

NQF measure # 0642

1b.2. Provided performance scoresProvide performance scores on the measure as specified (current and over time) at the specified level of analysis. (This is required for maintenance of endorsement. Include mean, std dev, min, max, interquartile range, scores by decile. Describe the data source including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities include). This information also will be used to address the sub-criterion on improvement (4b1) under Usability and Use.

2015-2016 Performance Rates (ACTION Registry) for Cardiac Rehab Inpatient Referral									
Year 2016	Number of Hospitals	Numerator	Denominator	Percentage	Min	Mean	Max	IQR	Standard-Deviation
Q1	1101	119220	153834	0.775	0	0.613781	1	0.4051	0.409366757
Q2	1111	122828	158046	0.7772	0	0.6185	1	0.3763	0.408066401
Q3	1119	126384	161642	0.7819	0	0.62209	1	0.3617	0.403743484
Q4	1122	129231	164520	0.7855	0	0.626772	1	0.3694	0.401194211
Year 2015	Number of Hospitals	Numerator	Denominator	Percentage	Min	Mean	Max	IQR	Standard-Deviation
Q1	1028	113452	143516	0.7905	0	0.6117	1	0.4273	0.411990318
Q2	1048	114319	145121	0.7877	0	0.614845	1	0.415	0.409592333
Q3	1065	114989	147208	0.7811	0	0.6166	1	0.3873	0.410184958
Q4	1100	116774	150124	0.7779	0	0.619972	1	0.4025	0.406531493

2015-2016 Performance Rates (ACTION Registry) for Cardiac Rehab Inpatient Referral by Decile

Year 2016	0	5	10	15	25	50	75	85	90	95	100
Q1	0	0.0181	0.115	0.2863	0.5504	0.8482	0.9555	0.9828	0.9953	1	1
Q2	0	0.0047	0.1225	0.3138	0.5801	0.8497	0.9564	0.9819	0.9944	1	1
Q3	0	0.0229	0.1383	0.3112	0.5909	0.8503	0.9526	0.9821	0.9947	1	1
Q4	0	0.0258	0.1423	0.3485	0.5862	0.8581	0.9556	0.9834	0.9946	1	1
Year 2015	0	5	10	15	25	50	75	85	90	95	100
Q1	0	0.0201	0.1165	0.263	0.5316	0.8572	0.9589	0.986	0.9954	1	1
Q2	0	0.0237	0.1199	0.2807	0.5412	0.8606	0.9562	0.9855	0.9955	1	1
Q3	0	0.0147	0.1025	0.3056	0.5693	0.8531	0.9566	0.9851	0.9957	1	1
Q4	0	0.0186	0.1253	0.3212	0.5611	0.8471	0.9636	0.9853	0.9975	1	1

2015-2016 Performance Rates (CathPCI Registry) for Cardiac Rehab Inpatient Referral									
Year 2016	Number of Hospitals	Numerator	Denominator	Percentage	Min	Mean	Max	IQR	Standard-Deviation
Q1	1794	391824	639751	0.6125	0	0.53779	1	0.6889	0.466717104
Q2	1798	396854	645452	0.6148	0	0.535781	1	0.7091	0.467904819
Q3	1725	400702	649104	0.6173	0	0.537336	1	0.6848	0.46616173
Q4	1741	405801	656858	0.6178	0	0.538281	1	0.6705	0.463936444
Year 2015	Number of Hospitals	Numerator	Denominator	Percentage	Min	Mean	Max	IQR	Standard-Deviation
Q1	1746	383291	613318	0.6249	0	0.529481	1	0.7609	0.475142364
Q2	1759	383985	621155	0.6182	0	0.5315	1	0.7558	0.475110579
Q3	1755	384829	627597	0.6132	0	0.529663	1	0.7548	0.474199117
Q4	1775	387736	635651	0.61	0	0.527809	1	0.7471	0.472158047

2015-2016 Performance Rates (CathPCI Registry) for Cardiac Rehab Inpatient Referral by Decile

Year 2016	0	5	10	15	25	50	75	85	90	95	100
Q1	0	0.0043	0.0168	0.0412	0.2486	0.7148	0.9375	0.9721	0.9856	0.9948	1
Q2	0	0.0032	0.0169	0.0414	0.2273	0.7197	0.9364	0.971	0.9836	0.9941	1
Q3	0	0.0041	0.015	0.0418	0.2488	0.7216	0.9336	0.9689	0.9829	0.994	1
Q4	0	0.0044	0.0164	0.0474	0.26	0.722	0.9305	0.9664	0.9809	0.9931	1
Year 2015	0	5	10	15	25	50	75	85	90	95	100
Q1	0	0.0008	0.0074	0.0264	0.1787	0.7131	0.9396	0.9749	0.9867	0.9967	1
Q2	0	0.0006	0.0086	0.0254	0.1882	0.7221	0.944	0.9752	0.9866	0.9958	1
Q3	0	0.0008	0.0088	0.0266	0.1841	0.7114	0.9389	0.9728	0.987	0.9959	1
Q4	0	0.001	0.0104	0.0303	0.1838	0.6961	0.9309	0.972	0.9861	0.9953	1



