure; arrhythmias

Introduction

Heart failure (HF) and chronic kidney disease (CKD) are highly coincident conditions; more than one-third of all patients with HF also have CKD.[1] Despite the fact that the presence of CKD independently predicts increased mortality and morbidity, HF patients with CKD are less likely to be provided with guideline-recommended HF medications, perhaps due to uncertainty regarding the benefit and risk of interventions in this patient population.[2–4] Implantable cardioverter defibrillators (ICD) and cardiac resynchronization therapy (CRT) devices are therapies that reduce mortality in many patients with HF.[5] Among patients with moderate to advanced CKD, a growing body of evidence suggests that ICD therapy is associated with a reduced or absent mortality benefit; however, current practice guidelines do not make specific provisions for the consideration of CKD in the decision to implant these devices.[6–9] Given the uncertainty regarding the effectiveness and potential risks with use of ICD/CRT in this population, we conducted this study in order to: 1) examine whether or not rates of guideline-recommended device prescription and use vary according to the presence and severity of CKD, and 2) evaluate temporal trends in prescription of ICD/CRT in HF patients with CKD.

Methods

Data for this study were obtained from the Get With The Guidelines-Heart Failure (GWTG-HF) database. The GWTG-HF program was established as a quality improvement initiative that involves data collection on patients hospitalized for HF as previously described.[10] Adult patients hospitalized with an episode of new or worsening HF as the primary reason for admission, or patients with significant HF symptoms that developed during hospitalization in which HF was the primary discharge diagnosis are eligible for the GWTG-HF registry. Data collected include patient demographics, clinical characteristics, prior therapies and interventions, in-hospital outcomes, and contraindications to evidence-based therapies. Specific data are collected regarding the eligibility for ICD/CRT, presence of an ICD/CRT on admission, any ICD/CRT implantation during the index hospitalization or scheduled outpatient implantation at the time of discharge, and documented contraindications to ICD/CRT implantation. Patient variables used for this study included demographic characteristics, hospital-reported medical history, left ventricular ejection fraction(LVEF),

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QRS duration on admission ECG, admission vital signs, chronic dialysis-dependency at enrollment, and admission serum creatinine values. Data quality is ensured by data checks to prevent out-of-range entries and periodic data audits.

Because the data are used primarily at the local site for quality improvement, institutions participating in GWTG-HF are granted a waiver of informed consent under the Common Rule. Quintiles (Cambridge, MA) served as the registry coordinating center, and the Duke Clinical Research Institute (Durham, NC) served as the data analysis center. Hospital data elements are collected for all enrolling hospitals from the American Hospital Association database. The Institutional Review Board of the Duke University Health System approved this study.

We selected patients who were hospitalized for HF between February 2008 and December 2014 and had available data on admission serum creatinine. Patients who did not survive to hospital discharge or were discharged to somewhere other than home were excluded. Additionally, patients with physician-documented contraindications to primary prevention ICD implantation including LVEF>35%, class IV heart failure symptoms, myocardial infarction <40 days prior to implant, coronary artery bypass surgery <90 days prior to implant, not on optimal medical therapy, and new-onset HF (<3 months) were excluded, consistent with clinical guidelines.[11] For the CRT analyses, we used a QRS duration of ≥150ms to determine patients who would be eligible for a guideline-recommended CRT (CRT with ICD or CRT pacemaker). A QRS cutoff of ≥150 ms was chosen because the evidence on efficacy of CRT from randomized clinical trials is strongest in these patients, and current guidelines designate CRT as a class I indication in patients with a QRS≥150 ms and left bundle branch block and as a class IIa indication in patients with a QRS≥150 ms and non-left bundle branch block morphology.[11]

The primary outcome was documented prescription of a de-novo ICD or CRT, either placed during hospitalization or planned to be placed following discharge. In a sensitivity analysis, we also included patients who had a pre-existing ICD or CRT prior to hospitalization to assess the prevalent use of guideline-based ICD/CRT by kidney function. As a secondary outcome, we examined the association between device prescription and one-year mortality among eGFR groups. Using linkage to GWTG-HF, mortality data were obtained from the Center for Medicare Services (CMS) claims database with indirect identifiers as described previously.[12]

Estimated glomerular filtration rate (eGFR) at admission was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation.[13] For consistency with prior literature, patients were then grouped into the following categories of estimated GFR (in mL/min per 1.73 m^2): ≥60, 59–30, <30 but not receiving dialysis, and dialysis-dependent. Because serum creatinine levels at admission for HF may not be at steady state due to acute kidney injury, we also performed a sensitivity analysis utilizing the discharge serum creatinine to determine eGFR categories. Baseline characteristics were compared between the eGFR groups. Differences in baseline characteristics and outcomes between groups were assessed using the Kruskal-Wallis and Pearson χ^2 tests as appropriate. Multivariable logistic regression models using generalized estimating equations to account for in-hospital

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clustering was performed to determine odds ratios for receiving a device within each eGFR stratum compared with the ≥60 group, utilizing baseline variables significantly associated with outcome ($p<0.05$) in adjusted models or variables thought to be clinically relevant to outcome. Multiple imputation was used to impute missing data for covariates; less than 2% missingness was observed for all variables used in the multivariable models. Temporal trends in ICD/CRT prescription were assessed using Cochran-Armitage tests. Finally, multivariable logistic regression models were performed to determine baseline variables that were independently associated with device prescription among patients with eGFR<60. A two-sided $p < 0.05$ was considered statistically significant. Analyses were performed with SAS software version 9.2 (SAS Institute, Cary, NC).

