10-31-2022

Cardiac Rehabilitation and the COVID-19 Pandemic: Persistent Declines in CR Participation and Access Among US Medicare Beneficiaries

Merilyn S. Varghese

Alexis Beatty

Yang Song

Jiaman Xu

Laurence S. Sperling

See next page for additional authors

Recommended Citation

Varghese MS, Beatty A, Song Y, Xu J, Sperling LS, Fonarow GC, Keteyian SJ, McConeghy KW, Penko J, Yeh RW, Figueroa JF, Wu WC, and Kazi DS. Cardiac Rehabilitation and the COVID-19 Pandemic: Persistent Declines in CR Participation and Access Among US Medicare Beneficiaries. Circ Cardiovasc Qual Outcomes 2022.

Authors

Merilyn S. Varghese, Alexis Beatty, Yang Song, Jiaman Xu, Laurence S. Sperling, Gregg C. Fonarow, Steven J. Keteyian, Kevin W. McConeghy, Joanne Penko, Robert W. Yeh, Jose F. Figueroa, Wen-Chih Wu, and Dhruv S. Kazi

10.1161/CIRCOUTCOMES.122.009618

Cardiac Rehabilitation and the COVID-19 Pandemic: Persistent Declines in CR Participation and Access Among US Medicare Beneficiaries

Running Title: *Varghese et al.; Effect of the Pandemic on Cardiac Rehabilitation*

Merilyn S. Varghese, MD[1,2]; Alexis Beatty, MD, MAS[3]; Yang Song, MSc[1]; Jiaman Xu, MPH[1]; Laurence S. Sperling, MD[4]; Gregg C. Fonarow, MD[5]; Steven J. Keteyian, PhD[6] ; Kevin W. McConeghy, PharmD, MS[7,8]; Joanne Penko, MS, MPH[9]; Robert W. Yeh, MD, MBA[1,2]; Jose F. Figueroa, MD, MPH[10,11]; Wen-Chih Wu, MD, MPH,[12,13];Dhruv S. Kazi, MD, MSc, MS[1,2]

[1]Richard A. and Susan F. Smith Center for Outcomes Research in Cardiology, Beth Israel Deaconess Medical Center, Boston, MA; [2]Harvard Medical School, Boston, MA; [3]Department of Epidemiology and Biostatistics, Division of Cardiology, Department of Medicine, University of California, San Francisco, CA; [4]Division of Cardiology, Department of Medicine, Emory Clinical Cardiovascular Research Institute, Emory University School of Medicine, Atlanta, GA; [5]Ahmanson-UCLA Cardiomyopathy Center, University of California Los Angeles, Los Angeles, CA; [6]Division of Cardiovascular Medicine, Henry Ford Hospital, Detroit, MI; [7] Department of Health Services, Policy, and Practice, Brown University School of Public Health, Providence, RI; [8] Center of Innovation Long-Term Services and Supports, Providence Veterans Administration Medical Center, Providence, RI; [9] Department of Epidemiology and Biostatistics, University of California San Francisco, San Francisco, CA; [10] Harvard T.H. Chan School of Public Health, Department of Health Policy & Management, Boston, MA; [11] Brigham and Women's Hospital, Department of Medicine, Division of General Internal Medicine, Boston, MA; [12] Providence VA Medical Center and the Miriam Hospital Cardiovascular Rehabilitation Center, Providence, RI; [13] Departments of Medicine, Epidemiology and Center for Global Cardiometabolic Health, Brown University, Providence, RI

Address for Correspondence:
Dhruv S. Kazi, MD, MSc, MS
Richard A. and Susan F. Smith Center for Outcomes Research in Cardiology,
Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA
Harvard Medical School, Boston, Massachusetts, USA
375 Longwood Ave, 4th Floor, Boston, MA 02215
Tel: 617-632-7701; Email: dkazi@bidmc.harvard.edu

This work was presented as an abstract at the American Heart Association Scientific Sessions, November 5 to November 7, 2022.

This manuscript was sent to Dr. Dennis T. Ko, MD, MSc, Senior Guest Editor, for review by expert referees, editorial decision, and final disposition.

Abstract

Background: The impact of the COVID-19 pandemic on participation in and availability of cardiac rehabilitation (CR) is unknown.

Methods: Among eligible Medicare fee-for-service beneficiaries, we evaluated, by month, the number of CR sessions attended per 100,000 beneficiaries, individuals eligible to initiate CR, and centers offering in-person CR between January 2019 and December 2021. We compared these outcomes between two periods: December 1, 2019 through February 28, 2020 (period 1, prior to declaration of the pandemic-related national emergency) and October 1, 2021 through December 31, 2021 (period 2, the latest period for which data are currently available).

Results: In period 1, Medicare beneficiaries participated in (mean ± SD) 895 ± 84 CR sessions per 100,000 beneficiaries each month. After the national emergency was declared, CR participation sharply declined to 56 CR sessions per 100,000 beneficiaries in April 2020. CR participation recovered gradually through December 2021, but remained lower than pre-pandemic levels (Period 2: 698 ± 29 CR sessions per month per 100,000 beneficiaries, p=.02). Declines in CR participation were most marked among dual Medicare and Medicaid enrollees, and patients residing in rural areas or socially vulnerable communities. There was no statistically significant change in CR eligibility between the two periods. Compared with 2,618 ± 5 CR centers in period 1, there were 2,464 ± 7 in period 2 (p<0.01). Compared with CR centers that survived the pandemic, 220 CR centers that closed were more likely to be affiliated with public hospitals, located in rural areas, and serve the most socially vulnerable communities.

