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Hospital-level variation in cardiac rehabilitation metrics

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Abstract

Background—To inform the delivery of cardiac rehabilitation (CR) care nationwide at the hospital level, we described hospital-level variation in CR metrics, overall and stratified by the hospital's tier of cardiac care provided.

Methods—This retrospective cohort analysis used Medicare fee-for-service (FFS) data (2018–2020), Parts A and B, and American Hospital Association (AHA) data (2018). We included beneficiaries with an acute myocardial infarction (AMI), percutaneous coronary intervention (PCI), or coronary artery bypass graft (CABG) in 2018, aged ≥65 years, and continuously enrolled in a FFS plan. We calculated hospital-level metrics for hospitals with ≥20 CR-qualifying

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Conflict of interest

Lisa M. Pollack, Anping Chang, Michael P. Thompson, Steven J. Keteyian, Haley Stolp, Hilary K. Wall, Laurence S. Sperling, and Sandra L. Jackson, have no conflicts of interest. Lisa M. Pollack, Anping Chang, Haley Stolp, Hilary K. Wall, Laurence S. Sperling, and Sandra L. Jackson have no financial disclosures.

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Supplementary materials

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events, which were identified using diagnostic/procedure codes. Claims for CR were identified by Healthcare Common Procedure Coding System (HCPCS) codes. We used multi-level models to examine patient- and hospital-level factors associated with CR metrics. Hospitals were stratified by tier of cardiac care provided (comprehensive, AMI/PCI, AMI-only care).

Results—Across the US, 2,212 hospitals treated individuals aged ≥ 65 years with a CR-qualifying event in 2018. By tier of cardiac care, 44.4% of hospitals provided comprehensive care, 31.2% provided AMI/PCI care, and 24.4% provided AMI-only care. Across all hospitals, there was substantial variation in CR enrollment (median 19.6%, interquartile range [IQR] = 7.0%, 32.8%). Among hospitals with enrollment ($n = 1,866$), median time to enrollment was 55.0 days (IQR = 41.0, 71.0), median number of CR sessions was 26.0 (IQR = 23.0, 29.0), and median percent completion was 26.0% (IQR = 10.5%, 41.2%). There was also substantial variation in CR performance metrics among hospitals within each tier of cardiac care (eg, median percent CR enrollment was 30.7% [IQR = 20.7%–41.3%] among comprehensive care hospitals, 18.6% [IQR = 9.5%–27.7%] among AMI/PCI hospitals, and 0.0% [IQR = 0.0%–7.7%] among AMI-only hospitals). In adjusted analyses, characteristics associated with lower odds of CR enrollment included patient-level factors (older age, female sex, non-White race or ethnicity), and hospital-level factors (for-profit ownership, regions other than the Midwest, rural location, medium/large hospital size).

Conclusions—This is the first national, hospital-level analysis of CR metrics among Medicare beneficiaries. Substantial variation across hospitals, including peer hospitals within the same tier of cardiac care, indicates opportunities for hospital-level quality improvement strategies to improve CR referral and participation metrics.

Background

Cardiac rehabilitation (CR) is a physician-supervised comprehensive cardiovascular risk reduction program endorsed by consensus guidelines for the secondary prevention of adverse health events among patients with cardiovascular disease (CVD).^{1–4} The medically-supervised program, which includes supervised exercise, education about healthy living, and counseling for behavioral health, is associated with better survival, fewer hospital readmissions, and improved exercise capacity and quality of life.^{5–9} Despite its benefits, enrollment in CR programs among eligible patients in the U.S. remains between 20 and 30 percent, well below the 70% participation goal set by Million Hearts®, a national initiative to prevent one million cardiovascular events by 2027.¹⁰

The Centers for Medicare & Medicaid Services (CMS) covers outpatient center-based CR services for Medicare-eligible beneficiaries.¹¹ Evaluating hospital-level CR program performance involves tracking CR use metrics to ensure quality of care and optimal patient outcomes. In Michigan, CR enrollment and participation rates vary across hospitals, suggesting that CR metrics may be associated with hospital-specific practice patterns.^{12–14} To our knowledge, no study has examined hospital-level performance in CR enrollment and participation after acute myocardial infarction (AMI) or coronary interventions (coronary artery bypass graft [CABG] or percutaneous coronary intervention [PCI]). Acute myocardial infarction is of particular significance given 800,000 people in the U.S. suffer a heart attack every year,¹⁵ and most hospitals provide some level of AMI care. Furthermore, AMI is an

unplanned event and patients may not be educated about CR prior to the event, as they sometimes are before a CABG/PCI procedure. While we have several studies tracking CR metrics at the individual-level,^{10,16} very little research exists at the hospital-level. Tracking of CR metrics at the hospital-level may be important for increasing CR participation because metrics are likely influenced by hospital-level variables that can be improved upon, such as systematic or automated referral processes as noted in the Million Hearts®/ American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Cardiac Rehabilitation Change Package, 2nd Edition (August 2023).¹⁷ In addition, hospitals can be conceptualized according to tier of cardiac care provided, ranging from comprehensive cardiac care to AMI-only care.^{18–20} Stratifying hospital performance by tier of cardiac care may facilitate benchmarking, allowing hospitals to compare their metrics against peer hospitals and revise processes where needed.

The lack of nationwide information at the hospital level on key CR delivery metrics (ie, enrollment, time to enrollment, participation/completion) makes it difficult to evaluate CR care delivery.²¹ Using administrative claims and hospital survey data, this analysis (1) describes hospital-level variation in CR metrics among Medicare-eligible individuals who had an AMI event, CABG, or PCI procedure (collectively referred to here as a CR-qualifying event) at the U.S. Census division- and national-level and (2) describes hospital-level CR variation within each tier of cardiac care. Regularly monitoring and analyzing CR metrics could assist hospitals in identifying areas for improvement in the workflow for their CR-eligible patients, as well as optimize patient care to improve outcomes for individuals recovering from a CR-qualifying event.