Results

Between February 2008 and December 2014, there were 310,468 patients hospitalized with HF across 357 inpatient facilities. We excluded 185,253 (59.7%) with LVEF >35% or with missing data on LVEF, 33,678 (10.8%)with new-onset HF or missing data on HF history, and 22,339(7.2%) patients who did not survive to hospital discharge or were discharged to somewhere other than home. 17,157 patients (5.5%) were excluded due to missing data on admission serum creatinine or dialysis history. The final ICD-eligible and CRT-eligible cohorts were determined from the remaining 52,041 patients with LVEF≤35%. (Figure 1A/B) 61.3% of patients eligible for guideline-based ICD or CRT had evidence of kidney disease with an eGFR <60. Demographic and clinical characteristics of the ICD-eligible cohort and CRT-eligible cohorts grouped by baseline eGFR status are shown in Table 1 and 2.

Figure 2 shows the rates of de-novo ICD and CRT prescription in eligible patients by eGFR group. 45% of all eligible patients with eGFR<60 received a de novo ICD, and only 30.5% of CRT-eligible CKD patients received a de novo CRT. Patients with an eGFR 59–30 had a slightly higher rate of ICD prescription compared to patients with eGFR≥60 (46% vs 44%, p<0.0001), whereas patients on dialysis had a much lower rate of prescription (32%, p<0.0001). CRT prescription rates were progressively lower with lower eGFR (p-value for trend <0.0001).

After adjustment for baseline covariates, dialysis patients were the least likely to receive an ICD compared with patients with an eGFR≥60 (aOR=0.61, 95%CI 0.5–0.76, p<0.0001) (Table 3). In contrast, patients with an eGFR 59–30 were more likely to receive a guideline-recommended ICD compared with patients with preserved renal function (aOR=1.08, 95%CI 1.01–1.14, p=0.02). For CRTs, after adjustment for baseline differences there was a trend towards decreased likelihood of CRT prescription among all eGFR groups <60 compared with the eGFR≥60 group, but the relationship was significant only for patients with eGFR<30 not on dialysis. However, eGFR was significantly associated with CRT prescription when examined as a continuous variable (aOR=0.97 per 10 decrease in eGFR, p=0.03).

The rate of ICD prescription increased over time for all non-dialysis patients, but was most pronounced among patients with an eGFR 59–30 (29% in 2008 to 52% in 2014, p-value for

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trend <0.0001) (Figure 3). ICD prescription also increased among chronic dialysis patients from 16% in 2008 to 42% in 2012, but subsequently declined to 33% in 2014 (p=0.0019). There were no significant time trends in CRT prescription among patients with eGFR<60 (Figure 4).

We examined the robustness of our study findings in 3 sensitivity analysis models (Supplemental Table 1). First, we used discharge creatinine measurements to determine eGFR given the possibility of misclassification using admission creatinine. The overall patterns of ICD and CRT prescription by eGFR group remained unchanged. Second, we included patients with pre-existing ICD and CRT devices at hospital admission to assess prevalent and incident device use. The overall pattern of ICD use or prescription among CKD patients also remained the same. For CRT devices, prescription among patients with eGFR<30 was increased, but otherwise findings in other eGFR groups remained unchanged. Finally, we used expanded QRS duration criteria (≥120 ms) suggested by 2012 update of device-based therapy guidelines as a class IIa recommendation for CRT prescription.[11] Only 29% in the overall cohort were prescribed a CRT due to the increased number of eligible patients. There was no change in the pattern of progressively declining CRT prescription with lower eGFR.

22.9% of the cohort had available mortality data via linkage to CMS claims data. In this limited analysis, one-year mortality progressively increased with CKD severity, and was more than two-fold higher among dialysis patients compared to patients with eGFR≥60 (unadjusted HR=2.8, 95% CI 2.1–4.0) (Supplemental Table 2). Comparison of mortality rates between device-eligible patients who were prescribed versus not prescribed ICD or CRT devices showed increased survival among those who were prescribed devices in all eGFR subgroups; the survival advantage was more pronounced among patients prescribed CRT devices.