Conclusions: The COVID-19 pandemic was associated with a persistent decline in CR participation and the closure of CR centers, which disproportionately affected rural and low-income patients and the most socially vulnerable communities. Innovation in CR financing and delivery is urgently needed to equitably enhance CR participation among Medicare beneficiaries.

Key Words: COVID-19; Cardiac Rehabilitation; Medicare; Rural; Socially Vulnerable

Non-Standard Abbreviations and Acronyms
CR- Cardiac Rehabilitation
CDC – Centers for Disease Control and Prevention
CMS- Centers for Medicare and Medicaid Services
FFS - Fee-for-Service

What is Known

- Cardiac rehabilitation (CR) reduces morbidity and mortality in select patients with cardiovascular disease, but uptake has been impeded by the limited availability of facilities that offer in-person CR.

What the Study Adds

- CR participation initially declined 94% in the initial month after the COVID-19 pandemic national health emergency was declared in March 2020 and has only partially recovered in the subsequent months.
- CR initiation and participation were lower in the last quarter of 2021 (Q4 2021) compared with a pre-pandemic control period, but eligibility was unchanged.
- 220 CR centers that were open pre-pandemic were no longer offering CR in Q4 2021; centers that closed were smaller and more likely to be located in rural or socially vulnerable communities compared with CR centers that remained open, raising concerns about equitable access to in-person CR.
- These findings suggest that achieving the goal of increasing CR participation to 70% of eligible patients will require innovation in CR financing and delivery.

Introduction

Cardiac rehabilitation (CR) – a structured program combining exercise, risk factor modification, and psychosocial support – reduces morbidity, mortality, and healthcare costs in appropriately selected patients with cardiovascular disease, yet fewer than 30% of eligible patients in the U.S. receives this therapy.[1, 2] The Million Hearts initiative of the Centers for Disease Control and Prevention and the Centers for Medicare and Medicaid Services (CMS) aims to increase CR participation to 70%, but increasing CR participation has been impeded in part by limited availability of facilities for in-person CR in many parts of the country.[1–4] One analysis, performed before the COVID-19 pandemic, suggested that even if all available CR centers were to operate at 110% capacity, they could only serve 47% of the CR-eligible population.[1,5]

In the immediate aftermath of the COVID-19 pandemic, there were marked declines in cardiovascular hospitalizations and procedures, including those that constitute primary qualifying events for CR (**Table 1**). But hospitalization and procedural volumes had recovered to pre-pandemic levels by 2021, suggesting that the number of patients eligible for CR had also returned to pre-pandemic levels.[6] A large number of CR centers stopped offering CR in the early months of the pandemic,[7] but whether there have been persistent effects on the availability of CR centers or participation in in-person CR is unknown. CMS began reimbursing providers for virtual CR in October 2020, but the extent of utilization is also unknown.[8]

Examining the effect of the COVID-19 pandemic on CR participation and availability could inform public health strategies to equitably increase access to and participation in CR. Therefore, we evaluated CR use among Medicare Fee-for-Service (FFS) beneficiaries from January 2019 through December 2021 and examined the number of CR centers offering CR to Medicare beneficiaries over the same time period.

Methods

Study Design and Data Source

We performed a retrospective study using Medicare FFS claims data provided by CMS via the Virtual Research Data Center.[9] Medicare files are available to researchers from CMS.[9] Additional methods are described in the Supplement. Interested researchers can contact the corresponding author for a copy of the statistical code, which will be shared under a Creative Commons (Attribution-NonCommercial-ShareAlike) license. We accessed enrollment data and healthcare claims for 100% of Medicare FFS beneficiaries from January 1, 2019 through December 31, 2021, including the inpatient, outpatient, and Master Beneficiary Summary files.[10–12] Healthcare claims were linked to American Hospital Association Annual Survey data, Rural-Urban Commuting Codes, and the Social Vulnerability Index.[13–15] The American Hospital Association Annual Survey data provide hospital-level information for CR centers, as the majority of CR sessions in the U.S. are delivered through hospital outpatient programs.[1,13] Rural-Urban Commuting Area codes provide information about the rural, metropolitan, or micropolitan communities in which patients live and CR centers are situated.[14] The Center for Disease Control and Prevention's Social Vulnerability Index quantifies community social deprivation using a composite index derived from 15 census variables in four categories: socioeconomic status, household composition and disability, minority status and English language deficiencies, and housing and transportation.[15,16]

CR Participation

Among Medicare FFS beneficiaries age 65 years or older, we identified the monthly number of CR sessions attended from January 1, 2019 through December 31, 2021. We used Current Procedural Terminology codes 93797 and 93798 to identify standard CR sessions in 100%

Medicare outpatient files (**Table S1**). In order to account for pandemic-related changes in the size of the Medicare population during this period, we defined CR participation as the number of CR sessions per 100,000 Medicare beneficiaries. We compared two time periods—December 1, 2019 through February 28, 2020 (the pre-pandemic baseline; period 1) with October 1, 2021 through December 31, 2021 (the time for which the most recent data on CR participation were available at the time of this analysis; period 2). In a secondary analysis, we evaluated how many CR sessions used "CR" or "DR" modifiers, which denote disaster or emergency-related claims, used in this context to identify virtual CR sessions.[17]