A. DEMOGRAPHICS

Last Name ²⁰⁰⁰ :	First Name ²⁰¹⁰ :	Middle Name ²⁰²⁰ :
SSN ²⁰³⁰ : <input type="checkbox"/> SSN N/A ²⁰³¹	Patient ID ²⁰⁴⁰ :	Other ID ²⁰⁴⁵ :
Birth Date ²⁰⁵⁰ : mm / dd / yyyy	Sex ²⁰⁶⁰ : <input type="checkbox"/> Male <input type="checkbox"/> Female	Patient Zip Code ³⁰⁰⁰ : <input type="checkbox"/> Zip Code N/A ³⁰⁰¹
Race: (check all that apply) <input type="checkbox"/> White ²⁰⁷⁰ <input type="checkbox"/> Black/African American ²⁰⁷¹ <input type="checkbox"/> American Indian/Alaskan Native ²⁰⁷³ <input type="checkbox"/> Asian ²⁰⁷² → If Yes, <input type="checkbox"/> Asian - Indian ²⁰⁸⁰ <input type="checkbox"/> Chinese ²⁰⁸¹ <input type="checkbox"/> Filipino ²⁰⁸² <input type="checkbox"/> Japanese ²⁰⁸³ <input type="checkbox"/> Korean ²⁰⁸⁴ <input type="checkbox"/> Vietnamese ²⁰⁸⁵ <input type="checkbox"/> Other ²⁰⁸⁶ <input type="checkbox"/> Native Hawaiian/Pacific Islander ²⁰⁷⁴ → If Yes, <input type="checkbox"/> Native Hawaiian ²⁰⁹⁰ <input type="checkbox"/> Guamanian or Chamorro ²⁰⁹¹ <input type="checkbox"/> Samoan ²⁰⁹² <input type="checkbox"/> Other Island ²⁰⁹³		
Hispanic or Latino Ethnicity ²⁰⁷⁶ : <input type="checkbox"/> No <input type="checkbox"/> Yes → If Yes, Ethnicity Type: (check all that apply) <input type="checkbox"/> Mexican, Mexican-American, Chicano ²¹⁰⁰ <input type="checkbox"/> Puerto Rican ²¹⁰¹ <input type="checkbox"/> Cuban ²¹⁰² <input type="checkbox"/> Other Hispanic, Latino or Spanish Origin ²¹⁰³		

B. ADMISSION

Means of Transport to First Facility ³¹⁰⁰ : <input type="checkbox"/> Self/Family <input type="checkbox"/> Ambulance <input type="checkbox"/> Air → If Ambulance or Air, EMS 1st Med. Contact Date/Time ^{3105, 3106} : _____ <input type="checkbox"/> Time Estimated ³¹⁰⁷ <input type="checkbox"/> Non-System Reason for Delay ³¹⁰⁸ → If Ambulance or Air, Non-EMS 1st Med. Contact Date/Time ^{3111, 3112} : _____ <input type="checkbox"/> Time Estimated ³¹¹³ → If Ambulance or Air, EMS Dispatch Date/Time ^{3152, 3153} : _____ (STEMI or STEMI Equiv.) → If Ambulance or Air, EMS Leaving Scene Date/Time ^{3154, 3155} : _____ (STEMI or STEMI Equiv.) → If Ambulance or Air, EMS Agency Number ³¹⁵⁶ : _____ (STEMI or STEMI Equiv.) → If Ambulance or Air, EMS Run Number ³¹⁵⁷ : _____ (STEMI or STEMI Equiv.) Cath Lab Activation Date/Time ^{3158, 3159} : _____ (STEMI or STEMI Equiv.)		
Transferred from Outside Facility ³¹¹⁰ : <input type="checkbox"/> No <input type="checkbox"/> Yes → If Yes, Means of Transfer ³¹¹⁵ : <input type="checkbox"/> Ambulance <input type="checkbox"/> Air → If Yes, Arrival at Outside Facility Date/Time ^{3120, 3121} : _____ <input type="checkbox"/> Time Estimated ³¹²² → If Yes, Transfer from Outside Facility Date/Time ^{3125, 3126} : _____ <input type="checkbox"/> Time Estimated ³¹²⁷ → If Yes, Name of Transferring Facility/AHA Number ^{3150, 3151} : _____		
Your Facility	Arrival Date/Time ^{3200, 3201} :	Location of First Evaluation ³²²⁰ : <input type="checkbox"/> ED <input type="checkbox"/> Cath Lab <input type="checkbox"/> Other
	Admission Date ³²¹⁰ :	→ If ED, Transfer Out Date/Time ^{3221, 3222} : _____
	Insurance Payors: (check all that apply) <input type="checkbox"/> Private Health Insurance ³³⁰⁰ <input type="checkbox"/> Medicare ³³⁰¹ <input type="checkbox"/> Medicaid ³³⁰² <input type="checkbox"/> Military Health Care ³³⁰³ <input type="checkbox"/> State-Specific Plan (non-Medicaid) ³³⁰⁴ <input type="checkbox"/> Indian Health Service ³³⁰⁵ <input type="checkbox"/> Non-US Insurance ³³⁰⁶ <input type="checkbox"/> None ³³⁰⁷	
	Provider Name ³³¹⁰⁻³³¹² :	Provider NPI ³³¹⁵ : HIC # ³³²⁰ :