Discussion

In this large population of hospitalized patients with HF, we examined guideline-recommended ICD and CRT prescription among eligible patients across categories of kidney function. We found that CKD was highly prevalent among patients with HF, with more than 60% of all patients having an eGFR<60. ICD/CRT prescription was low among patients with CKD. Compared with patients without significant CKD, guideline-recommended ICD prescription was higher among patients with moderate CKD and significantly lower among patients on dialysis. In contrast, guideline recommended CRT prescription declined progressively with lower levels of kidney function. Sensitivity analyses using discharge serum creatinine to determine kidney function, accounting for devices present during hospital admission, and using less a less stringent QRS criterion for CRT eligibility did not substantially alter the trends observed in the primary analysis. In a limited analysis of mortality rates, we found that prescription of devices appeared to be associated with a survival advantage, particularly for CRT prescription. Our analysis of temporal prescription trends showed an increasing rates of prescription of both ICD and CRT among CKD patients.

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Previous studies have suggested that guideline-recommended therapies for HF are less likely to be used in patients with CKD. In a prior study of the GWTG-HF registry, lower eGFR was associated with lower usage rates of beta-blockers, ACEI/ARB, and anticoagulation for atrial fibrillation.[2] A more recent study of HF patients receiving care at outpatient cardiology clinics examined adherence to 7 guideline-recommended therapies among CKD patients, including ICD/CRT use.[4] The authors found no independent association between prescription of ICD or CRT and kidney function, although the lack of association could be explained by insufficient statistical power given the smaller size of the ICD/CRT-eligible cohort (6,383 patients ICD-eligible and 1,263 patients CRT-eligible) in that study. Several potential factors may explain the apparent eGFR-based differences observed in our study. First, differences in prescription may reflect physician attitudes towards certain CKD subgroups based on perceptions of risk/benefit and the current state of evidence. Increased prescription of ICD among patients with moderate CKD might be related to a perception of increased risk with an increased burden of ischemic heart disease and sudden cardiac death (SCD) in these patients. Lower prescription of ICD among more advanced CKD patients including dialysis patients could be related to the higher rates of complications, and concern for lack of benefit due to competing risks of non-arrhythmic death. Overall, concerns for increased risks of device-related complications and the lack of strong evidence supporting the benefit of ICD/CRT in patients with more advanced CKD may have influenced physicians' decisions not to follow guideline recommendations. Second, patients may also differ in preferences for implantable device therapy due to the high burden of co-morbidities and invasive procedures already borne by this patient population, particularly among patients receiving chronic dialysis.[14]

Patients with CKD are at a markedly increased risk of SCD. The risk of SCD is two-fold greater among patients with an eGFR 15–59 compared to with an eGFR≥60, and chronic dialysis patients are among the highest risk groups for SCD with an annual rate of 6%.[15–17] Although ICD are proven to reduce SCD and overall mortality in selected populations, the role of these devices in patients with CKD remains unclear, since patients with advanced CKD have been excluded from previous clinical trials and higher risks of competing causes of death may limit device efficacy. A meta-analysis of 3 randomized trials of primary prevention ICD found no significant mortality benefit among patients with an eGFR<60.[9] A recent analysis found no significant survival advantage among dialysis patients who received guideline-recommended primary prevention ICD compared to propensity-matched dialysis patients with HF.[8] Adding to the uncertainty surrounding the role of ICD among CKD patients are potential safety concerns including an increased rate of implantation-related and infectious ICD complications.[18,19] While these data should be confirmed in randomized controlled trials, the current available evidence may not support the increased utilization of ICD in patients with moderate CKD (eGFR 30–59) relative to patients with less severe CKD that was observed in our study.

CRT in reduced ejection fraction patients with evidence of electric dyssyncrony is associated with improvement in LVEF, reduced risk of ventricular arrhythmia and improvement in HF symptoms.[20] Secondary analyses of CRT trials examining outcomes among patients with mild to moderate CKD have reported similar benefits compared to those observed in HF patients without CKD, but with higher rates of complications.[21,22] A recent retrospective

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study evaluating the comparative effectiveness of CRT with ICD versus ICD alone in CRT-eligible patients found a lower risk of death or HF hospitalization among patients with moderate-to-severe CKD.[23] Other observational studies of CKD patients have noted significant improvements in renal function among patients who received a CRT-D versus those who received an ICD alone.[24,25] Taken together, these findings suggest that the underutilization of guideline-recommended CRT among patients with CKD observed in our study may not be justified; thus, our study findings may highlight an important opportunity to improve care and outcomes for CKD patients.

Several limitations should be considered in interpreting this study's findings. First, contraindications to therapy were recorded as documented in the medical record and may have been underreported. We did not have information on several important variables including New York Heart Association functional classification and electrocardiographic data such as left bundle branch morphology; both are factors that might have influenced guideline-based treatment decisions. Second, creatinine measurement at hospital admission may not reflect steady state conditions, leading to misclassification of chronic kidney disease status. To address this limitation, we performed a sensitivity analysis using the discharge serum creatinine to determine eGFR which did not show any substantial changes from the primary analysis, decreasing the likelihood of misclassification bias. Third, hospitals enrolled in the GWTG-HF program might have a higher likelihood of following guideline-based recommendations, and thus our results may not be generalizable to overall community practice. Fourth, we do not have data on whether patients who were scheduled for planned device implantation after hospital discharge actually received prescribed devices; it is possible that these patients did not ultimately receive a prescribed device due to intervening illness or non-compliance. The primary purpose of our study was to evaluate guideline-based prescribing patterns rather than compliance with prescribed therapy, but we acknowledge that our results may over-report actual ICD/CRT usage. Fifth, we only had data on mortality for a proportion of the cohort and the results of our unadjusted mortality analysis may have been subject to selection bias and confounding. Lastly, residual measured and unmeasured confounding may have impacted some of our findings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Conflict of Interest Disclosures:

Dr. DeVore reports research support from the American Heart Association, Amgen, and Novartis. Dr. Friedman reports educational grants from Boston Scientific and St. Jude Medical. Dr. Fonarow reports consultancy fees from Amgen, Baxter, Bayer, Janssen, Novartis, and Medtronic. All authors reviewed and approved the final manuscript.