CR Eligibility and Initiation

For each month of the study period, we identified Medicare FFS beneficiaries age 65 years and older who were eligible to initiate CR on the first day of the month (i.e., individuals who had experienced a primary CR-qualifying event in the preceding year). Primary qualifying events included acute myocardial infarction, coronary artery bypass grafting, percutaneous coronary intervention, heart valve repair or replacement, or heart or heart-lung transplant. These were identified using claims codes as previously described (**Table S2-S6**).[2] We did not evaluate CR-eligibility for patients with stable angina or stable chronic heart failure with reduced ejection fraction as in prior surveillance studies (due to challenges with accurately identifying onset of stable angina or presence of reduced ejection fraction using claims data, as well as the historically very low rates of participation in CR for these indications).[2] We excluded patients who had participated in CR in the year before the qualifying event or between the qualifying event and the first day of each month being evaluated, as recent participation may preclude eligibility for CR. We excluded patients who were discharged to a skilled nursing facility, long-term acute care, or hospice after the index hospitalization for the qualifying event or any

hospitalizations between the qualifying event and date of eligibility. We compared patient characteristics among those eligible for CR in period 1 to those eligible in period 2 (including key demographic, clinical, and socioeconomic factors). Among patients eligible to initiate CR each month, we identified those initiating CR by the presence of one or more claims for CR in that month.

Availability of CR Centers

CR centers that were operational in a given period were identified by their submission of at least one outpatient claim for CR for a Medicare FFS beneficiary in that period. We considered a CR center "closed" if it had one or more claims for CR in period 1 but had no claims for CR in period 2. We calculated the number of CR centers operational each month. We compared community and health system-level characteristics for CR centers that closed between periods 1 and 2 compared with those that remained operational between the two periods (excluding 24 (11%) CR centers that closed and 10 (1%) of CR centers that remained open for which community- and health system- level data were not available).

Statistical Analyses

Continuous variables were compared using Student's t-test, whereas categorical variables were compared using Pearson chi-square tests. All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, North Carolina) using a 2-tailed p-value <0.05 to define significance. All analyses adhered to the data use agreement between Beth Israel Deaconess Medical Center and the Centers for Medicare and Medicaid Services. The study was deemed exempt from Institutional Review Board review by Beth Israel Deaconess Medical Center's Committee on Clinical Investigations, and informed consent requirements were waived due to 45 Code of

Federal Regulations parts 160 and 164 which cover research for public health activities and purposes.[2]

Results

Cardiac Rehabilitation Participation

Prior to the pandemic (i.e., in period 1), Medicare beneficiaries participated in (mean ± SD) 895 ± 84 monthly CR sessions per 100,000 beneficiaries. After the declaration of the national emergency in March 2020, CR participation declined to 56 CR sessions per 100,000 beneficiaries in April 2020 (**Figure 1**). CR participation recovered gradually through December 2021, with 698 ± 29 monthly CR sessions per 100,000 beneficiaries in period 2 (p=0.02 compared with period 1). Claims with "CR" and "DR" modifiers (virtual CR) were observed starting in March 2020, and increased in frequency through the end of the study (**Figure S1**). However, the number of virtual CR sessions was very low, accounting for 3.6 ± 0.3 out of the 698 ± 29 monthly CR sessions per 100,000 Medicare beneficiaries in period 2).

Cardiac Rehabilitation Eligibility and Initiation

Although the number of CR-eligible patients each month showed some variation over the study period (**Figure S2**), there was no significant difference in the monthly number of CR-eligible individuals between period 1 and period 2 (746 ± 26 per 100,000 Medicare beneficiaries in period 1 versus 728 ± 3 eligible patients per 100,000 Medicare beneficiaries in period 2, p=0.30). Among eligible patients, 7,971 ± 846 initiated CR each month in period 1. This declined sharply after the pandemic-related national emergency was announced: 445 patients initiated CR in April 2020. The number of patients initiating CR each month increased in the months that followed,

but had not reached pre-pandemic levels by the end of 2021 (6,247 ± 279 Medicare beneficiaries initiated CR each month in period 2, p=0.03 compared with period 1).

Compared with patients who initiated CR in period 1, those who initiated in CR in period 2 were less likely to be dually eligible for Medicare and Medicaid, or residing in rural areas or the most socially vulnerable communities (**Table 2**). CR initiation declined for patients who had had an acute myocardial infarction or percutaneous coronary intervention, but modestly increased for those who had undergone valve surgery or transplant (**Table 2**).

Cardiac Rehabilitation Center Availability

During period 1, 2,618 ± 5 CR centers offered one or more CR sessions to Medicare FFS beneficiaries per month. After the public-health emergency was announced, only 685 centers offered CR services to Medicare beneficiaries in April 2020 (**Figure 2**). The number of centers offering CR services recovered in subsequent months but had not reached pre-pandemic levels by the end of 2021 (2,464 ± 7 CR centers offering one or more CR sessions per month in period 2, p<0.01). Between periods 1 and 2, 220 CR centers appeared to have ceased offering services to Medicare beneficiaries while 77 new CR centers had opened in the interim (**Table 3**).

Compared with CR centers that remained operational during the study period, centers that closed had fewer total facility personnel in period 1(922.42 ± 1927.05 for CR centers that closed versus 1245.08 ± 2056.80 for centers that remained open, p=0.03) and offered fewer monthly CR sessions prior to the pandemic (53.2 ± 56.02 for CR centers that closed versus 121.8 ± 112.97 for centers that remained open, p<0.01). Community- and health system- level data were not available for 24 (11%) CR centers that closed, and 10 (1%) of CR centers that remained open. Centers that closed were more likely to be in New England and the Mid-Atlantic regions of the U.S., be located in small towns or rural areas, and were more likely to serve the most socially

vulnerable communities. CR centers that closed were more likely to be affiliated with public or municipal hospitals compared with CR centers that survived the pandemic. There were no statistically significant differences in the affiliated hospital bed size or teaching status between the two groups.