C. CARDIAC STATUS ON FIRST MEDICAL CONTACT

Symptom Onset Date/Time ^{4000, 4001} : _____ <input type="checkbox"/> Time Estimated ⁴⁰⁰² <input type="checkbox"/> Time Not Available ⁴⁰⁰³		
First ECG Obtained ⁴⁰¹⁰ : <input type="checkbox"/> Pre-Hospital (e.g. ambulance) <input type="checkbox"/> After 1st hosp. arrival		
First ECG Date/Time ^{4020, 4021} : _____ <input type="checkbox"/> Non-System Reason for Delay ⁴⁰²²		
STEMI or STEMI Equivalent ⁴⁰³⁰ : <input type="checkbox"/> No <input type="checkbox"/> Yes → If Yes, ECG Findings ⁴⁰⁴⁰ : <input type="checkbox"/> ST elevation <input type="checkbox"/> LBBB (new or presumed new) <input type="checkbox"/> Isolated posterior MI → If Yes, STEMI or STEMI Equivalent First Noted ⁴⁰⁴¹ : <input type="checkbox"/> First ECG <input type="checkbox"/> Subsequent ECG → If Subsequent ECG, Subsequent ECG with STEMI or STEMI Equivalent Date/Time ^{4042, 4043} : _____ → If No, Other ECG Findings ⁴⁰⁴⁴ : <input type="checkbox"/> New or presumed new ST depression <input type="checkbox"/> New or presumed new T-Wave inversion (demonstrated within first 24 hours of medical contact) <input type="checkbox"/> Transient ST elevation lasting < 20 minutes <input type="checkbox"/> Old LBBB <input type="checkbox"/> None <input type="checkbox"/> Other		
Heart Failure ⁴¹⁰⁰ : <input type="checkbox"/> No <input type="checkbox"/> Yes	Heart Rate ⁴¹²⁰ : (bpm)	Cardiac Arrest ⁴¹³⁵ : <input type="checkbox"/> No <input type="checkbox"/> Yes
Cardiogenic Shock ⁴¹¹⁰ : <input type="checkbox"/> No <input type="checkbox"/> Yes	Systolic BP ⁴¹³⁰ : (mmHg)	→ If Yes, Pre-Hospital ⁴¹⁴⁰ : <input type="checkbox"/> No <input type="checkbox"/> Yes → If Yes, Outside Facility ⁴¹⁴⁵ : <input type="checkbox"/> No <input type="checkbox"/> Yes



D. HISTORY AND RISK FACTORS

Height ⁵⁰⁰⁰ :	(cm)	Weight ⁵⁰¹⁰ :	(kg)	Prior Heart Failure (previous Hx) ⁵⁰⁹⁰ :	O No O Yes
Current/Recent Smoker (< 1 year) ⁵⁰²⁰ :	O No O Yes	Prior PCI ⁵¹⁰⁰ :		O No O Yes	
Hypertension ⁵⁰³⁰ :	O No O Yes	→ If Yes, Most Recent PCI Date ⁵¹⁰¹ :			
Dyslipidemia ⁵⁰⁴⁰ :	O No O Yes	Prior CABG ⁵¹¹⁰ :		O No O Yes	
Currently on Dialysis ⁵⁰⁵⁰ :	O No O Yes	→ If Yes, Most Recent CABG Date ⁵¹¹¹ :			
Cancer ⁵⁰⁶⁵ :	O No O Yes	Atrial Fibrillation or Flutter ⁵¹²⁰ :		O No O Yes	
→ If Yes, Cancer Type ⁵⁰⁶⁶ :	O Solid Organ O Hematologic	Cerebrovascular Disease ⁵¹³⁰ :		O No O Yes	
Diabetes Mellitus ⁵⁰⁷⁰ :	O No O Yes	→ If Yes, Prior Stroke ⁵¹³¹ :		O No O Yes	
→ If Yes, Diabetes Therapy ⁵⁰⁷¹ :	O None O Diet O Oral O Insulin O Other	→ If Yes, Prior TIA ⁵¹³² :		O No O Yes	
Prior MI ⁵⁰⁸⁰ :	O No O Yes	Peripheral Arterial Disease ⁵¹⁴⁰ :		O No O Yes	