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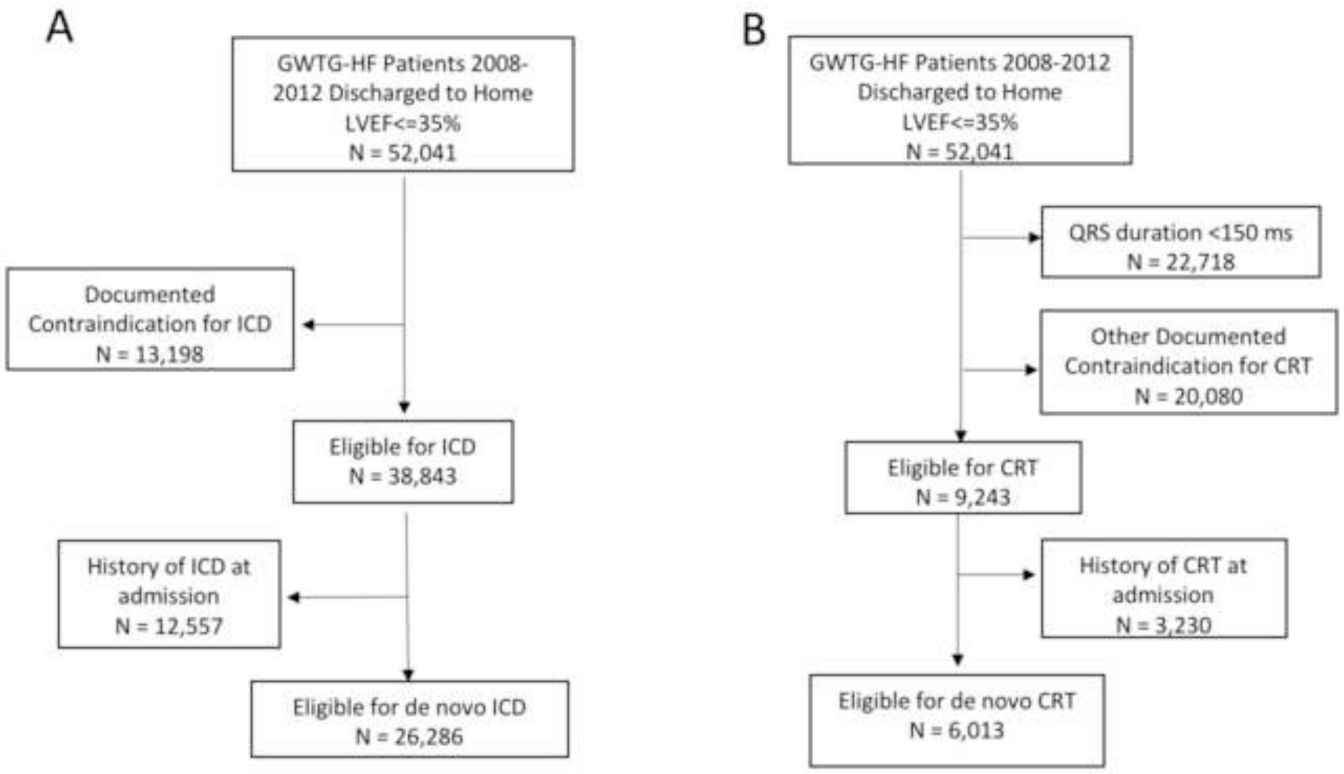

Figure 1.

A/B: Flowchart illustrating determination of ICD-eligible (A) and CRT-eligible (B) cohorts.