Discussion

We found that the onset of the COVID-19 pandemic produced an initial large but temporary decline in CR participation and eligibility among Medicare FFS beneficiaries, with a partial recovery over the ensuing months. Our study offers four key findings. First, at the end of 2021, CR participation among Medicare FFS beneficiaries remained significantly lower than in pre-pandemic levels. Second, these persistent declines in CR participation were not explained by changes in CR eligibility, which remained largely unchanged, but rather by lower rates of initiation of CR. In other words, these findings were not due to fewer patients experiencing a CR-qualifying event such as a myocardial infarction or coronary artery bypass surgery, but because a smaller proportion of eligible patients initiated CR. Third, declines in CR initiation disproportionately affected dual-eligible beneficiaries, as well as patients residing in rural areas or in the most socially vulnerable communities. Fourth, 220 CR centers, representing 8% of centers available before the pandemic, closed during the pandemic, and these closures were only partially offset by the opening of 77 new CR centers. Our analysis suggests that CR centers that closed during the pandemic disproportionately served socially vulnerable communities, further exacerbating concerns about equitable CR access.

Few prior studies have evaluated the impact of the COVID-19 pandemic on CR. Immediately after the onset of the pandemic, an estimated 75% of CR centers worldwide experienced transient closures.[7] Our study found that while the majority of CR centers in the US have resumed operations, 220 CR centers that offered services in period 1 did not offer CR services in period 2, likely further exacerbating the scarcity of in-person CR. The small number of virtual CR sessions among Medicare beneficiaries suggests that uptake of virtual CR was not sufficient to offset the decline in in-center CR, despite Medicare's decision to cover virtual CR during the public health emergency.[17] One possible explanation is the uncertainty with regard to long-term financial sustainability of virtual CR. Medicare has only temporarily expanded reimbursement to virtual CR during the public health emergency, so CR centers may be less willing to invest in the software, digital devices, and workflow changes needed to provide virtual CR at scale.

The observed persistent declines in CR participation and initiation are likely multi-factorial. In addition to the reduction in the number of available CR centers, out-of-pocket costs – including travel time, lost wages, and copayments – may have impeded CR initiation. The initial surge in unemployment during the pandemic followed by an uneven economic recovery disproportionately affected low-income households and produced higher poverty rates nationally.[18] It is plausible that pandemic-related economic strain has made it harder for individuals to take time out from work to attend CR or to be able to afford the associated costs. Prior work has suggested that out-of-pocket costs dissuade patients from participating in CR; in one study, every $10 increase was associated with 1.5 fewer CR sessions attended.[19] This may have been exacerbated during the COVID-19 pandemic.

Even before the pandemic, there were marked disparities in CR access and use: patients with lower socioeconomic level and those residing in rural areas were less likely to participate in CR.[1,20–24] We observe larger declines in CR initiation in dual Medicare and Medicaid enrollees, rural residents, and residents of the most socially vulnerable communities, suggesting that the pandemic may have exacerbated inequities in CR participation. In addition to the economic impact of the pandemic as discussed above, these disparities may have also partially resulted from changes in access to in-person CR: CR centers that closed during the pandemic were disproportionately located in small towns or rural areas, served socioeconomically vulnerable communities, and were affiliated with public or municipal hospitals. These trends make a case for innovation in the financing and delivery of CR to equitably enhance access to and participation in CR.

Several new care models have been developed to address declines in CR participation. Novel models of CR delivery include virtual CR, in which clinicians observe patients exercising in real-time with audiovisual technology, and remote CR, in which exercise occurs asynchronously with clinicians monitoring transmitted data.[1,25] Combining models of delivery according to an individual patient's needs, such as in-person CR sessions with virtual or remote CR may help address geographic barriers and transportation difficulties.[1,26] Available evidence suggests that patients participating in hybrid CR achieve similar exercise training intensity and similar outcomes compared with in-person CR, but additional studies in underrepresented patient populations are needed. [27–30] The application, tailoring, and assessment of virtual and remote CR to address COVID-19-related impacts on rural and socioeconomically vulnerable communities will be critical to improving CR participation in these underserved populations.

Our study has a few key limitations. First, claims data capture CR use but not CR referral. Therefore, we are unable to assess whether observed declines in CR participation were because clinicians were making fewer referrals for CR or because fewer patients were enrolling in CR after receiving a referral. Second, our analyses were limited to CR services used by Medicare FFS beneficiaries. Our findings should not be extrapolated to Medicare Advantage enrollees or commercially insured individuals. However, since the majority of CR-qualifying events occur in older adults, an analysis of Medicare FFS patients offers insight into the overall state of CR services in the US. Third, our secondary analysis relied on the use of "CR" or "DR" modifiers to identify virtual CR sessions. Incomplete use of these modifiers by providers would result in underestimation of the number of CR sessions delivered virtually. Fourth, we defined a CR center as being operational if it submitted at least one outpatient claim for CR for a Medicare FFS beneficiary in a given period. Centers that exclusively provide services to commercially insured patients would not have appeared in the data. A low-volume center that had no claims for CR between October through December 2021 would have been misclassified as closed. For instance, some centers may have temporarily shut down their CR services in response to staffing shortages in 2021, and may resume CR services at a later date. Future studies should examine the long-term operational impact of the pandemic. Fifth, our analysis of CR center closures was limited by missing community and healthy system- level data on 24 CR centers that closed during the pandemic and 10 CR centers that remained open. Compared with CR centers for which data were available, centers with missing data offered a similar number of CR sessions and served a similar number of unique patients in the pre-pandemic period (data not shown). Sixth, while we examined changes in CR availability and access, we did not directly evaluate the

effect of these changes on health outcomes. Future studies should examine the effect of CR centers and declining CR participation on long-term health outcomes.

