Utilization of Cardiac Rehabilitation Among Cardiac Intensive Care Unit Survivors

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Cardiac rehabilitation (CR) is associated with decreased mortality and rehospitalization rates for patients with a variety of cardiac conditions. Although CR referral rates for STEMI patients have improved, rates for heart failure have remained low. Many of these patients are admitted to the cardiac intensive care unit (CICU). However, it is unknown how often CICU survivors qualify for cardiac rehabilitation, how often they are referred, and why eligible patients are not referred. This is a retrospective single-center study of 417 consecutive patients admitted to CICU for >48 hours from March 30, 2016 to March 30, 2017. We excluded patients with in-hospital mortality or those discharged AMA, to hospice or transferred. Chart abstraction was used to determine CR indications based on known American College of Cardiology/American Heart Association guidelines. If CR was indicated, medical records through September 2017 were reviewed to determine both referral and participation rates. In the absence of a referral, medical records were reviewed for potential barriers. A total of 296 CICU survivors were identified upon discharge with 185 (63%) having guideline-directed indications for CR referral. The most common indications were heart failure with reduced ejection fraction (HFrEF, 38%), cardiothoracic surgery (26%), and STEMI (23%). Upon discharge, only 30% of patients were referred to CR. The referral rate increased by 33% to 63% by 18 months postdischarge. CR referrals were most frequently placed following STEMI (91%), NSTEMI (80%), and postpercutaneous coronary intervention (80%). Only 35% of HFrEF discharges were referred to CR. Of patients not referred to CR, no explanation for a lack of referral was documented 87% of the time. In conclusion, nearly 2 of 3 patients discharged from the CICU had CR indications, most commonly HFrEF. CR referrals are frequently not placed and reason for nonreferral is rarely documented. CICU admission may provide a defined event to prompt referral. **(Am J Cardiol 2019;124:1478−1483)**

Cardiac rehabilitation (CR) is known to decrease mortality, reduce hospital admissions, and improve functional status in patients with coronary artery disease, previous myocardial infarction, heart failure with reduced ejection fraction (HFrEF), and following cardiac surgery.[1−7] Despite these clear benefits, CR is underutilized.[8−10] The lack of participation in CR has been attributed to low referral rates as well as low enrollment rates among those referred.[11−15] The underutilization of CR is particularly prominent in HFrEF patients.[16] Despite the proven benefit of decreased cardiovascular mortality and rehospitalizations,[16−18] CR referral rates for HFrEF remain as low as 10%, well below the 60% national referral rate for patients undergoing percutaneous coronary intervention (PCI).[11,16] This discrepancy may in part be due to widely adopted standardized CR referral systems which have improved both referral and enrollment more than two-fold compared with usual care.[19] Cardiac intensive care unit (CICU) survivors are at an increased risk of readmission and have decreased functional status at discharge.[20,21] Given the acuity of their illness, these patients may benefit from CR not only due to their cardiac indication but also due to rehabilitation needs following critical illness. We hypothesized that CICU survivors may represent a population enriched in patients who would benefit from CR but underutilize the program. With use of patient-level data from this single-center retrospective cohort study, we sought to define the frequency of a CR indication within the CICU survivor population, the rate of CR referrals, and barriers to referral at discharge and postdischarge.

Methods

We evaluated consecutive adult patients admitted to CICU from March 30, 2016 to March 30, 2017 at the University of Michigan. We included all patients (≥18 years) admitted to the CICU for >48 hours. Patients with a CICU stay <48 hours were excluded to avoid evaluating those admitted solely for postprocedure monitoring. We also

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excluded patients who died in-hospital, were transferred to another institution, were discharged against medical advice, or were discharged to hospice. This study was approved by the University of Michigan Institutional Review Board.

University of Michigan is a tertiary medical center with approximately 50,000 hospital discharges in 2018. The CR program at this center consists of trained personnel whose goal is to facilitate the enrollment of patients into CR after a referral is placed by a practitioner. This program has a structured telephone follow-up system which aims to overcome barriers to participation and facilitate enrollment in other local CR programs if patients are unable to attend at our tertiary medical center system. This program allowed us to identify if CR was started at this tertiary medical center, why the patient may not have enrolled here, and whether CR was established elsewhere.