HOME FUNCTIONING

Walking ⁵²⁰⁰ :	O Unassisted O Assisted O Wheelchair/Non-ambulatory O Unknown
Cognition ⁵²⁰⁵ :	O Normal O Mildly impaired O Mod/Severely impaired O Unknown
Basic ADLs ⁵²¹⁰ : (includes bathing, eating, dressing and toileting)	O Independent of all ADLs O Partial assist =1 ADL O Full assist >1 ADL O Unknown

E. MEDICATIONS

Oral Medications

MEDICATION	HOME MEDS	MEDICATIONS ADMINISTERED IN FIRST 24 HOURS (UP TO 24 HOURS AFTER FIRST MEDICAL CONTACT*)	MEDICATIONS PRESCRIBED AT HOSPITAL DISCHARGE (DISCHARGE MEDICATIONS ARE NOT REQUIRED FOR PATIENTS WHO EXPIRED OR WERE DISCHARGED TO 'OTHER ACUTE CARE HOSPITAL', 'AMA' OR ARE RECEIVING HOSPICE CARE)
Aspirin ⁶⁰⁰⁰⁻⁶⁰²²	O No O Yes	O No O Yes O Contraindicated	O No O Yes O Contraindicated → If Yes, Dose: O 75-100mg O >100mg
Clopidogrel ⁶⁰⁵⁰⁻⁶⁰⁷¹	O No O Yes	O No O Yes O Contraindicated → If Yes, Start Date/Time: _____ → If Yes, Dose: _____mg	O No O Yes O Contraindicated → If Yes, Dose: _____mg
Ticlopidine ⁶¹⁰⁰⁻⁶¹²¹	O No O Yes		O No O Yes O Contraindicated → If Yes, Dose: _____mg
Prasugrel ⁶¹⁵⁰⁻⁶¹⁷¹	O No O Yes	O No O Yes O Contraindicated → If Yes, Start Date/Time: _____	O No O Yes O Contraindicated → If Yes, Dose: _____mg
Ticagrelor ⁶¹⁸⁰⁻⁶¹⁹⁰	O No O Yes	O No O Yes O Contraindicated → If Yes, Start Date/Time: _____	O No O Yes O Contraindicated
Warfarin ⁶²⁰⁰⁻⁶²²⁰	O No O Yes		O No O Yes O Contraindicated
Dabigatran ⁶²²⁵⁻⁶²²⁶	O No O Yes		O No O Yes O Contraindicated
Rivaroxaban ⁶²³⁰⁻⁶²³¹	O No O Yes		O No O Yes O Contraindicated
Apixaban ⁶²⁴⁰⁻⁶²⁴¹	O No O Yes		O No O Yes O Contraindicated
Beta Blocker ⁶²⁵⁰⁻⁶²⁷⁰	O No O Yes	O No O Yes O Contraindicated	O No O Yes O Contraindicated
ACE Inhibitor ⁶³⁰⁰⁻⁶³²⁰	O No O Yes	O No O Yes O Contraindicated	O No O Yes O Contraindicated
Angiotensin Receptor Blocker ⁶³⁵⁰⁻⁶³⁷⁰	O No O Yes	O No O Yes O Contraindicated	O No O Yes O Contraindicated
Aldosterone Blocking Agent ⁶⁴⁰⁰⁻⁶⁴²⁰	O No O Yes		O No O Yes O Contraindicated
Statin ⁶⁴⁵⁰⁻⁶⁴⁷¹	O No O Yes	O No O Yes O Contraindicated	O No O Yes O Contraindicated → If Yes, Dose: O Intensive statin therapy O Less than intensive statin therapy
Non-Statins Lipid-Lowering Agent ⁶⁵⁰⁰⁻⁶⁵²⁰	O No O Yes		O No O Yes O Contraindicated