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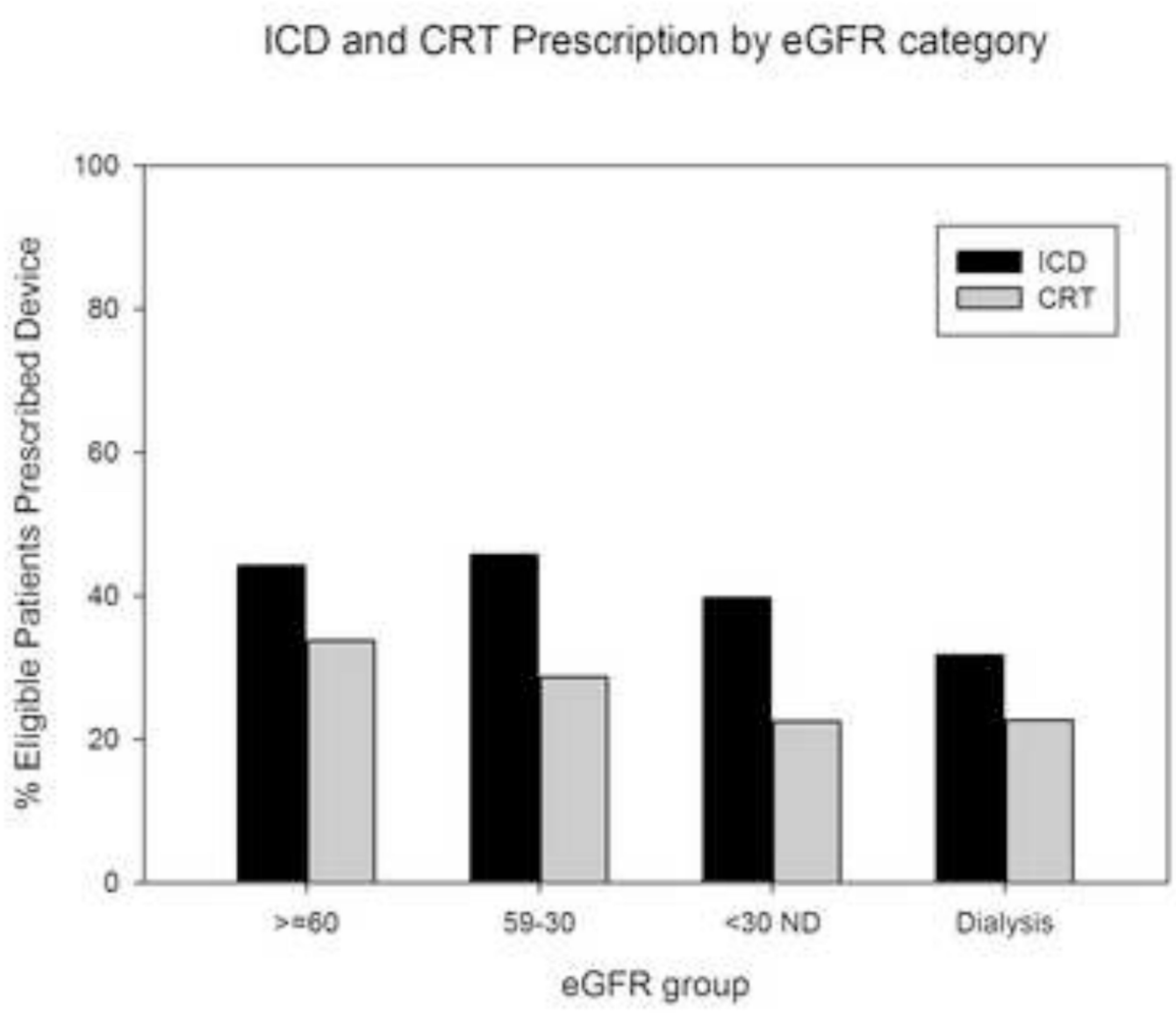

Figure 2.

ICD and CRT prescription by eGFR group. Compared with patients with a baseline eGFR≥60 mL/min per 1.73 m^2, patients with an eGFR 59–30 mL/min per 1.73 m^2 had a slightly higher rate of ICD prescription (46% vs. 44%, p<0.0001) whereas patients on dialysis had a much lower rate of prescription (32%, p<0.0001). CRT prescription rates were progressively lower with lower eGFR (p<0.0001 for CRT prescription by eGFR category.) (ND=non-dialysis)