Conclusions

Among Medicare FFS beneficiaries, the COVID-19 pandemic was associated with persistent declines in participation in CR and the closure of CR centers. As a result, we are now farther from the Million Hearts' national goal of increasing CR participation to 70% of eligible patients than we were at the start of the pandemic, and the closure of CR centers will likely impede the achievement of this goal.[3] Innovation in CR financing and delivery, including the scaling up of effective virtual or hybrid CR models, is urgently needed to equitably increase CR participation nationally.

Sources of Funding

This work was supported by a post-doctoral fellowship to Dr Varghese from the American Heart Association (grant #899763), a grant from the National Heart, Lung, and Blood Institute to Dr Yeh and Dr Kazi (R01HL157530), and by the Richard A and Susan F Smith Center for Outcomes Research in Cardiology.

Disclosures

Dr Beatty was formerly employed by (2018-2019) and held stock in (2019-2021) Apple Inc.

Dr Fonarow reports consulting for Abbott, Amgen, AstraZeneca, Bayer, Cytokinetics, Eli Lilly, Janssen, Medtronic, Merck, and Novartis.

Supplemental Material

Supplemental Methods:

Tables S1-S6

Supplemental Results:

Figures S1-S2

References 31-32

References

1. Beatty AL, Brown TM, Corbett M, Diersing D, Keteyian SJ, Mola A, Stolp H, Wall HK, Sperling LS. Million Hearts Cardiac Rehabilitation Think Tank: Accelerating New Care Models. *Circ Cardiovasc Qual Outcomes*. 2021;14(10). doi:10.1161/CIRCOUTCOMES.121.008215
2. Keteyian SJ, Jackson SL, Chang A, Brawner CA, Wall HK, Forman DE, Sukul D, Ritchey MD, Sperling LS. Tracking Cardiac Rehabilitation Utilization in Medicare Beneficiaries: 2017 UPDATE. *J Cardiopulm Rehabil Prev*. Published online February 28, 2022. doi:10.1097/HCR.0000000000000675
3. Ades PA, Keteyian SJ, Wright JS, Hamm LF, Lui K, Newlin K, Shepard DS, Thomas RJ. Increasing Cardiac Rehabilitation Participation From 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative. *Mayo Clin Proc*. 2017;92(2):234-242. doi:10.1016/j.mayocp.2016.10.014
4. Wall HK, Stolp H, Wright JS, Ritchey MD, Thomas RJ, Ades PA, Sperling LS. The Million Hearts Initiative: Catalyzing Utilization of Cardiac Rehabilitation and accelerating implementation of new care models. *J Cardiopulm Rehabil Prev*. 2020;40(5):290-293. doi:10.1097/HCR.0000000000000547
5. Pack QR, Goel K, Lahr BD, Greason KL, Squires RW, Lopez-Jimenez F, Zhang Z, Thomas RJ. Participation in Cardiac Rehabilitation and Survival After Coronary Artery Bypass Graft Surgery: A Community-Based Study. *Circulation*. 2013;128(6):590-597. doi:10.1161/CIRCULATIONAHA.112.001365
6. Diamond JE, McIlvaine S, Korjian S, Cruden P, Dechen T, Piatkowski G, Kazi DS, Gavin M. Patterns of Recovery in Cardiovascular Care after the COVID-19 Pandemic Surge. *Am J Med Sci*. 2022;363(4):305-310. doi:10.1016/j.amjms.2021.09.005
7. Ghisi GL de M, Xu Z, Liu X, Mola A, Gallagher R, Babu AS, Yeung C, Marzolini S, Buckley J, Oh P, Contractor A, Grace SL. Impacts of the COVID-19 Pandemic on Cardiac Rehabilitation Delivery around the World. *Glob Heart*. 2021;16(1):43. doi:10.5334/gh.939
8. Centers for Medicare and Medicaid Services. Trump Administration Drives Telehealth Services in Medicaid and Medicare | CMS. Accessed September 25, 2022. https://www.cms.gov/newsroom/press-releases/trump-administration-drives-telehealth-services-medicaid-and-medicare