Materials and methods

Data sources

This retrospective cohort hospital-level analysis used Medicare Administrative and Claims data and American Hospital Association (AHA) data. We used Medicare Parts A and B and enrollment information (from the master beneficiary summary data file [MBSF]) from the Chronic Conditions Data Warehouse (CCW) Virtual Research Data Center (VRDC), 2018–2020, to obtain beneficiary-level information. From the enrollment files, we identified Medicare fee-for-service (FFS) eligibility and demographic information. From the Medicare Part A file, we identified the CR-qualifying events and beneficiaries' history of events. From the Part B institutional and non-institutional claims files, we identified the CR visits to calculate CR metrics. Beneficiaries were followed longitudinally using unique beneficiary identifiers from CCW to calculate the CR metrics.

We obtained hospital-level characteristics from fiscal year 2018 AHA Annual Survey Database for 4,052 hospitals; we used AHA data from fiscal years 2016 (4 hospitals) and 2017 (13 hospitals) when hospitals could not be linked to Medicare using the 2018 data, and 4 hospitals could not be linked at all.²² The AHA dataset is derived from annual voluntary surveys sent to all AHA-registered U.S. hospitals. Survey data from respondent hospitals are merged into yearly datasets. We linked the Medicare claims data to the AHA survey data using the CMS provider number. This research was considered exempt from Institutional Review Board review under 45 Code of Federal Regulations 46.101[b] [5], which covers

Department of Health and Human Services research and demonstration projects, which are designed to study, evaluate, or examine public benefit or service programs.

Study population

At the hospital-level (Appendix Figure 1A), we included all hospitals who treated patients with a CR-qualifying event in 2018, aged ≥ 65 years, continuously enrolled in a Medicare FFS plan or until death. We excluded hospitals (1) in U.S. territories, (2) with < 20 CR-qualifying events (because CR metrics would be statistically unstable), and (3) that could not be linked with the AHA data.

At the patient-level (Appendix Figure 1B), we included Medicare FFS beneficiaries with an AMI, PCI, or CABG in 2018, aged ≥ 65 years old as of January 1, 2018, continuously enrolled in a FFS plan from 90 days before the CR-qualifying event (pre-CR period) though the end of the CR treatment period (365 days and 36 weeks after the CR-qualifying event) or until date of death, and without a history of an AMI, PCI, or CABG in the pre-CR period (see Appendix Figure 2 for study timeline of CR-qualifying events). AMI events were identified using *International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM)* diagnosis codes (first or second-listed code) (Appendix Table 1A) according to the Million Hearts® Outpatient CR Use Surveillance Methodology.^{10,21} CABG and PCI procedures were identified using *International Classification of Diseases, 10th Revision, Procedure Coding System (ICD-10-PCS)* procedural codes (any location) on inpatient claims, or current procedural terminology (CPT) codes (any location) on outpatient or clinician claims (Appendix Table 1A).^{10,21}

We excluded beneficiaries who (1) died < 21 days after the CR-qualifying event; (2) had ≥ 90 consecutive days in an inpatient acute care hospital, other inpatient hospital, or postacute care setting (extended hospital stay) within the pre-CR period or initiated an extended hospital stay within 21 days after the CR-qualifying event; (3) received hospice care in the pre-CR period or initiated hospice care within 21 days after the CR-qualifying event;^{10,16,21} or (4) had end-stage renal disease in the pre-CR period or after the CR-qualifying event.²¹

Identifying CR claims

Standard and intensive CR claims were identified by Healthcare Common Procedure Coding System (HCPCS) codes and revenue center code 0943 within 365 days of the qualifying event index date in alignment with previous research and Medicare benefit guidance (Appendix Table 1B).^{10,11,23} For single events, the index date was the inpatient hospital discharge date associated with the CR-qualifying event. For combination events (≥ 2 CR-qualifying events within 21 days), the index date was that associated with the last event. The number of individual CR sessions on different dates was used to identify number of CR sessions. If ≥ 1 CR session was identified on the same day, each individual session was counted separately.²¹ The hospital where the CR-qualifying event occurred is referred to as the index hospital.

Tier of cardiac care

Hospitals can be conceptualized according to level of cardiac care provided.^{18–20} In our analysis, hospitals were stratified into mutually exclusive categories by tier of cardiac care provided: (1) hospitals that performed ≥ 10 CABG and ≥ 10 PCI procedures (ie, AMI, CABG, and PCI care available, referred to as “comprehensive” care); (2) hospitals that performed ≥ 10 PCI procedures but < 10 CABG procedures (ie, AMI and PCI care available, referred to as “AMI/PCI” care); and (3) hospitals that performed < 10 CABG and < 10 PCI procedures (ie, “AMI-only” care). To eliminate potential billing errors, a cutoff of 10 was used to determine whether a hospital performed a procedure.

Hospital-level CR metrics

We calculated hospital-level CR use metrics consistent with the Million Hearts[®] Outpatient CR Use Surveillance Methodology²¹: (1) CR enrollment (ie, number of beneficiaries who attended ≥ 1 CR session within 365 days of the CR-qualifying event out of the number of CR-qualifying events within the measurement period) and (2) time to CR enrollment (ie, time in days from the CR-qualifying event index date or hospital discharge date after index event to the first CR session date). Although they may not be as directly influenced by the index hospital, we also examined variation in the number of CR sessions (ie, number of CR sessions attended within 36 weeks of the first CR session date) and CR completion (ie, number of individuals who attended ≥ 36 CR sessions within 36 weeks of the first CR session date out of the number of individuals who enrolled in CR). The CR metrics were calculated based on CR encounters at any outpatient facility and attributed to the index hospital where the CR-qualifying event occurred. As such, hospitals without CR programs were included in our calculation of CR metrics if the patient who had a CR-qualifying event at that hospital attended CR at any outpatient facility.