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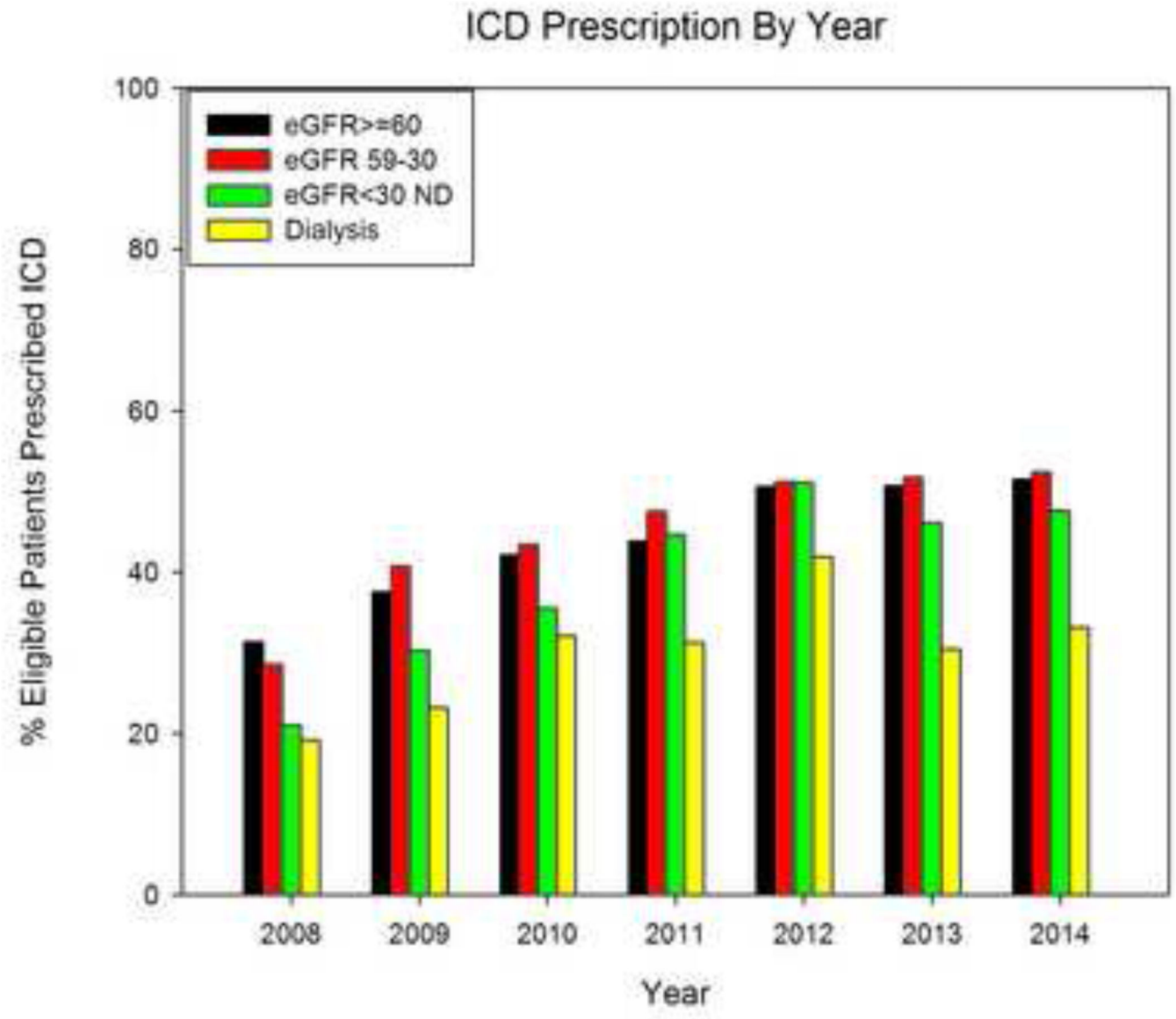

Figure 3.
ICD prescription by eGFR group and admission year. (ND=non-dialysis)

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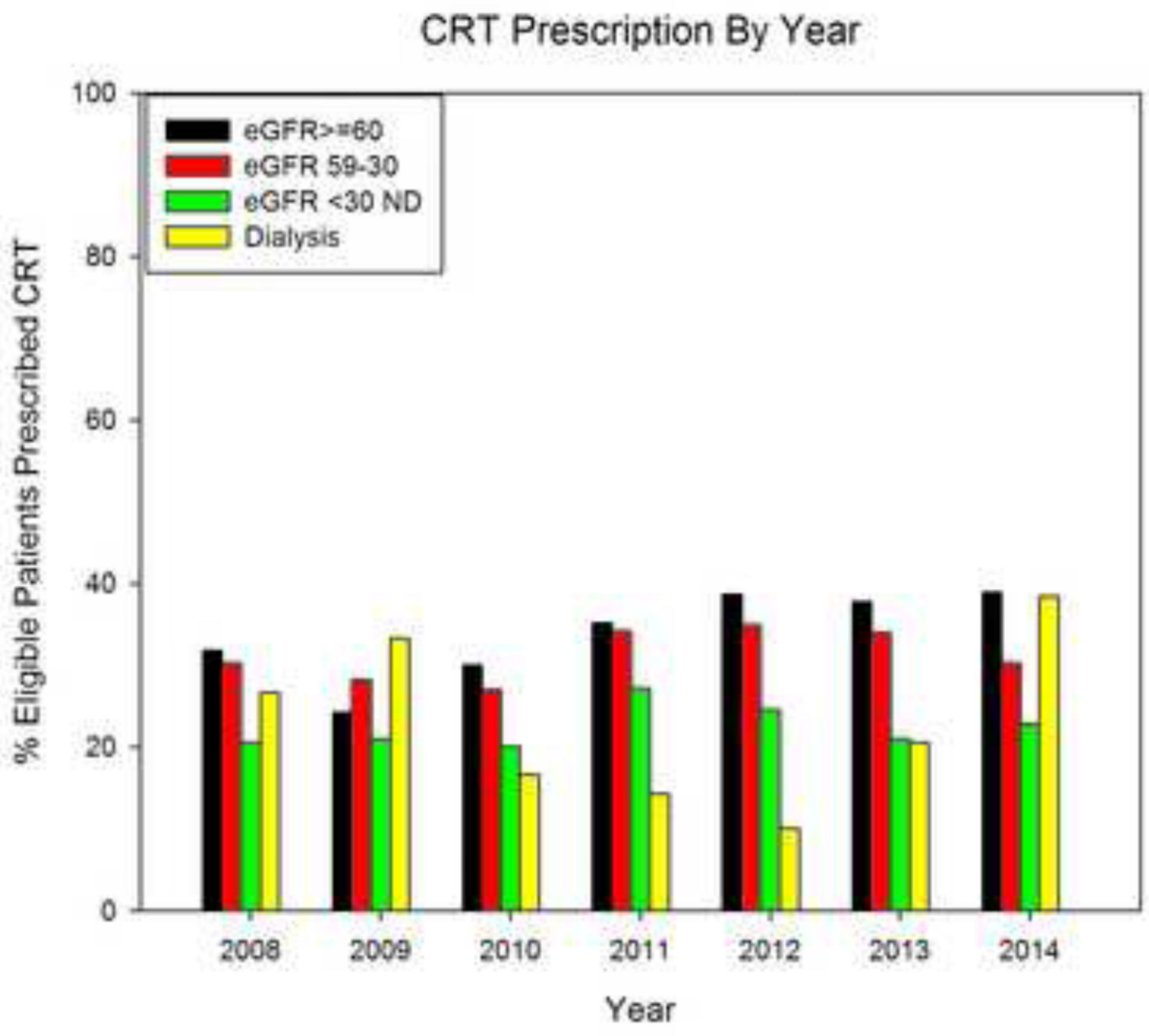