Patients were referred to CR by placement of an order within the electronic medical record (EMR, EPIC; Madison, Wisconsin) at time of discharge or following discharge by a medical provider. This referral could have been entered manually or automatically by an automatic referral system depending on the discharge diagnoses. For automatic referrals, discharge diagnoses were paired with customized discharge "order sets" to automatically place a referral to CR for patients with a discharge diagnosis of ST-elevation myocardial infarction (STEMI) or non-ST elevation myocardial infarction (NSTEMI) using ICD-10-CM codes (STEMI: I21.01, I21.02, I21.09, I21.11, I21.19, I21.21, I21.29, I21.3; NSTEMI: I21.4, Nonspecific MI: I21.9).

Discharge summaries and problem-lists were reviewed for known indications for CR based on American Heart Association (AHA)/American College of Cardiology (ACC) guidelines.[8] Although heart failure with preserved ejection fraction (HFpEF) does not have a guideline indication for CR, we recorded this diagnosis to determine its prevalence in our cohort as structured exercise programs have improved functional capacity and quality of life in these patients.[22,23] For each patient, only 1 indication for CR was selected. If a patient had multiple indications, the primary diagnosis was selected. If the patient had multiple indications but none were a primary diagnosis, the indication was selected in the following order: STEMI, postcardiac surgery (transcatheter aortic valve replacement, surgical valve replacement, cardiac transplantation), NSTEMI Type 1 (by discharge summary, confirmed with positive troponin), PCI, HFrEF (ejection fraction $\leq$35% by cardiac imaging), chronic angina, and then HFpEF.

If CR was indicated, discharge summaries, orders, referrals, outpatient clinic visits, and telephone encounters were reviewed in the EMR by a physician to determine if a referral was ordered at discharge or following discharge by the date of September 30, 2017. If no referral to CR was placed, the hospital progress notes, discharge summaries, outpatient visits, and telephone encounters were evaluated to identify the reason for nonreferral.

If a CR referral was placed, patient attendance or absence was evaluated within clinic notes and telephone encounters in the EMR. Attendance was defined as a patient attending at least 1 CR session or documentation stating they had participated in CR at an outside institution.

Demographic information was abstracted using DataDirect (Progress Software; Bedford, Massachusetts) and Clarity (EPIC; Madison, Wisconsin). Postdischarge clinical events, such as emergency department or hospital readmissions, were evaluated using the same programs only within our EMR; no outside hospital system was accessed to evaluate events. Mortality at September 30, 2017 was abstracted using DataDirect. Time to mortality was measured from data of discharge until recorded mortality date.

Statistical analysis was carried out using Prism (GraphPad Software, San Diego, California) and R Statistical Software v. 3.5.2 (R Core Team, Vienna, Austria). Patient characteristics, CR indications, and postdischarge events were described using frequencies and proportions reported as percentages. Continuous variables were reported as medians with interquartile ranges (IQR). Sociodemographic and clinical characteristics of participants referred to CR at discharge were compared with those not-referred at discharge using Fisher's exact test for categorical variables and Mann-Whitney *U* tests for continuous variables. Sociodemographic and clinical characteristics of participants referred to CR after discharge versus never-referred were compared using the same statistical approach.

Results

There were 417 patients admitted the CICU for >48 hours, of whom 332 (80%) survived to discharge. Another 36 were discharged AMA, to hospice, or transferred to another hospital. After excluding these patients, 296 (71%) patients met inclusion criteria and were analyzed in this study. The cohort was mostly male (67%) with a mean age of 62 years (Table 1). Median ICU length of stay was 5 days (IQR 4, 8) with a hospital length of stay of 14 days (IQR 8, 24). Noncardiac comorbid conditions were common including diabetes mellitus (43%), chronic kidney disease (44%), and COPD (23%) (Table 1).

Among the 296 patients in our cohort, 206 (70%) had a condition that would support the use of CR: 185 (63%) had an ACC/AHA guideline-based indication for CR, whereas 21 had HFpEF (7%) as their primary indication for CR. The most common indications for CR were HFrEF (38%), cardiothoracic (CT) surgery (26%), and STEMI (23%) (Table 2).

Only 30% of patients with an ACC/AHA indication were referred to CR at hospital discharge. By 6 to 18 months post-discharge, 63% had been referred (Table 2). CR referral rates at hospital discharge were highest for STEMI (77%), chronic angina (67%), and post-PCI (60%). NSTEMI type I was referred 53% of the time. Comparatively, patients were unlikely to be referred for CR at discharge if their indication was HFrEF (7%), CT surgery (8%), or HFpEF (10%). By 6 to 18 months postdischarge, referrals had markedly improved for CT surgery patients, with conditions most likely to be referred including STEMI (91%), PCI (80%), NSTEMI (80%), and CT surgery (73%). CR referral rates remained low for HFrEF (35%) and HFpEF (19%) (Table 2).