Hospital characteristics

Hospital-level categorical variables included information on geographic location, including urbanicity (urban, rural) and U.S. Census region and division (Northeast [New England, Middle Atlantic], Midwest [East North Central, West North Central], South [South Atlantic, East South Central, West South Central], West [Mountain, Pacific]). We included information on hospital economic model (nonprofit, for-profit, public); teaching status (nonteaching, teaching); service type (general medical and surgical, heart, other specialty treatment); critical care access designation (yes, no), community hospital designation (yes, no); and whether the hospital provided cardiac intensive care (yes, no) and CR (yes, no). Continuous variables included information on total hospital beds and intensive care unit (ICU) beds for cardiovascular disease care. About 15.1% of AHA hospitals did not respond to the annual survey.

Patient characteristics

Patient-level variables included age at the CR-qualifying event index date (65–70, 71–75, 76–80, 81–85, > 85 years), sex (male, female), race and ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic, Non-Hispanic Asian, Other/Unknown), and CR-qualifying

indication (AMI with CABG and PCI, AMI with CABG, AMI with PCI, AMI only, CABG with PCI, CABG only, and PCI only).

Statistical analysis

Data are described using standard statistical summary measures, including mean $\pm$ standard deviation (SD), median (interquartile range [IQR]; quartile 1 = 25%, quartile 3 = 75%), and range (minimum, maximum). For count metrics (CR enrollment, CR completion), we report percentages for the summary measures. For continuous metrics (time to CR enrollment, number of CR sessions), we report the mean number of days to CR enrollment/CR sessions within each hospital (each individual has a value for number of days to CR enrollment/CR sessions), and the median of the mean number of days to CR enrollment/CR sessions. Chi-square tests were used to compare differences in proportions for categorical variables by tier of cardiac care; Kruskal-Wallis tests were used to compare differences in medians for continuous variables by tier of cardiac care using SAS PROC NPAR1WAY.²⁴

In adjusted analyses, using SAS PROC GLIMMIX, we used generalized linear mixed models with binary distribution and logit function to examine patient- and hospital-level factors associated with CR enrollment and completion (among hospitals with enrollment) and present estimates as odds ratios (ORs). Among hospitals with enrollment, we used similar models but with gamma distribution and log-link function to examine factors associated with time to enrollment and number of sessions, and we present differences in means estimates as means ratios. In supplemental analyses, because enrollment is associated with CR-qualifying indication and hospital performance on CR enrollment may thereby be associated with patient case-mix, we stratified by CR-qualifying indication to examine the association between tier of cardiac care with CR metrics for the relevant comparisons: for patients with AMI only among all 3 tiers of cardiac care (reference = AMI only care), and for patients with PCI only or AMI with PCI among hospitals with comprehensive cardiac care and AMI/PCI care available (reference = AMI/PCI care). In addition, given that comprehensive care hospitals made up the majority of the patient population, we performed a supplemental analysis to stratify the comprehensive care hospitals (N = 983) by hospital size (small [<200 beds], medium [200–499 beds], and large [≥ 500 beds]) using the hospital bed size variable from the AHA data. All models included patient- and hospital-level factors and accounted for clustering of patients within hospitals. The patient-level factors included age (reference = ≤ 70), race and ethnicity (reference = non-Hispanic White), sex (reference = male), and CR-qualifying indication (reference = AMI only). The hospital-level factors included hospital economic model (reference = public), region (reference = Midwest), urbanicity (reference = urban), teaching status (reference = nonteaching), cardiac intensive care hospital (reference = yes), and cardiac rehabilitation hospital (reference = yes). A P value $< .05$ was used to indicate statistical significance. All analyses were performed with SAS (v.9.4; SAS Institute, Inc., Cary, NC).

Results

Study population

Across the United States, 2,212 hospitals treated individuals aged ≥ 65 years with a CR-qualifying event in 2018 (Appendix Figure 1A). Within the 2,212 hospitals, 240,947 beneficiaries had a CR-qualifying event in 2018 and were alive for ≥ 21 days after the event without an extended hospital stay, hospice care, or end-stage renal disease (Appendix Figure 2B).

Hospital characteristics overall and by tier of cardiac care

Characteristics of U.S. hospitals overall and by tier of cardiac care are presented in Table 1. Overall, nearly all hospitals included in the analysis were of general medical and surgical service type (99.1%) and non-critical access hospitals (98.6%). Most hospitals were under non-profit ownership (70.1%) and nonteaching institutions (89.5%). Geographically, most hospitals were in a major metropolitan area (83.7%).

By tier of cardiac care, 44.4% ($n = 983$) of hospitals provided comprehensive care, while 31.2% ($n = 690$) provided AMI/PCI care, and 24.4% ($n = 539$) provided AMI-only care. More comprehensive care hospitals were in metropolitan areas (95.4%), whereas more AMI-only care hospitals were in rural areas (8.7%). Compared with AMI-only and AMI/PCI care hospitals, a higher percentage of comprehensive care hospitals were cardiac intensive care (70.0%) and cardiac rehabilitation hospitals (81.2%). An individual-level analytic cohort summary table is presented in Appendix Table 2.