Figure 4.
CRT prescription by eGFR group and admission year. (ND=non-dialysis)

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Table 1

Baseline Characteristics of ICD-Eligible Patients by eGFR category

Variable	eGFR≥60 (N=10153)	eGFR 30–59 (N=10958)	eGFR<30, not on dialysis (N=4112)	Dialysis (N=1063)	P-value
Demographics					
Age (Mean± SD)	61.1±14.6	71.7±12.6	73.3±12.6	64.7±14.3	<.0001
Women	30.9(%)	36.6(%)	41.3(%)	36.9(%)	<.0001
Black	33.1(%)	21.2(%)	20.2(%)	33.4(%)	<.0001
White	51.1(%)	65.1(%)	65.3(%)	47.4(%)	
Medical History					
Coronary artery disease	47.0(%)	59.6(%)	64.0(%)	59.2(%)	<.0001
Prior coronary artery bypass grafting	17.7(%)	27.5(%)	30.2(%)	24.1(%)	<.0001
Previous myocardial infarction	24.2(%)	29.1(%)	29.6(%)	26.6(%)	<.0001
Prior percutaneous intervention	17.7(%)	21.6(%)	21.6(%)	22.8(%)	<.0001
Hypertension	77.0(%)	79.1(%)	79.5(%)	83.9(%)	<.0001
Diabetes mellitus	39.2(%)	45.6(%)	52.4(%)	54.8(%)	<.0001
Atrial fibrillation	25.5(%)	37.7(%)	36.1(%)	23.4(%)	<.0001
Chronic obstructive pulmonary disease or asthma	31.6(%)	31.0(%)	29.1(%)	33.3(%)	0.012
Cerebral vascular accident/Transient ischemic attack	11.6(%)	15.0(%)	16.6(%)	18.0(%)	<.0001
Hyperlipidemia *	47.9(%)	55.8(%)	57.5(%)	49.5(%)	<.0001
Peripheral vascular disease	7.8(%)	13.1(%)	15.8(%)	18.5(%)	<.0001
Valvular heart disease	15.6(%)	19.5(%)	20.5(%)	16.9(%)	<.0001
Smoking	32.6(%)	16.3(%)	12.8(%)	21.0(%)	<.0001
Anemia *	9.8(%)	15.9(%)	25.8(%)	38.7(%)	<.0001
Ischemic history *	53.8(%)	67.0(%)	71.8(%)	65.2(%)	<.0001
Admission Variables (Mean ± SD)					
Body mass index (kg/m^2)	29.3±7.4	28.3±6.2	27.8±6.2	27.1±5.0	<.0001
Systolic blood pressure (mmHg)	135.6± 27.2	133.0±27.1	133.1±28.7	143.2±31.3	<.0001
Diastolic blood pressure (mmHg)	82.9±18.8	77.8±17.9	75.3±17.8	80.5±20.4	<.0001
Serum creatinine (mg/dL)	1.0±0.2	1.5±0.3	5.7±23.7	7.4±33.0	<.0001

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Variable	eGFR≥60 (N=10153)	eGFR 30–59 (N=10958)	eGFR<30, not on dialysis (N=4112)	Dialysis (N=1063)	P-value
Blood urea nitrogen (mg/dL)	18.4±8.3	29.6±11.7	52.5±22.2	46.6±24.7	<.0001
eGFR on admission	83.5±29.5	45.0±4.3	21.1±6.8	N/A	<.0001
QRS duration on admission electrocardiogram	121.9±0.0	133.1±0.0	135.6±0.0	118.9±25.5	<.0001