E. MEDICATIONS (CONT)

Intravenous and Subcutaneous Medications

CATEGORY	MEDICATIONS ADMINISTERED								
GP IIb/IIIa Inhibitor ⁶⁸⁰⁰ (any time during this hospitalization)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated → If Yes, Medication Type ⁶⁸⁰¹ : <input type="radio"/> Eptifibatide <input type="radio"/> Tirofiban <input type="radio"/> Abciximab → If Yes, Start Date/Time ^{6802, 6803} : _____ → If Eptifibatide or Tirofiban, Dose ⁶⁸⁰⁶ : <input type="radio"/> Full <input type="radio"/> Reduced <input type="radio"/> Other								
Anticoagulant ⁶⁸⁵⁰	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated → If Yes, Medication Type(s): <table border="0"> <tr> <td><input type="checkbox"/> IV Unfractionated Heparin⁶⁸⁵¹</td><td> Initial Bolus⁶⁸⁵⁴: <input type="radio"/> No <input type="radio"/> Yes → If Yes, Initial Bolus Dose⁶⁸⁵⁵: _____ units → If Yes, Start Date/Time^{6858, 6859}: _____ Initial Infusion⁶⁸⁵⁶: <input type="radio"/> No <input type="radio"/> Yes → If Yes, Initial Infusion Dose⁶⁸⁵⁷: _____ units/hr → If Yes, Start Date/Time^{6866, 6867}: _____ </td></tr> <tr> <td><input type="checkbox"/> Enoxaparin (LMWH)⁶⁸⁶⁰</td><td> Start Date/Time^{6861, 6862}: _____ Initial SubQ Dose⁶⁸⁶³: _____ mg Initial IV Bolus⁶⁸⁶⁴: <input type="radio"/> No <input type="radio"/> Yes Injection Freq.⁶⁸⁶⁵: <input type="radio"/> q12hr <input type="radio"/> q24hr <input type="radio"/> None </td></tr> <tr> <td><input type="checkbox"/> Bivalirudin⁶⁸⁷⁵</td><td>Start Date/Time^{6876, 6877}: _____</td></tr> <tr> <td colspan="2"><input type="checkbox"/> Other parenteral anticoagulants given⁶⁸⁹⁵</td></tr> </table>	<input type="checkbox"/> IV Unfractionated Heparin ⁶⁸⁵¹	Initial Bolus ⁶⁸⁵⁴ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Initial Bolus Dose ⁶⁸⁵⁵ : _____ units → If Yes, Start Date/Time ^{6858, 6859} : _____ Initial Infusion ⁶⁸⁵⁶ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Initial Infusion Dose ⁶⁸⁵⁷ : _____ units/hr → If Yes, Start Date/Time ^{6866, 6867} : _____	<input type="checkbox"/> Enoxaparin (LMWH) ⁶⁸⁶⁰	Start Date/Time ^{6861, 6862} : _____ Initial SubQ Dose ⁶⁸⁶³ : _____ mg Initial IV Bolus ⁶⁸⁶⁴ : <input type="radio"/> No <input type="radio"/> Yes Injection Freq. ⁶⁸⁶⁵ : <input type="radio"/> q12hr <input type="radio"/> q24hr <input type="radio"/> None	<input type="checkbox"/> Bivalirudin ⁶⁸⁷⁵	Start Date/Time ^{6876, 6877} : _____	<input type="checkbox"/> Other parenteral anticoagulants given ⁶⁸⁹⁵	
<input type="checkbox"/> IV Unfractionated Heparin ⁶⁸⁵¹	Initial Bolus ⁶⁸⁵⁴ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Initial Bolus Dose ⁶⁸⁵⁵ : _____ units → If Yes, Start Date/Time ^{6858, 6859} : _____ Initial Infusion ⁶⁸⁵⁶ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Initial Infusion Dose ⁶⁸⁵⁷ : _____ units/hr → If Yes, Start Date/Time ^{6866, 6867} : _____								
<input type="checkbox"/> Enoxaparin (LMWH) ⁶⁸⁶⁰	Start Date/Time ^{6861, 6862} : _____ Initial SubQ Dose ⁶⁸⁶³ : _____ mg Initial IV Bolus ⁶⁸⁶⁴ : <input type="radio"/> No <input type="radio"/> Yes Injection Freq. ⁶⁸⁶⁵ : <input type="radio"/> q12hr <input type="radio"/> q24hr <input type="radio"/> None								
<input type="checkbox"/> Bivalirudin ⁶⁸⁷⁵	Start Date/Time ^{6876, 6877} : _____								
<input type="checkbox"/> Other parenteral anticoagulants given ⁶⁸⁹⁵									