Hospital-level variation in CR metrics overall and by tier of cardiac care

Hospital-level CR metrics overall and by tier of cardiac care are presented in Figure 1. Overall, across all hospitals, there was variation in CR enrollment (median 19.6%, IQR = 7.0%, 32.8%). Among hospitals with CR enrollment ($n = 1,866$), the median (of the mean) time to enrollment was 55.0 days (IQR = 41.0, 71.0) and number of CR sessions was 26.0 (IQR = 23.0, 29.0). The median CR percent completion was 26.0% (IQR = 10.5%, 41.2%). By tier of cardiac care, comprehensive care hospitals served 189,674 patients (78.7%), AMI/PCI care hospitals served 41,679 patients (17.3%), and AMI-only care hospitals served 9,594 patients (4.0%). There was variation in CR performance metrics within each tier of cardiac care. For example, the median percent CR enrollment was 30.7% (IQR = 20.7%, 41.3%) for comprehensive care, 18.6% (IQR = 9.5%, 27.7%) for AMI/PCI care, and 0.0% (IQR = 0.0%, 7.7%) for AMI-only care hospitals. The median (of the mean) time to CR enrollment was 56.0 days (IQR = 43.0, 68.0) for comprehensive care, 54.0 days (IQR = 37.0, 73.0) for AMI/PCI care, and 64.0 days (IQR = 38.0, 122.0) for AMI-only care hospitals. The CR metrics by tier of cardiac care and U.S. Census division are presented in Appendix Figures 3–6. Appendix Tables 3–6 present all summary measures, including number of hospitals, number of patients served in each hospital, mean (SD), median (IQR), minimum, and maximum, for all hospital-level CR metrics by tier of cardiac care and division.

Patient- and hospital-level factors associated with CR metrics

Patient- and hospital-level factors associated with CR metrics are presented in Table 2. Compared with AMI only, other CR-qualifying indications were highly associated with higher odds of CR enrollment: CABG only (OR = 15.51, 95% CI, 14.99, 16.06); CABG with PCI (OR = 15.40, 95% CI, 12.40, 19.14); AMI with CABG and PCI (OR = 12.62, 95% CI, 10.92, 14.58); AMI with CABG (OR = 11.87, 95% CI, 11.34, 12.41); AMI with PCI (OR = 6.39, 95% CI, 6.20, 6.59); PCI only (OR = 3.94, 95% CI, 3.81, 4.07). CR-qualifying indications other than AMI only were also highly associated with fewer mean days to CR enrollment, higher mean number of CR sessions, and higher odds of CR completion. Characteristics associated with inferior CR metrics (ie, lower odds of CR enrollment, more mean days to CR enrollment, fewer mean number of CR sessions, and/or lower odds of CR completion) included patient-level factors such as older age (vs ≤ 70), female sex (vs male), non-White race or ethnicity (vs Non-Hispanic White), and hospital-level factors such as for-profit ownership (vs public), U.S. Census regions other than the Midwest (vs Midwest), rural location (vs urban), and medium or large hospital size (vs small).

Supplemental analyses

In stratified analyses by CR-qualifying indication for the relevant comparisons (Appendix Tables 7–8), 37.1% of patients served by the hospitals included in our study had an AMI only (n = 89,284), 24.5% had an AMI with PCI (n = 59,039), and 18.5% had a PCI only (n = 44,645) (Appendix Table 2). Among patients with AMI only, after controlling for patient- and hospital-level factors, hospitals with more comprehensive cardiac care were associated with higher odds of CR enrollment (comprehensive care: OR = 2.01, 95% CI: 1.76, 2.29; AMI/PCI care: OR = 1.56, 95% CI, 1.38, 1.77 vs AMI-only), fewer mean days to CR enrollment (comprehensive care: -17.48, 95% CI, -22.97, -6.34 and AMI/PCI care: -13.98, 95% CI, -20.08, -2.20 vs AMI-only), but lower odds of CR completion (comprehensive care: OR = 0.68, 95% CI, 0.50, 0.93) (Appendix Table 8). Among patients with PCI only, after controlling for patient- and hospital-level factors, hospitals with more comprehensive cardiac care were associated with higher odds of CR enrollment (comprehensive care: OR = 1.12, 95% CI: 1.04, 1.20 vs AMI/PCI care) (Appendix Table 8).

In a subset analyses of comprehensive care hospitals stratified by hospital size (Appendix Tables 9–10, Appendix Figure 7), small hospitals had slightly higher percent CR enrollment (31.9% vs 30.6% medium and 30.1% large) and shorter time to enrollment (47 days vs 56 medium and 59 large) (Appendix Figure 7). In adjusted analyses, relative to small hospitals, medium hospitals had lower enrollment (OR = 0.84, 95% CI, 0.81, 0.87) and longer time to enrollment (11.40; 95% CI, 8.8, 14.4) as did large hospitals (CR enrollment: 0.84 95% CI, 0.80, 0.87; time to enrollment: 11.70; 95% CI, 8.9, 15.0) (Appendix Table 8).

Discussion

Summary of main findings

This study was the first national, hospital-level analysis of CR metrics among Medicare beneficiaries. In a large cohort of hospitals (n = 2,212) serving more than 240,000 Medicare FFS beneficiaries eligible for CR, using CMS claims and AHA data, we showed that just

under half of hospitals provided comprehensive cardiac care (40%), but served over three quarters of eligible patients (78%), and a quarter of hospitals provided no procedural care and served only 4% of eligible patients. We presented hospital-level CR use benchmarks nationally, with median CR enrollment at 19.6%. Among hospitals with enrollment, median time to enrollment was 55 days, number of sessions attended was 26.0, and completion was 26.0%. Our innovative study design highlighted wide variation in CR performance across all hospitals nationally, and also within each tier of cardiac care. This information is important because it suggests where efforts might be focused, considering limited healthcare resources. Comprehensive cardiac care hospitals have higher percent enrollment and participation, but they also serve the most patients; efficient use of resources may suggest learning first from high-performers among these centers.