* History of anemia and history of hyperlipidemia were determined at the discretion of hospital staff. Ischemic history is a composite of medical history of coronary artery disease, prior CABG, Previous MI, prior PCI

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Table 2

Baseline Characteristics of CRT-Eligible Patients by eGFR Category

	eGFR≥60 (N=1942)	eGFR 30–59 (N=2838)	eGFR<30, not on dialysis (N=1054)	Dialysis (N=179)	P-value
Demographics					
Age (Mean±SD)	66.3±13.4	74.4±11.3	76.5±10.6	70.6±11.2	<.0001
Women	28.4(%)	31.0(%)	37.4(%)	32.4(%)	<.0001
Black	21.2(%)	12.8(%)	12.6(%)	19.0(%)	<.0001
White	66.2(%)	76.5(%)	75.1(%)	57.5(%)	
Medical History					
Coronary artery disease	55.4(%)	62.8(%)	69.3(%)	67.0(%)	<.0001
Prior coronary artery bypass grafting	24.6(%)	33.2(%)	37.8(%)	29.6(%)	<.0001
Previous myocardial infarction	24.8(%)	28.8(%)	33.6(%)	30.2(%)	<.0001
Prior percutaneous intervention	19.5(%)	22.9(%)	21.9(%)	23.5(%)	0.045
Hypertension	75.4(%)	76.0(%)	76.5(%)	78.8(%)	0.8743
Diabetes mellitus	38.6(%)	43.3(%)	47.4(%)	58.1(%)	<.0001
Atrial fibrillation	30.5(%)	41.0(%)	43.6(%)	30.2(%)	<.0001
Chronic obstructive pulmonary disease or asthma	27.5(%)	29.1(%)	28.7(%)	28.5(%)	0.544
Cerebral vascular accident/Transient ischemic attack	11.8(%)	15.6(%)	16.7(%)	16.2(%)	0.0003
Hyperlipidemia *	53.6(%)	58.3(%)	57.1(%)	57.0(%)	0.0199
Peripheral vascular disease	8.1(%)	12.5(%)	16.4(%)	19.6(%)	<.0001
Valvular heart disease	16.2(%)	20.1(%)	24.1(%)	26.3(%)	<.0001
Smoking	23.9(%)	11.7(%)	10.0(%)	12.9(%)	<.0001
Anemia *	7.9(%)	14.2(%)	23.3(%)	34.1(%)	<.0001
Ischemic history *	61.9(%)	71.1(%)	78.0(%)	76.0(%)	<.0001
Admission Variables (Mean ± SD)					
Body mass index (kg/m^2)	28.4±6.5	27.9±5.8	27.4±5.5	27.4±5.3	0.0002
Systolic blood pressure (mmHg)	131.2±25.9	129.4±25.7	127.1±24.9	130.8±29.2	0.005
Diastolic blood pressure (mmHg)	78.1±16.6	74.4±15.5	71.5±14.9	71.9±17.1	<.0001
Serum creatinine (mg/dL)	1.0±0.2	1.5±0.2	5.0±18.1	5.0±2.7	<.0001

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	eGFR≥60 (N=1942)	eGFR 30–59 (N=2838)	eGFR<30, not on dialysis (N=1054)	Dialysis (N=179)	P-value
Blood urea nitrogen (mg/dL)	19.5±7.8	30.5±12.3	53.1±22.5	41.0±21.3	<.0001
eGFR on admission	79.6±26.9	44.5±4.3	21.6±6.6	N/A	<.0001
QRS duration on admission electrocardiogram	169.9±0.0	173.0±0.0	174.9±0.0	172.9±14.0	<.0001

* History of anemia and history of hyperlipidemia were determined at the discretion of hospital staff. Ischemic history is a composite of medical history of coronary artery disease, prior CABG, Previous MI, prior PCI

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Table 3

Association between Baseline Kidney Function and Prescription of Implantable Cardioverter Defibrillator or Cardiac Resynchronization Therapy Among Eligible Patients*

	ICD Prescription		CRT Prescription	
eGFR (ml/min/1.75 m^2)	**aOR=(95% CI)**	**P-value**	**aOR=(95% CI)**	**P-value**
≥60	Reference		Reference	
59–30	1.08 (1.01–1.14)	0.02	0.92 (0.79–1.07)	0.28
<30 (not on dialysis)	0.97 (0.90–1.06)	0.53	0.80 (0.67–0.95)	0.01
On Dialysis	0.61 (0.50–0.76)	<.0001	0.69 (0.44–1.08)	0.1
Decrease (per 10 ml/min)	1.00 (0.99–1.01)	0.4501	0.97 (0.94–1.00)	0.03

* ICD analyses adjusted for admission year, age, gender, race, insurance status, cigarette smoking in the past year, systolic blood pressure on admission, history of anemia, ischemic heart disease, diabetes, hyperlipidemia, hypertension, atrial fibrillation, and hospital region. CRT analysis adjusted for significant factors in the final model that influenced CRT prescription including admission year, age, race, systolic blood pressure on admission, diabetes, and anemia due to decreased number of events.