F. PROCEDURES AND TESTS

Non-invasive Stress Testing ⁷⁰⁰⁰ : <input type="radio"/> No <input type="radio"/> Yes	→ If Yes, Date ⁷⁰⁰¹ : _____
LVEF ⁷⁰¹⁰ : _____ % <input type="checkbox"/> LVEF Not Assessed ⁷⁰¹¹	→ If Not Assessed, Planned for after discharge ⁷⁰¹² : <input type="radio"/> No <input type="radio"/> Yes
Diagnostic Coronary Angiography ⁷⁰²⁰ : <input type="radio"/> No <input type="radio"/> Yes	→ If Yes, Provider Name ⁷⁰⁴⁰⁻⁷⁰⁵⁰ : _____ Provider NPI ⁷⁰⁵⁵ : _____
→ If Yes, Angiography Date/Time ^{7021, 7022} : _____	
→ If Yes, Number of Diseased Vessels ⁷⁰⁶⁰ : <input type="radio"/> None <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3	
→ If Yes, Left Main Stenosis \geq 50% ⁷⁰⁶⁵ : <input type="radio"/> No <input type="radio"/> Yes	
→ If Yes and Prior CABG is 'Yes', Graft is Present ⁷⁰⁷⁰ : <input type="radio"/> No <input type="radio"/> Yes - graft patent <input type="radio"/> Yes - graft not patent	
→ If Yes, Proximal LAD \geq 70% ⁷⁰⁷⁵ : <input type="radio"/> No <input type="radio"/> Yes	
→ If Yes and Prior CABG is 'Yes', Graft is Present ⁷⁰⁸⁰ : <input type="radio"/> No <input type="radio"/> Yes - graft patent <input type="radio"/> Yes - graft not patent	
→ If No, Diagnostic Cath Contraindication ⁷⁰³⁵ : <input type="radio"/> No <input type="radio"/> Yes	
PCI ⁷¹⁰⁰ : <input type="radio"/> No <input type="radio"/> Yes	→ If Yes, Provider Name ⁷¹¹³⁻⁷¹¹⁵ : _____ Provider NPI ⁷¹¹⁶ : _____
→ If Yes, Cath Lab Arrival Date/Time ^{7101, 7102} : _____	
→ If Yes, Arterial Access Site ⁷¹¹² : <input type="radio"/> Femoral <input type="radio"/> Brachial <input type="radio"/> Radial <input type="radio"/> Other	
→ If Yes, First Device Activation Date/Time ^{7103, 7104} : _____	
→ If Yes, Stent(s) Placed ⁷¹⁰⁵ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Stent Type(s): <input type="checkbox"/> Bare metal stent ⁷¹⁰⁶ <input type="checkbox"/> Drug eluting stent ⁷¹⁰⁷ <input type="checkbox"/> Other ⁷¹⁰⁸	
→ If Yes, PCI Indication ⁷¹⁰⁹ : <input type="radio"/> Primary PCI for STEMI <input type="radio"/> Rescue PCI for STEMI (after failed full-dose lytic) <input type="radio"/> PCI for NSTEMI	
<input type="radio"/> PCI for STEMI (stable after successful full-dose lytic) <input type="radio"/> PCI for STEMI (unstable, >12 hr from sx onset)	
<input type="radio"/> PCI for STEMI (stable, >12 hr from sx onset) <input type="radio"/> Other	
→ If Primary PCI for STEMI, Non-System Reason for Delay in PCI ⁷¹¹⁰ :	
<input type="radio"/> Difficult vascular access <input type="radio"/> Cardiac arrest and/or need for intubation before PCI	
<input type="radio"/> Patient delays in providing consent for the procedure <input type="radio"/> Difficulty crossing the culprit lesion during the PCI procedure	
<input type="radio"/> Other <input type="radio"/> None	
CABG ⁷²⁰⁰ : <input type="radio"/> No <input type="radio"/> Yes	→ If Yes, CABG Date/Time ^{7201, 7202} : _____
Patient treated with an in-hospital hypothermia protocol ⁷²⁰⁵ : <input type="radio"/> No <input type="radio"/> Yes	
→ If Yes, Where initiated ⁷²⁰⁶ : <input type="radio"/> Pre-Hospital <input type="radio"/> ER <input type="radio"/> Cath Lab <input type="radio"/> ICU/CCU	