This study was unique in its analysis of hospital-level metrics by tier of cardiac care, which can inform hospitals of their performance relative to peer hospitals. Previous analyses of the Michigan Value Collaborative statewide multipayer registry demonstrated that hospital-level factors may be associated with CR enrollment¹² and participation.^{13,14} Our study expanded on prior analyses by the inclusion of AMI events and examining hospital performance at a national level. Our levels of cardiac care were delineated similarly to the American Heart Association and The Joint Commission's new certification for hospitals, where, as of 2022, hospitals can be certified according to level of cardiac care provided, ranging from AMI-only care (ie, Level III: Acute Heart Attack Ready) to comprehensive cardiac care (ie, Comprehensive Cardiac Center).^{18–20} While our data were collected before this certification, future analyses could examine whether the certifications (and potential related improvements in cardiac care) might be associated with better CR metrics.

As seen in previous studies,^{12–14,25,26} patient case-mix did not fully explain variation in hospital performance as we observed variation in CR metrics across hospital tiers even after stratifying by CR-qualifying indication. For example, for patients with AMI only, controlling for patient- and hospital-level factors, it was notable that comprehensive and AMI/PCI hospitals had nearly 2-times higher odds of CR enrollment, and about 14–17 fewer mean days to enrollment than AMI-only care hospitals. AMI-only hospitals served almost 10,000 patients. Given that AMI-only hospitals were the lowest-performing hospitals across all metrics for patients with AMI, and all hospital tiers performed lower than the national 70% CR participation target,^{27,28} our findings can encourage hospitals to evaluate their processes for improving CR enrollment and participation. The responsibility to refer and enroll qualifying patients into CR lies heavily with the inpatient referring physician and the care coordination staff responsible for educating the patient about the benefits of CR and facilitating enrollment in a program. For example, top performing hospitals are known to facilitate enrollment in nonemergency transportation programs, vocational rehabilitation services, and/or case management programs to optimize the likelihood of enrollment and completion of CR. Once enrolled, the responsibility to optimize the number of sessions attended and the completion of the program largely lies with the patient, the outpatient hospital CR program staff, and, ideally, the patient's primary physician or cardiologist who receives the 30-day reports. Because there may be a continued role for the index hospital in providing wraparound services to address patient barriers to participation, in addition to

examining enrollment and time to enrollment, we also included participation and completion metrics in this analysis.

Hospitals engaging in measuring performance and quality improvement efforts can refer to strategies in the Million Hearts®/ AACVPR Cardiac Rehabilitation Change Package, 2nd Edition to improve CR utilization and delivery.¹⁷ This may begin with establishing hospital champions and engaging hospital administrators and the care team to review their performance and initiate steps to improve their post cardiac-event care processes.¹⁷ Another strategy is to incorporate CR referral into routine hospital processes of care, such as including automatic, opt-out referral to CR in electronic health records, and developing standard processes for informing a CR program of a referred patient or empowering patients to self-refer to CR. Tools and resources to inform and equip hospital teams to incorporate CR referral into routine hospital care processes and to standardize the CR referral process with automatic referrals and care coordination were developed through the Agency for Healthcare Research Quality TAKEheart initiative. Additional care process improvements are informed by the 2018 American College of Cardiology (ACC)/ American Heart Association (AHA) Task Force on performance measures that describes CR-specific performance and quality measures and recommends all eligible inpatients (prior to discharge) and outpatients be referred to an outpatient CR program.¹ Early appointments to outpatient CR at hospital discharge (ie, an orientation appointment within 10 days) is another approach that has significantly improved attendance at orientation compared with the median time from hospital discharge to enrollment (ie, an orientation appointment at 35 days).²⁹ Other ways to optimize CR care coordination include developing infrastructure for organizing inpatient CR liaisons to schedule the first outpatient CR visit or delivery models to accommodate individual needs (eg, case management or supportive services) and navigating cost-sharing barriers.^{17,30} Such coordination of care could particularly help underserved populations, such as women and patients with lower socioeconomic status.^{31,32} Ultimately, the availability of hospital-level performance data may help spur a broad array of strategies that have varying degrees of impact and investment to improve the delivery of clinical guideline-directed care for cardiac patients.³³

Limitations

Our study is not without limitations. First, our findings are not generalizable to all hospitals, as we excluded hospitals who did not treat patients who met our inclusion criteria. Second, our metrics were derived entirely from CMS data and included only adults over age 65; CR metrics may differ among Medicare Advantage, commercially insured, or younger patient populations, so the observed metrics in this report may differ from true metrics among all patients served by each hospital. In addition, hospital-level CR metrics may have been differentially affected due to differing patient population demographics across hospitals (i.e., some hospitals may serve a larger percentage of younger patients, and therefore their true metrics may have been more divergent from the observed results compared to other hospitals that serve an older patient population). Finally, AHA data on the location of CR centers may not align with the availability of programs as assessed by localized hospital networks and quality improvement organizations. Future initiatives include scaling-up work by the Michigan Value Collaborative³⁴ by creating individual hospital-level reports of CR metrics

for each hospital in the United States, to be used by hospitals for quality improvement efforts.