Of the 117 patients referred to CR, 64 (55% of all referred, 35% of total eligible) participated in CR, with 28 (24%) participating at outside institutions. An additional 28

Table 1
Cardiac intensive care unit survivor demographics

Variable	
Age (years)	62 (50,70)
Length of stay - intensive care unit (days)	5 (4,8)
Length of stay - hospital (days)	14 (8,24)
Female	99 (33%)
White	236 (80%)
Black	48 (16%)
Hispanic/other/unknown	12 (4%)
Insurance type	
Medicaid	26 (9%)
Medicare	106 (36%)
Other governmental	11 (4%)
Private	101 (34%)
Discharge location	
Home	121 (41%)
Home with services	107 (36%)
Subacute rehabilitation facility	53 (18%)
Inpatient rehabilitation/long-term care facility	11 (4%)
Cerebrovascular accident/transient ischemic attack	44 (15%)
Dementia	6 (2%)
Diabetes mellitus	128 (43%)
Moderate to severe chronic kidney disease	130 (44%)
End-stage renal disease	16 (5%)
Liver disease-severe	10 (3%)
Pulmonary disease	111 (38%)
Chronic obstructive pulmonary disease	67 (23%)
Malignancy − nonmetastatic	39 (13%)
Malignancy- metastatic	15 (5%)
Charlson comorbidity score	5 (3,7)
30-day readmission rates	
Number of patients	74 (25%)
Total # readmissions	104 (35%)
90-day readmission rates	
Number of patients	116 (39%)
Total # readmissions	234 (79%)
90-day emergency department visits	
Number of patients	81 (27%)
Total # readmissions	121 (41%)

Continuous variables are listed in median and interquartile range.
Categorical variables are reported as count (frequency) and proportions (percentages).

(24%) referred patients expressed their intention to participate at outside institutions but participation could not be confirmed by chart review. No difference in participation rates were appreciated for patients referred at discharge (49%) or after discharge (60%, p >0.05).

Of 185 CR-eligible patients, 130 (70%) were not referred at hospital discharge. In 61 (47%) of cases, no reason for nonreferral was documented in the EHR. The most commonly documented reasons were: "needing to wait until post-operative clinic follow-up" (n = 38, 29%), and the patient being too deconditioned for CR (n = 17, 13%) (Table 5). Among patients never referred to CR, the majority (59, 87%) had no documented reason for a CR nonreferral (Table 3).

Patients referred to CR at discharge had a shorter ICU length of stay (4 days vs 6 days, p = 0.01, Table 4) and hospital length of stay (7 days vs 20.5 days, p <0.01, Table 4) compared with patients not referred to CR at hospital discharge. Patients referred to CR at discharge were also more likely to be discharged home or home with health services (93% vs 76%, p = 0.02). Gender (p >0.05), ethnicity (p >0.05), and insurance type (p >0.05) did not differ by referral status at hospital discharge. Notably, there were no differences between patient referred postdischarge and those never referred to CR for age, ICU length of stay, hospital length of stay, gender, Charlson comorbidity score, ethnicity, insurance type, or discharge location (all p >0.05). (Supplemental Table 1)

Among the 66 HFrEF patients that were not referred to CR at discharge, 20 (30%) received a referral postdischarge and 46 (70%) did not. Of HFrEF patients who received a referral postdischarge, all had documented follow-up >90 days postdischarge compared with only 27 out of 46 (59%) of those not referred. In patients referred to CR postdischarge, 75% were referred at a University of Michigan clinic visit, and 25% were referred by an outside provider.

Outcomes were indistinguishable between patients referred versus not referred to CR at hospital discharge (Table 5). There was no difference in 30-day (20% vs 27%, p >0.05) or 90-day (31% vs 45%, p >0.05) hospital readmissions or 90-day ED visits (20% vs 30%, p >0.05). Likewise, there was no difference between 30-day (26% vs 28%, p >0.05) or 90-day (44% vs 46%, p >0.05) hospital readmissions or 90-day ED visits (27% vs 32%, p >0.05) for those referred to CR after discharge and those never referred (p >0.05). There was a significant difference between mortality within our study period when comparing patients referred to CR postdischarge versus those never referred to CR (3% vs 16%, p = 0.018) (Supplemental Table 2).