G. REPERFUSION STRATEGY (IMMEDIATE REPERFUSION)

→ IF STEMI OR STEMI EQUIVALENT⁴⁰³⁰ = 'YES'Was Patient a Reperfusion Candidate⁸⁰⁰⁰:☐ No ☐ Yes→ If No, Primary Reason⁸⁰¹¹:
☐ No ST elevation/LBBB ☐ MI diagnosis unclear ☐ Chest pain resolved
☐ ST elevation resolved ☐ MI symptoms onset >12 hours ☐ No chest pain ☐ Other
→ If Yes, Primary PCI⁸⁰¹⁵:☐ No ☐ Yes→ If Yes, Thrombolytics⁸⁰²⁰:☐ No ☐ Yes→ If Yes, Strength of Dose⁸⁰²¹:☐ Full dose ☐ Reduced dose→ If Yes, Type of Thrombolytics⁸⁰²²:☐ Tenecteplase ☐ Reteplase ☐ Other→ If Yes, Dose Start Date/Time^{8023, 8024}:

→ If Yes, Non-System Reason for Delay⁸⁰²⁵:☐ No ☐ Yes→ If No, Lytic ineligible and requiring prolonged transferred time for primary PCI⁸⁰²⁶:☐ No ☐ Yes→ If Reperfusion Candidate is 'Yes' and Primary PCI is 'No', Reason Primary PCI Not Performed⁸⁰³⁰
☐ Non-compressible vascular puncture(s) ☐ Spontaneous reperfusion (documented by cath only) ☐ Other
☐ Active bleeding on arrival or within 24 hours ☐ Patient/family refusal ☐ Not performed (not a PCI center)
☐ Quality of life decision ☐ DNR at time of treatment decision ☐ No reason documented
☐ Anatomy not suitable to primary PCI ☐ Prior allergic reaction to IV contrast ☐ Thrombolytic Administered
→ If Reperfusion Candidate is 'Yes' and Thrombolytics is 'No', Reason Thrombolytics Not Administered⁸⁰³⁵
☐ Known bleeding diathesis ☐ Ischemic stroke w/in 3 months except acute ischemic stroke within 3 hours
☐ Recent bleeding within 4 weeks ☐ Any prior intracranial hemorrhage
☐ Recent surgery/trauma ☐ Pregnancy
☐ Intracranial neoplasm, AV malformation, or aneurysm ☐ Prior allergic reaction to thrombolytics
☐ Severe uncontrolled hypertension ☐ DNR at time of treatment decision
☐ Suspected aortic dissection ☐ Other
☐ Significant close head or facial trauma within previous 3 months ☐ Expected DTB < 90 minutes
☐ Active peptic ulcer ☐ No reason documented
☐ Traumatic CPR that precludes thrombolytics

H. IN-HOSPITAL CLINICAL EVENTS

Reinfarction⁹⁰⁰⁰:☐ No ☐ Yes→ If Yes, Date⁹⁰⁰¹:

Cardiogenic Shock⁹⁰¹⁰:☐ No ☐ Yes→ If Yes, Date⁹⁰¹¹:

Heart Failure⁹⁰²⁰:☐ No ☐ Yes→ If Yes, Date⁹⁰²¹:

CVA/Stroke⁹⁰³⁰:☐ No ☐ Yes→ If Yes, Date⁹⁰³¹:

→ If Yes, Hemorrhagic⁹⁰³²:☐ No ☐ YesAtrial Fibrillation⁹⁰⁶⁰:☐ No ☐ Yes→ If Yes, Date⁹⁰⁶⁵:

VTach/VFib⁹⁰⁷⁰:☐ No ☐ Yes→ If Yes, Date⁹⁰⁷⁵:

Cardiac Arrest⁹⁰³⁵:☐ No ☐ Yes→ If Yes, Date⁹⁰³⁷:

Suspected Bleeding Event⁹⁰⁴⁰:☐ No ☐ Yes→ If Yes, Suspected Bleeding Event Date⁹⁰⁴¹:

→ If Yes, Bleeding Event Location: (check all that apply)

☐ Access Site⁹⁰⁴² ☐ Retroperitoneal⁹⁰⁴³ ☐ GI⁹⁰⁴⁴ ☐ GU⁹⁰⁴⁵ ☐ Other⁹⁰⁴⁶
→ If Yes, Surgical Procedure or Intervention Required⁹⁰⁴⁷:☐ No ☐ YesRBC/Whole Blood Transfusion⁹⁰⁵⁰:☐ No ☐ Yes→ If Yes, First Transfusion Date⁹⁰⁵¹:

→ If Yes, CABG-Related Transfusion⁹⁰⁵²:☐ No ☐ YesNew Requirement For Dialysis⁹⁰⁸⁰:☐ No ☐ Yes→ If Yes, Date⁹⁰⁸⁵:

Mechanical Support⁹⁰⁹⁰:☐ No ☐ Yes→ If Yes, Device⁹⁰⁹⁵:
☐ IABP ☐ Impella ☐ TandemHeart
☐ ECMO ☐ LVAD ☐ Other