Conclusion

In this large-scale, hospital-level analysis of 2,212 hospitals across the United States, we found that hospitals treated over 240,000 Medicare beneficiaries with a CR-qualifying event in 2018. Hospitals had wide variation in CR metrics, nationally and among peer hospitals within each tier of cardiac care. Tracking CR metrics at the hospital-level may encourage quality improvement efforts to examine processes, such as automatic referral, to increase CR participation and improve secondary CVD prevention and quality of life among patients experiencing cardiac events.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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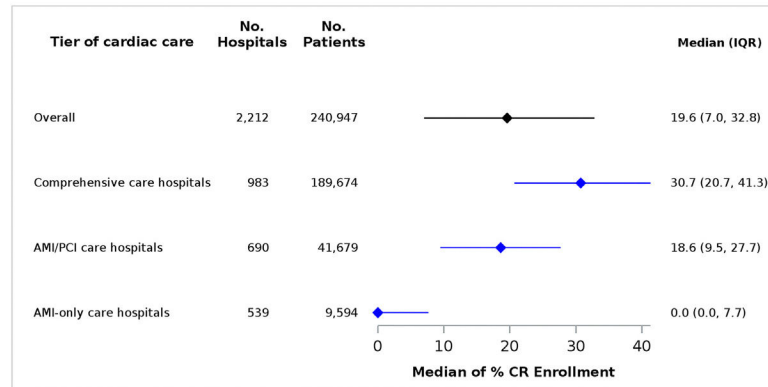
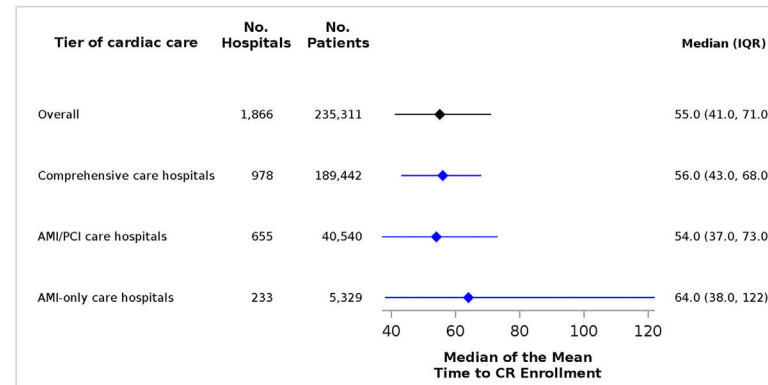
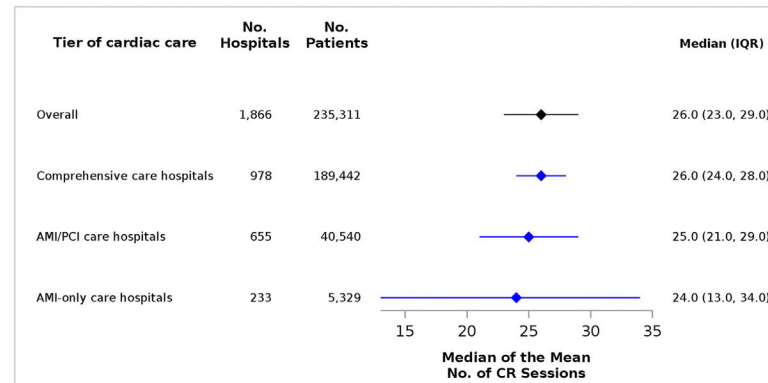
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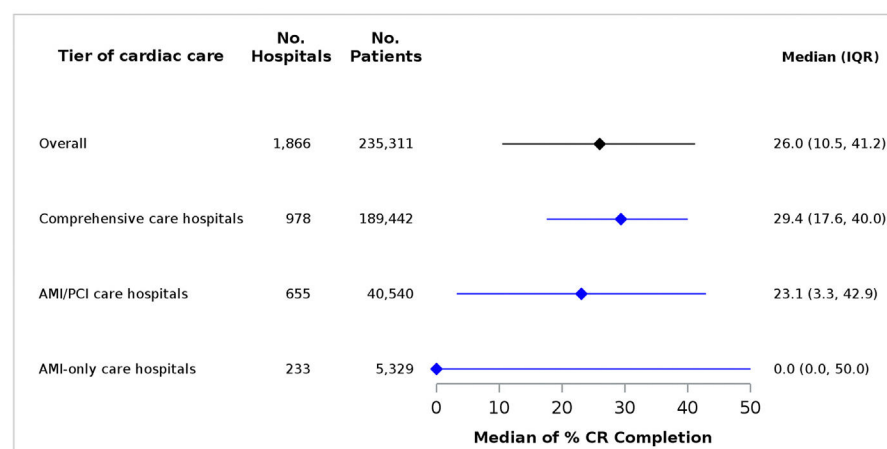
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A. CR enrollment^b (%)B. Time to CR enrollment^c (days)C. Number of CR sessions^d

D. CR completion^e (%)**Figure 1.**

Hospital-level CR metrics by tier of cardiac care^a [A-D] **A**, CR enrollment^b (%) **B**, Time to CR enrollment^c (days) **C**, Number of CR sessions^d **D**, CR completion^e (%). Abbreviations: AMI, acute myocardial infarction; CABG, coronary artery bypass graft surgery; CR, cardiac rehabilitation; IQR, interquartile range; No., number; PCI, percutaneous coronary Intervention ^a Hospitals that performed ≥ 10 CABG and ≥ 10 PCI procedures were defined as AMI, CABG, and PCI care hospitals. Hospitals that performed ≥ 10 PCI procedures but < 10 CABG procedures were defined as AMI and PCI care hospitals. Hospitals that performed < 10 CABG and < 10 PCI procedures were defined as AMI only care hospitals. ^b CR enrollment: Number of beneficiaries who attended ≥ 1 CR session within 365 days of the CR-qualifying event out of the number of CR-qualifying events within the measurement period. ^c Time to CR enrollment: Time in days from the CR-qualifying event index date or hospital discharge date after index event to the first CR session date. ^d Number of CR sessions: Number of CR sessions attended within 36 weeks of the first CR session date. ^e CR completion: Number of individuals who attended ≥ 36 CR sessions within 36 weeks of the first CR session date out of the number of individuals who enrolled in CR.