Table 2
Cardiac rehabilitation indications for surviving patients in the cardiac intensive care unit

Cardiac rehabilitation indication	Eligible for cardiac rehabilitation	Referred at discharge	Referred postdischarge	Ever referred	Participation in cardiac rehabilitation
ACC/AHA guideline - total	185 (63%)	55 (30%)	62 (33%)	117 (63%)	64 (35%)
Heart failure with reduced ejection fraction </= 35%	71 (38%)	5 (7%)	20 (28%)	25 (35%)	15 (21%)
Cardiothoracic surgery	48 (26%)	4 (8%)	31 (65%)	35 (73%)	22 (46%)
ST-Elevation myocardial infarction	43 (23%)	33 (77%)	6 (14%)	39 (91%)	20 (47%)
Non-ST-elevation myocardial infarction	15 (8%)	8 (53%)	4 (27%)	12 (80%)	7 (47%)
Percutaneous coronary intervention	5 (3%)	3 (60%)	1 (20%)	4 (80%)	0 (0%)
Chronic angina	3 (2%)	2 (67%)	0 (0%)	2 (67%)	0 (0%)
Heart failure with preserved ejection fraction	21	2 (9.5%)	2 (9.5%)	4 (19%)	0 (0%)

HFpEF was not included in the total given a lack of ACC/AHA guideline indications, however it was counted to determine the frequency of illness in the intensive care unit.

Table 3
Reasons for an absence of a cardiac rehabilitation referral at hospital discharge and postdischarge

Documented reasons for CR nonreferral	At hospital discharge	Postdischarge
Total	130	68
No reason given	61 (47%)	59 (87%)
Postsurgery, waiting until follow up	38 (29%)	0 (0%)
Too deconditioned, needs physical/occupational therapy	17 (13%)	3 (4%)
Malignant arrhythmia	4 (3%)	1 (1%)
Not on optimized heart failure medication >6 weeks	2 (2%)	1 (1%)
Waiting on procedure (cardiac surgery, percutaneous coronary intervention)	1 (1%)	1 (1%)
Stated in plan but no referral ordered	6 (5%)	0 (0%)
Attending outside of home institution	1 (1%)	3 (4%)

Table 4
Patient characteristics between those referred to cardiac rehabilitation at hospital discharge and those not referred at discharge

Patient characteristics	Referred at discharge		p Value
	Yes (N = 55)	No (N = 130)	
Age (years)	61 (51.5,71)	60.5 (49, 68.75)	0.268
Length of stay - intensive care unit (days)	**4 (3,7)**	**6 (4, 9)**	**0.001**
Length of stay - hospital (days)	**7 (5,16.5)**	**20.5 (12, 32)**	**<0.0001**
Female	15 (27%)	40 (31%)	0.726
Charlson comorbidity score	4 (2, 6)	5 (3, 7)	0.011
Self-reported Ethnicity			
White	48 (89%)	101 (78%)	0.272
Black	5 (9%)	23 (18%)	-
Other/unknown	1 (2%)	6 (5%)	-
Hispanic	1 (2%)	5 (4%)	0.58
Insurance type			
Medicaid	6 (11%)	12 (9%)	0.787
Medicare	23 (42%)	39 (30%)	0.128
Other governmental	5 (9%)	5 (4%)	0.166
Private	20 (36%)	42 (32%)	0.612
Discharge location			
Home/home with services	**51 (93%)**	**97 (76%)**	**0.02**
Skilled rehabilitation facility	4 (7%)	23 (18%)	-
Inpatient rehabilitation/long-term care facility	0 (0%)	7 (5%)	-

Continuous variables are listed in median and interquartile range with Mann-Whitney *U* tests for comparison without groups.
Categorical variables are reported as count (frequency) and proportions (percentages). Groups were compared using Fisher's exact test analysis.

Table 5
Postdischarge events between patients referred to cardiac rehabilitation at hospital discharge and those not referred at discharge

Postdischarge events	Referred at discharge		p Value
	Yes (N = 55)	No (N = 130)	
30-day readmission			
Number of patients	11 (20%)	35 (27%)	0.357
Total # readmissions	14 (25%)	51 (39%)	
90-day readmission			
Number of patients	17 (31%)	58 (45%)	0.102
Total # readmissions	31 (56%)	126 (97%)	
90-day emergency department visits			
Number of patients	11 (20%)	39 (30%)	0.205
Total # of visits	14 (25%)	63 (49%)	
Known mortality	4 (7%)	13 (10%)	0.781
Time to mortality (months)	11 (9,14)	10 (7, 14)	0.57

Continuous variables are listed in median and interquartile range with Mann-Whitney *U* tests for comparison without groups.
Categorical variables are reported as count (frequency) and proportions (percentages). Groups were compared using Fisher's exact test analysis.
Mortality abstracted at 9/30/2017.
Time to mortality measured from date of hospital discharge until recorded mortality date.