9. Research Data Assistance Center|CMS. Virtual Research Data Center. Accessed September 9, 2022. https://resdac.org/cms-virtual-research-data-center-vrdc
10. Research Data Assistance Center|CMS. Outpatient (Fee-for-Service). Accessed September 8, 2021. https://resdac.org/cms-data/files/op-ffs
11. Research Data Assistance Center|CMS. MedPAR. Accessed September 8, 2021. https://resdac.org/cms-data/files/medpar
12. Research Data Assistance Center|CMS. Master Beneficiary Summary File (MBSF) Base. Accessed September 8, 2021. https://resdac.org/cms-data/files/mbsf-base
13. American Hospital Association Annual Survey Database. Accessed May 2, 2022. https://www.ahadata.com/aha-annual-survey-database
14. Healthcare Cost and Utilization Project (HCUP) NIS Notes. Patient Location: NCHS Urban-Rural Code. Agency for Healthcare Research and Quality, Rockville, MD. Accessed May 26, 2022. https://www.hcup-us.ahrq.gov/db/vars/pl_nchs/nisnote.jsp
15. CDC/ATSDR. Social Vulnerability Index (SVI). Published June 13, 2022. Accessed July 13, 2022. https://www.atsdr.cdc.gov/placeandhealth/svi/index.html
16. Flanagan BE, Hallisey EJ, Adams E, Lavery A. Measuring Community Vulnerability to Natural and Anthropogenic Hazards: The Centers for Disease Control and Prevention's Social Vulnerability Index. *J Environ Health*. 2018;80(10):34-36.
17. Centers for Medicare and Medicaid Services. Medicare Claims Processing Manual. https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/clm104c38.pdf
18. Shrider EA, Kollar M, Chen F, Semega J. Income and Poverty in the United States: 2020. *US Census Bur*. Published online September 2021:92.
19. Farah M, Abdallah M, Szalai H, Berry R, Lagu T, Lindenauer PK, Pack QR. Association Between Patient Cost Sharing and Cardiac Rehabilitation Adherence. *Mayo Clin Proc*. 2019;94(12):2390-2398. doi:10.1016/j.mayocp.2019.07.018
20. Beatty AL, Truong M, Schopfer DW, Shen H, Bachmann JM, Whooley MA. Geographic Variation in Cardiac Rehabilitation Participation in Medicare and Veterans Affairs Populations: Opportunity for Improvement. *Circulation*. 2018;137(18):1899-1908. doi:10.1161/CIRCULATIONAHA.117.029471
21. Bachmann JM, Duncan MS, Shah AS, Greevy RA, Lindenfeld J, Keteyian SJ, Thomas RJ, Whooley MA, Wang TJ, Freiberg MS. Association of Cardiac Rehabilitation With Decreased Hospitalizations and Mortality After Ventricular Assist Device Implantation. *JACC Heart Fail*. 2018;6(2):130-139. doi:10.1016/j.jchf.2017.11.002
22. Brown TM, Hernandez AF, Bittner V, Cannon CP, Ellrodt G, Liang L, Peterson ED, Piña IL, Safford MM, Fonarow GC, American Heart Association Get With The Guidelines Investigators. Predictors of cardiac rehabilitation referral in coronary artery disease patients: findings from the American Heart Association's Get With The Guidelines Program. *J Am Coll Cardiol*. 2009;54(6):515-521. doi:10.1016/j.jacc.2009.02.080
23. Balady GJ, Ades PA, Bittner VA, Franklin BA, Gordon NF, Thomas RJ, Tomaselli GF, Yancy CW. Referral, Enrollment, and Delivery of Cardiac Rehabilitation/Secondary Prevention Programs at Clinical Centers and Beyond: A Presidential Advisory From the American Heart Association. *Circulation*. 2011;124(25):2951-2960. doi:10.1161/CIR.0b013e31823b21e2
24. Gaalema DE, Higgins ST, Shepard DS, Suaya JA, Savage PD, Ades PA. State-by-state variations in cardiac rehabilitation participation are associated with educational attainment,

income, and program availability. *J Cardiopulm Rehabil Prev*. 2014;34(4):248-254. doi:10.1097/HCR.0000000000000059
25. Sandesara PB, Lambert CT, Gordon NF, Fletcher GF, Franklin BA, Wenger NK, Sperling L. Cardiac Rehabilitation and Risk Reduction. *J Am Coll Cardiol*. 2015;65(4):389-395. doi:10.1016/j.jacc.2014.10.059
26. Keteyian SJ, Ades PA, Beatty AL, Gavic-Ott A, Hines S, Lui K, Schopfer DW, Thomas RJ, Sperling LS. A Review of the Design and Implementation of a Hybrid Cardiac Rehabilitation Program: AN EXPANDING OPPORTUNITY FOR OPTIMIZING CARDIOVASCULAR CARE. *J Cardiopulm Rehabil Prev*. 2022;42(1):1-9. doi:10.1097/HCR.0000000000000634
27. Nkonde-Price C, Reynolds K, Najem M, Yang SJ, Batiste C, Cotter T, Lahti D, Gin N, Funahashi T. Comparison of Home-Based vs Center-Based Cardiac Rehabilitation in Hospitalization, Medication Adherence, and Risk Factor Control Among Patients With Cardiovascular Disease. *JAMA Netw Open*. 2022;5(8):e2228720. doi:10.1001/jamanetworkopen.2022.28720
28. Buckingham SA, Taylor RS, Jolly K, Zawada A, Dean SG, Cowie A, Norton RJ, Dalal HM. Home-based versus centre-based cardiac rehabilitation: abridged Cochrane systematic review and meta-analysis. *Open Heart*. 2016;3(2):e000463. doi:10.1136/openhrt-2016-000463
29. Thomas RJ, Beatty AL, Beckie TM, Brewer LC, Brown TM, Forman DE, Franklin BA, Keteyian SJ, Kitzman DW, Regensteiner JG, Sanderson BK, Whooley MA. Home-Based Cardiac Rehabilitation: A Scientific Statement From the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association, and the American College of Cardiology. *Circulation*. 2019;140(1). doi:10.1161/CIR.0000000000000663
30. Keteyian SJ, Grimshaw C, Brawner CA, Kerrigan DJ, Reasons L, Berry R, Peterson EL, Ehrman JK. A Comparison of Exercise Intensity in Hybrid Versus Standard Phase Two Cardiac Rehabilitation. *J Cardiopulm Rehabil Prev*. 2021;41(1):19-22. doi:10.1097/HCR.0000000000000569
31. Centers for Medicare and Medicaid Services. Billing and Coding: Outpatient Cardiac Rehabilitation (A54070). Accessed August 15, 2022. https://www.cms.gov/medicare-coverage-database/view/article.aspx?articleid=54070
32. Million Hearts Cardiac Rehabilitation Collaborative Surveillance Workgroup. Outpatient Cardiac Rehabilitation Use Surveillance Methodology. Published online February 2019. https://millionhearts.hhs.gov/files/Cardiac-Rehab-Use-Surveillance-Guidance.pdf

Table 1. Qualifying Events for Cardiac Rehabilitation

Primary Qualifying Events
Acute myocardial infarction
Percutaneous coronary intervention
Coronary artery bypass grafting
Valve replacement or repair
Heart or Heart-lung transplant
Secondary Qualifying Events
Stable chronic heart failure with reduced ejection fraction
Stable angina

Table 2. Baseline Characteristics of Medicare fee-for-service beneficiaries who are eligible for or initiate cardiac rehabilitation (CR).