Characteristics of U.S. hospitals by tier of cardiac care, Medicare FFS CCW Administrative and Claims data (2018–2020) and AHA (2016–2018) data *

Table 1.

	All Hospitals (N=2,212)		Comprehensive care available [†] (n=983)		AMI/PCI care available [§] (n=690)		AMI-only care available [¶] (n=539)		p-value [‡]
	N	%	N	%	N	%	N	%	
Hospital characteristics									
Urbanicity									
Urban	2,153	97.3	979	99.6	682	98.9	492	91.3	<0.0001
Rural	59	2.7	4	0.4	8	1.2	47	8.7	<0.0001
Hospital region/Division									
Northeast	400	18.1	135	13.8	105	15.2	160	29.7	
New England	120	5.4	32	3.3	25	3.6	63	11.7	<0.0001
Middle Atlantic	280	12.7	103	10.5	80	11.6	97	18.0	<0.0001
Midwest	516	23.3	266	27.0	159	23.1	91	16.9	
East North Central	361	16.3	183	18.6	106	15.4	72	13.4	0.0210
West North Central	155	7.0	83	8.4	53	7.7	19	3.5	0.0011
South	863	39.0	380	38.7	296	42.9	187	34.7	
South Atlantic	430	19.4	165	16.8	150	21.7	115	21.3	0.0184
East South Central	156	7.1	70	7.1	49	7.1	37	6.9	0.9809
West South Central	277	12.5	145	14.8	97	14.1	35	6.5	<0.0001
West	433	19.6	202	20.5	130	18.9	101	18.8	
Mountain	147	6.7	75	7.6	62	9.0	10	1.9	<0.0001
Pacific	286	12.9	127	12.9	68	9.9	91	16.9	0.0013
Hospital ownership									
For profit	444	20.1	181	18.4	171	24.8	92	17.1	0.0008
Nonprofit	1,550	70.1	716	72.8	448	64.9	386	71.6	0.0016
Public (government)	218	9.9	86	8.8	71	10.3	61	11.3	0.2468
Teaching status									
Teaching	233	10.5	188	19.1	33	4.8	12	2.2	<0.0001
Nonteaching	1,979	89.5	795	80.9	657	95.2	527	97.8	<0.0001
Cardiac intensive care hospital									
Yes	925	41.8	688	70.0	163	23.6	74	13.7	<0.0001

	All Hospitals (N=2,212)		Comprehensive care available [†] (n=983)		AMI/PCI care available [§] (n=690)		AMI-only care available [¶] (n=539)		p-value [‡]
	N	%	N	%	N	%	N	%	
No	953	43.1	182	18.5	405	58.7	366	67.9	<0.0001
Hospital non-respondents	334	15.1	113	11.5	122	17.7	99	18.4	0.0001
Cardiac rehabilitation hospital									
Yes	1,509	68.2	798	81.2	428	62.0	283	52.5	<0.0001
No	369	16.7	72	7.3	140	20.3	157	29.1	<0.0001
Hospital non-respondents	334	15.1	113	11.5	122	17.7	99	18.4	0.0001
Hospital bed size									
Small (<200 beds)	1,000	45.2	157	16.0	417	60.4	426	79.0	< .0001
Medium (200–499 beds)	930	42.0	572	58.2	251	36.4	107	19.9	< .0001
Large (>500 beds)	282	12.7	254	25.8	22	3.2	6	1.1	< .0001
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	
Total hospital beds	217	129,	343	227,	170	116,	121	77, 189	<0.0001
ICU beds for CVD	0	510 0, 11	10	510 0, 20	0	260 0, 0	0	0, 0	<0.0001

Abbreviations: AHA, American Hospital Association; AMI, acute myocardial infarction; CCW, Chronic Conditions Warehouse; CABG, coronary artery bypass graft surgery; CR, cardiac rehabilitation; CVD, cardiovascular disease; FFS, fee-for-service; ICU, intensive care unit; IQR, interquartile range; PCI, percutaneous coronary intervention

* Overall, all hospitals included in the analysis were community hospitals (100%) and nearly all were of general medical and surgical service type (99.1%) and non-critical access hospitals (98.6%).

[†] Hospitals that performed ≥10 CABG and ≥10 PCI procedures (ie, AMI, CABG, and PCI care available).

[§] Hospitals that performed ≥10 PCI procedures but < 10 CABG procedures (ie, AMI and PCI care available).

[¶] Hospitals that performed < 10 CABG and < 10 PCI procedures (ie, AMI only care).

[‡] Chi-square tests were used to compare differences in proportions for categorical variables by tier of cardiac care; Kruskal-Wallis tests were used to compare differences in medians for continuous variables by tier of cardiac care using SAS PROC NPAR1WAY.

Table 2.