Discussion

In this study, a majority of CICU survivors had a guideline-directed indication for CR, and another small minority had nonguideline indications. However, only 30% of patients with guideline indications were referred to CR at hospital discharge. Referral rates improved to 63% postdischarge in patients with a guideline indication, with most postdischarge referrals occurring at the time of follow-up clinic visits. The most common indications for CR in CICU survivors were HFrEF, CT surgery, and STEMI. Rates of CR referral varied markedly across indications. However, in contrast to previous studies,[24,25] we saw no difference in referral rates by gender, race, or insurance status.

Despite known benefits from CR such as improved quality of life and decreased hospitalization rates,[3,17,18] heart failure patients can have referral rates as low as 10%.[16] In our study, we also found that heart failure patients represented the subgroup with the lowest rate of referral. Interestingly, these referral rates were higher than national averages over the course of our study. However, when compared with referral rates with patients following STEMI and CT surgery, it is clear heart failure patients represent a population with significant underutilization of CR. CR in chronic HFrEF has been shown to safely decrease morbidity and mortality.[26,27] Given these benefits, developing systems to promote CR referral in HFrEF following CICU admission has the potential to improve utilization of an intervention with proven clinical benefit. We, therefore, present potential solutions for improving CR in CICU patients, particularly those with HFrEF.

Automated referral systems have previously been shown to increase CR referral rates for acute myocardial infarction (STEMI, NSTEMI) patients from 34% to 73% over 12 months.[28] Multiple studies have shown that such systems can achieve referral rates of approximately 70%.[19,28,29] Consistent with previous studies,[11,13] STEMI/NSTEMI patients had some of the highest referral rates in our cohort. This is likely due to increased physician awareness of the benefits of CR and the utilization of automatic referral systems.[19,30] Our institution utilizes an automated referral system for STEMI/NSTEMI as well as a CR Coordination Program which addresses potential financial and travel barriers for patients to ensure that CR referrals lead to patient enrollment. These programs achieved referral rates of up to 91% for STEMI/NSTEMI and overall participation rates of approximately 50% in patients referred. There is a potential opportunity to improve CICU CR referral rates by expanding automatic referral systems to other indications such as HFrEF or have patients automatically referred due to the CICU admission itself.

Within our cohort, all CR referrals for post-CABG patients were placed during the postdischarge clinic visit. This need for evaluation postdischarge was clearly documented in discharge summaries for these patients to ensure they were medically ready for rehabilitation. Regardless of stability at time of hospital discharge, HFrEF patients must wait 6 weeks postdischarge to begin CR per current guidelines. This may influence referral rates at hospital discharge; however, this does not explain the continued low referral rates postdischarge. A postdischarge clinic visit may be an optimal time to evaluate readiness for enrollment in CR, particularly for patients who need of a period of stabilization such as patients with HFrEF, following CT surgery, or discharged to rehabilitation facilities.

Other improvements to CR referral include requiring inpatient physicians to determine patient candidacy for CR as part of the hospital discharge process. Alternatively, a referral could be placed at discharge (regardless of health stability) if appropriate screening protocols are in place to prohibit patients from participating before medically ready. This could also allow insurance authorization to be completed and for CR programs to determine if there are any other barriers to the patient attending CR. Finally, home-based CR programs can be promoted in an attempt to improve patient enrollment and compliance. The feasibility and efficacy of these possible solutions require further evaluation before being recommended.

This study has several limitations. First, this single-center study has limited generalizability; multicenter studies are needed. Second, while we benefited from an established CR Coordination Program to examine participation rates, documentation regarding participation in CR was limited to postdischarge communications only within our EMR thereby limiting our ability to determine of patients participated outside of our system. Therefore, we may have underestimated CR participation that occurred outside of our health system. Third, our examination of potential barriers to referral was limited to our EMR which resulted in frequently being unable to ascertain why CR referrals were not provided. It is possible a true barrier to CR was present but not documented. As well, this limited our ability to determine emergency department visits or readmissions took place at outside hospitals. Finally, low occurrence rates for chronic angina and PCI may create a false representation of actual referral rates for these indications.

In conclusion, a large majority of patients admitted to the CICU have indications for CR. Although certain populations have higher referral rates for CR, referral rates for HFrEF could be improved. Automatic referral systems may improve referral rates for HFrEF patients like that of STEMI/NSTEMI patients. Future research should seek to clarify barriers to CR referral and identify interventions to increase CR referral and participation rates.

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Supplementary materials

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