	Patients Eligible for CR			Patients who Initiate CR		
	Period 1 December 2019 – February 2020	Period 2 October 2021 – December 2021	P value	Period 1 December 2019– February 2020	Period 2 October 2021 – December 2021	P value
Total (n)	319,229	287,735		23,914	18,741	
Age (median, IQR)	75.8 (70.0,81.0)	75.0 (70.0,81.0)		73.0 (69.0,79.0)	74.0 (70.0,79.0)	
Age groups (%, n)			<.01			<.01
65-74	49.06% (156603/319229)	47.35% (136247/287735)		56.17% (13433/23914)	54.35% (10185/18741)	
75-84	36.25% (115722/319229)	37.66% (108358/287735)		36.03% (8617/23914)	37.84% (7091/18741)	
≥85	14.69% (46904/319229)	14.99% (43130/287735)		7.79% (1864/23914)	7.82% (1465/18741)	
Sex, male (%, n)	63.41% (202422/319229)	63.44% (182544/287735)	.80	67.86% (16227/23914)	67.23% (12600/18741)	0.17
Race/ethnicity (%, n)			<.01			0.90
Non-Hispanic White	86.44% (275953/319229)	87.37% (251395/287735)		91.21% (21813/23914)	91.12% (17076/18741)	
Non- Hispanic Black	6.12% (19525/319229)	5.23% (15052/287735)		3.35% (800/23914)	3.30% (618/18741)	
Hispanic	1.81% (5779/319229)	1.76% (5071/287735)		0.89% (213/23914)	0.95% (178/18741)	
Asian	1.52% (4840/319229)	1.32% (3790/287735)		0.41% (97/23914)	0.45% (85/18741)	
Other/Unknown	4.11% (13132/319229)	4.32% (12427/287735)		4.14% (991/23914)	4.18% (784/18741)	
Region by census division (%, n)			<.01			<.01
New England	4.18% (13281/317655)	4.58% (13115/286556)		5.45% (1304/23907)	5.27% (987/18737)	
Middle Atlantic	13.59% (43173/317655)	13.93% (39913/286556)		10.52% (2514/23907)	10.24% (1918/18737)	
East North Central	13.73% (43617/317655)	13.92% (39879/286556)		19.68% (4706/23907)	20.81% (3900/18737)	
West North Central	6.18% (19634/317655)	6.34% (18154/286556)		10.61% (2537/23907)	11.24% (2106/18737)	
South Atlantic	21.99% (69849/317655)	22.34% (64013/286556)		22.31% (5333/23907)	22.06% (4133/18737)	
East South Central	8.11% (25748/317655)	7.42% (21274/286556)		6.27% (1499/23907)	5.72% (1072/18737)	
West South Central	13.68% (43462/317655)	12.51% (35837/286556)		9.73% (2326/23907)	9.44% (1768/18737)	
Mountain	6.44% (20447/317655)	6.42% (18386/286556)		6.50% (1553/23907)	6.11% (1144/18737)	
Pacific	12.10% (38444/317655)	12.56% (35985/286556)		8.93% (2135/23907)	9.12% (1709/18737)	

Dual-Eligible (%,n)	10.90% (34791/319229)	9.43% (27145/287735)	<.01	4.11% (984/23914)	3.49% (204/18741)	<.01
Social Vulnerability Index of Patient Zip Code (%, n)			<.01			<.01
Fourth (least) vulnerable quantile	18.48% (57821/312925)	19.80% (55923/282425)		25.91% (6128/23651)	27.29% (4970/18213)	
Third vulnerable quantile	25.04% (78358/312925)	25.72% (72645/282425)		28.92% (6841/23651)	29.17% (5312/18213)	
Second vulnerable quantile	32.10% (100439/312925)	31.95% (90231/282425)		30.50% (7213/23651)	29.11% (5301/18213)	
First (most) vulnerable quantile	24.39% (76307/312925)	22.53% (63626/282425)		14.67% (3469/23651)	14.44% (2630/18213)	
Rural-Urban Commuting Area (%, n)			<.01			<.01
Metro	74.56% (237723/318855)	75.36% (216657/287478)		73.97% (17684/23908)	75.25% (14101/18738)	
Micro	12.93% (41227/318855)	12.47% (35840/287478)		13.43% (3211/23908)	12.88% (2413/18738)	
Small-town/rural	12.52% (39905/318855)	12.17% (34981/287478)		12.60% (3013/23908)	11.87% (2224/18738)	
CR Indication (%, n)						
Myocardial Infarction (MI)						
MI only	38.04% (121433/319229)	35.21% (101318/287735)	<.01	29.28% (7001/23914)	26.79% (5021/18741)	<.01
MI with PCI	18.85% (60160/319229)	17.90% (51515/287735)	<.01	20.95% (5010/23914)	18.87% (3536/18741)	<.01
MI with CABG	2.23% (7130/319229)	2.26% (6498/287735)	0.52	5.06% (1210/23914)	4.84% (907/18741)	0.30
Percutaneous Coronary Intervention	60.23% (192261/319229)	58.30% (167757/287735)	<.01	54.50% (13033/23914)	51.75% (9698/18741)	<.01
Coronary Artery Bypass Surgery (CABG)						
CABG only	9.55% (30488/319229)	10.14% (29177/287735)	<.01	24.02% (5745/23914)	24.35% (4564/18741)	0.43
CABG and Valve Surgery	1.42% (4528/319229)	1.53% (4399/287735)	<.01	3.19% (764/23914)	3.38% (633/18741)	0.29
Valve Surgery	15.10% (48207/319229)	18.47% (53142/287735)	<.01	21.91% (5240/23914)	24.66% (4622/18741)	<.01
Heart Transplant	0.13% (400/319229)	0.16% (457/287735)	<.01	0.09% (21/23914)	0.15% (29/18741)	.05