Patient- and hospital-level factors associated with CR metrics[†]

	CR enrollment [§] Odds ratio (95% CI)	Time to enrollment, day [¶] Difference in means (95% CI)	No. of sessions [‡] Difference in means (95% CI)	Completion Odds ratio (95% CI)
Age (years)				
≤70	Reference	Reference	Reference	Reference
71–75	1.00 (0.97, 1.02)	1.36 (0.24, 2.67)	0.72 (0.47, 0.99)	1.10 (1.06, 1.15)
76–80	0.85 (0.83, 0.87)	4.89 (3.33, 6.70)	0.76 (0.48, 1.06)	1.12 (1.07, 1.18)
81–85	0.64 (0.62, 0.66)	6.79 (4.74, 9.18)	0.45 (0.13, 0.81)	1.15 (1.08, 1.22)
>85	0.34 (0.33, 0.36)	8.73 (5.71, 12.28)	−0.72 (−1.13, −0.27)	0.93 (0.84, 1.02)
Sex				
Female	0.84 (0.82, 0.85)	5.81 (4.40, 7.43)	−1.61 (−1.73, −1.47)	0.82 (0.79, 0.86)
Male	Reference	Reference	Reference	Reference
Race and ethnicity				
Non-Hispanic White	Reference	Reference	Reference	Reference
Non-Hispanic Black	0.62 (0.59, 0.66)	11.72 (8.20, 15.86)	−0.14 (−0.63, 0.41)	1.02 (0.92, 1.12)
Hispanic	0.52 (0.49, 0.55)	2.91 (0.00, 6.41)	−0.65 (−1.18, −0.05)	1.00 (0.89, 1.12)
Non-Hispanic Asian	0.57 (0.52, 0.62)	7.08 (2.61, 12.52)	−0.76 (−1.50, 0.07)	0.92 (0.78, 1.08)
Other/Unknown	0.95 (0.90, 1.01)	0.32 (−2.02, 3.15)	0.15 (−0.38, 0.72)	1.00 (0.90, 1.11)
CR-qualifying indication				
AMI with CABG and PCI	12.62 (10.92, 14.58)	−24.04 (−27.72, −18.99)	3.40 (2.07, 4.90)	1.75 (1.42, 2.17)
AMI with CABG	11.87 (11.34, 12.41)	−23.72 (−24.04, −23.12)	2.16 (1.66, 2.70)	1.27 (1.17, 1.38)
AMI with PCI	6.39 (6.20, 6.59)	−34.13 (−33.03, −35.17)	1.05 (0.69, 1.44)	1.13 (1.06, 1.21)
AMI only	Reference	Reference	Reference	Reference
CABG with PCI	15.40 (12.40, 19.14)	−27.56 (−32.59, −20.38)	2.30 (0.62, 4.24)	1.27 (0.93, 1.73)
CABG only	15.51 (14.99, 16.06)	−28.14 (−27.66, −28.47)	2.42 (1.98, 2.89)	1.30 (1.22, 1.39)
PCI only	3.94 (3.81, 4.07)	−22.23 (−22.44, −21.79)	0.08 (−0.25, 0.45)	1.00 (0.93, 1.07)
Hospital ownership				
For profit	0.77 (0.73, 0.80)	6.39 (3.72, 9.56)	−0.33 (−0.74, 0.12)	1.10 (1.01, 1.20)
Nonprofit	1.02 (0.98, 1.06)	2.55 (0.78, 4.66)	−0.07 (−0.39, 0.28)	1.05 (0.99, 1.12)
Public	Reference	Reference	Reference	Reference

	CR enrollment [§] Odds ratio (95% CI)	Time to enrollment, day [¶] Difference in means (95% CI)	No. of sessions [‡] Difference in means (95% CI)	Completion Odds ratio (95% CI)
U.S. census region				
Northeast	0.53 (0.51, 0.55)	19.24 (16.10, 22.87)	-0.45 (-0.73, -0.14)	0.86 (0.81, 0.92)
Midwest	Reference	Reference	Reference	Reference
South	0.51 (0.50, 0.52)	12.09 (9.96, 14.55)	0.46 (0.19, 0.76)	1.26 (1.21, 1.32)
West	0.56 (0.54, 0.58)	10.58 (8.30, 13.25)	-1.28 (-1.52, -1.01)	0.85 (0.80, 0.90)
Urbanicity				
Urban	Reference	Reference	Reference	Reference
Rural	0.58 (0.47, 0.71)	2.60 (-5.85, 13.19)	-0.18 (-1.96, 1.82)	1.01 (0.71, 1.44)
Cardiac intensive care				
No	1.08 (1.05, 1.11)	-2.89 (-3.87, -1.71)	-0.07 (-0.32, 0.20)	0.95 (0.91, 1.00)
Yes	Reference	Reference	Reference	Reference
Cardiac rehabilitation				
No	0.63 (0.60, 0.65)	4.81 (2.55, 7.47)	-0.41 (-0.77, -0.01)	0.97 (0.89, 1.04)
Yes	Reference	Reference	Reference	Reference
Teaching status				
Teaching	1.02 (0.99, 1.05)	4.48 (2.89, 6.34)	0.16 (-0.10, 0.44)	0.99 (0.94, 1.04)
Nonteaching	Reference	Reference	Reference	Reference
Hospital size				
Small (<200 beds)	Reference	Reference	Reference	Reference
Medium (200–499 beds)	0.90 (0.88, 0.93)	9.37 (7.22, 11.84)	0.39 (0.09, 0.72)	1.02 (0.97, 1.08)
Large (≥500 beds)	0.91 (0.88, 0.94)	10.21 (7.68, 13.15)	0.44 (0.08, 0.83)	1.00 (0.94, 1.07)

Abbreviations: AML, acute myocardial infarction; CABG, coronary artery bypass graft surgery; CR, cardiac rehabilitation; No., number; PCI, percutaneous coronary intervention.

[†] Bolded cells indicate statistical significance, p value < 0.05.

[§] Generalized linear mixed models with binary distribution and logit function to examine hospital-level factors associated with CR enrollment.

[¶] Generalized linear mixed models with normal distribution and identity function to examine hospital-level factors associated with time to enrollment (among hospitals with enrollment).

[‡] Generalized linear mixed models with normal distribution and identity function to examine hospital-level factors associated with number of sessions attended (among hospitals with enrollment).

^{||} Generalized linear mixed models with binary distribution and logit function to examine hospital-level factors associated with CR completion (among hospitals with enrollment).