IQR = interquartile range

Table 3. Characteristics of Cardiac Rehabilitation (CR) Centers. Compared with CR centers that remained operational during the study period, centers that closed had fewer staff and offered fewer median monthly CR sessions prior to the pandemic (i.e., were smaller). They were more likely to be in New England the Mid-Atlantic regions of the US, in small towns or rural areas, and were more likely to serve the most socially vulnerable communities. CR centers that closed were more likely to be affiliated with public or municipal hospitals. There were no statistically significant differences in the bed size or the teaching status of the affiliated hospital.

	CR centers that closed by October – December 2021 (Period 2)	CR centers that stayed open by October – December 2021 (Period 2)	P value
Total (n)	220	2451	
Monthly sessions in period 1 (mean, SD)	53.2 (46.02)	121.8 (112.97)	<.01
Monthly unique patients in period 1 (mean, SD)	8.5 (8.3)	18.8 (17.1)	<.01
Region by census division (%, n)			<.01
New England	7.14% (14/196)	4.75% (116/2441)	
Middle Atlantic	13.78% (27/196)	8.44% (206/2441)	
East North Central	14.29% (28/196)	21.38% (522/2441)	
West North Central	14.80% (29/196)	20.20% (493/2441)	
South Atlantic	8.67% (17/196)	15.20% (371/2441)	
East South Central	8.16% (16/196)	6.39% (156/2441)	
West South Central	12.76% (25/196)	9.95% (243/2441)	
Mountain	11.22% (22/196)	6.84% (167/2441)	
Pacific	9.18% (18/196)	6.84% (167/2441)	
Rural-Urban Commuting Area (%, n)			.04
Metro	47.45% (93/196)	53.91% (1317/2443)	
Micro	17.35% (34/196)	19.32% (472/2443)	
Small-town/rural	35.20% (69/196)	26.77% (654/2443)	
Social Vulnerability Index (%, n)			.03
Fourth (least) vulnerable quantile	20.41% (40/196)	26.46% (646/2441)	
Third vulnerable quantile	23.98% (47/196)	29.05% (709/2441)	
Second vulnerable quantile	34.69% (68/196)	28.19% (688/2441)	
First (most) vulnerable quantile	20.92% (41/196)	16.30% (398/2441)	
Staffing (mean, SD)			
Total facility personnel	922.42 (1927.05)	1245.08 (2056.80)	.03
Physicians	27.18 (119.43)	36.52 (143.71)	0.30
Registered nurses	252.46 (461.25)	370.08 (578.83)	<.01
Respiratory therapists	14.09 (23.31)	19.99 (29.48)	<.01
All other personnel	452.89 (1038.20)	577.98 (1001.36)	0.09
Affiliated hospital bed size (%, n)			0.14
Small (<100)	48.73% (96/197)	42.70% (1044/2445)	
Medium (100-399)	40.61% (80/197)	42.45% (1038/2445)	
Large (> 400)	10.66% (21/197)	14.85% (363/2445)	
Affiliated hospital teaching status (%, n)			0.28

Major	**	6.67% (163/2445)	
Minor	**	44.21% (1081/2445)	
None	46.19% (91/197)	49.12% (1201/2445)	
Ownership (%, n)			<.01
Federal/Military	**	**	
Private, for-profit	**	**	
Private, not-for-profit	59.90% (118/197)	71.53% (1749/2445)	
Public/Municipal	23.86% (47/197)	18.04% (441/2445)	

** Data suppressed in compliance with Centers for Medicaid and Medicare Service data-use-agreement for small cell sizes.
Community- and health system-level data were not available for 24 (11%) CR centers that closed, and 10 (1%) of CR centers that remained open.
SD = standard deviation, IQR = interquartile range.

Figure Legends

Figure 1. Cardiac Rehabilitation Participation Among Medicare Fee-for-Service Beneficiaries (2019-2021). The monthly number of cardiac rehabilitation sessions per 100,000 Medicare beneficiaries sharply declined after the announcement of the national emergency related to the COVID-19 pandemic in March 2020. Recovery has been incomplete: Medicare beneficiaries participated in (mean ± SD) 895 ± 84 monthly CR sessions per 100,000 beneficiaries between December 2019 and February 2020, compared with 698 ± 29 monthly CR sessions per 100,000 beneficiaries between October 2021 and December 2021 (p=0.02).

Figure 2. Number of Cardiac Rehabilitation Centers (CR) Serving Medicare Fee-for-Service Beneficiaries (2019-2021). The figure shows the number of cardiac rehabilitation centers that submitted one or more claims for CR for Medicare fee-for-service beneficiaries each month. Of the 2,618 CR centers that offered one or more CR sessions to Medicare beneficiaries before the pandemic (i.e., in period 1, December 2019 through February 2020), 220 centers were no longer operational in period 2 (October 2021 through December 2021). Centers that closed were, on average, smaller, with fewer employees, and were more likely to be located in small towns or rural communities as well as the most socially vulnerable communities compared with CR centers that survived the pandemic.