I. LABORATORY RESULTS

CARDIAC MARKERS

Positive Cardiac Markers Within First 24 Hours¹⁰⁰⁰⁰: ☐ No ☐ Yes

	Troponin	CK-MB
Initial	Collected ¹⁰⁰¹⁰ : <input type="radio"/> No <input type="radio"/> Yes – I <input type="radio"/> Yes – T → If Yes, Value ¹⁰⁰¹³ : _____ (ng/mL) → URL ¹⁰⁰¹⁴ : _____	Collected ¹⁰⁰²⁰ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Value ¹⁰⁰²³ : _____ <input type="radio"/> IU/L <input type="radio"/> % <input type="radio"/> (mg/mL)/IU <input type="radio"/> ng/mL → ULN ¹⁰⁰²⁵ : _____
Peak	Collected ¹⁰⁰³⁰ : <input type="radio"/> No <input type="radio"/> Yes – I <input type="radio"/> Yes – T → If Yes, Value ¹⁰⁰³³ : _____ (ng/mL) → URL ¹⁰⁰³⁴ : _____ <input type="checkbox"/> Peak same as initial ¹⁰⁰³⁵	Collected ¹⁰⁰⁴⁰ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Value ¹⁰⁰⁴³ : _____ <input type="radio"/> IU/L <input type="radio"/> % <input type="radio"/> (mg/mL)/IU <input type="radio"/> ng/mL → ULN ¹⁰⁰⁴⁵ : _____ <input type="checkbox"/> Peak same as initial ¹⁰⁰⁴⁶

CREATININE

Initial	Collected ¹⁰¹⁰⁰ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Date/Time ^{10101, 10102} : _____ → If Yes, Value ¹⁰¹⁰³ : _____ (mg/dL)	Peak	Collected ¹⁰¹¹⁰ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Date/Time ^{10111, 10112} : _____ → If Yes, Value ¹⁰¹¹³ : _____ (mg/dL) <input type="checkbox"/> Peak same as initial ¹⁰¹¹⁴
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HEMOGLOBIN

Initial	Collected ¹⁰¹⁵⁰ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Date/Time ^{10151, 10152} : _____ → If Yes, Value ¹⁰¹⁵³ : _____ (g/dL)	Lowest	Collected ¹⁰²⁰⁰ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Date/Time ^{10201, 10202} : _____ → If Yes, Value ¹⁰²⁰³ : _____ (g/dL) <input type="checkbox"/> Lowest same as initial ¹⁰²⁰⁴
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INITIAL HEMOGLOBIN A1C

Collected¹⁰²⁵⁰: ☐ No ☐ Yes → If Yes, **Date/Time**^{10251, 10252}: _____ → If Yes, **Value**¹⁰²⁵³: _____ %

INITIAL INR

Collected¹⁰³⁰⁰: ☐ No ☐ Yes → If Yes, **Date/Time**^{10301, 10302}: _____ → If Yes, **Value**¹⁰³⁰³: _____

LIPIDS (MG/DL)

Panel Performed¹⁰³⁵⁰: ☐ No ☐ Yes → If Yes, **Date/Time**^{10351, 10352}: _____ ☐ Value Out of Range¹⁰³⁶⁰
 → If Yes, **TC**¹⁰³⁵³: _____ → If Yes, **HDL**¹⁰³⁵⁴: _____ → If Yes, **LDL**¹⁰³⁵⁵: _____ → If Yes, **Triglycerides**¹⁰³⁵⁶: _____

INITIAL BNP

Collected¹⁰⁴⁰⁰: ☐ No ☐ Yes → If Yes, **Value**¹⁰⁴⁰¹: _____ (pg/mL)

INITIAL NT-PROBNP

Collected¹⁰⁴⁰⁵: ☐ No ☐ Yes → If Yes, **Value**¹⁰⁴⁰⁶: _____ (pg/mL)

J. DISCHARGE

Discharge Date¹¹⁰⁰⁰: _____ **Provider Name**¹¹⁰⁰³⁻¹¹⁰⁰⁵: _____ **Provider NPI**¹¹⁰⁰⁶: _____

Comfort Measures Only¹¹⁰¹⁰: ☐ No ☐ Yes

Enrolled in Clinical Trial During Hospitalization¹¹⁰²⁰: ☐ No ☐ Yes

Discharge Status¹¹¹⁰⁰: ☐ Alive ☐ Deceased

 → If Alive, **Smoking Counseling**¹¹¹⁰¹: ☐ No ☐ Yes

 → If Alive, **Cardiac Rehabilitation Referral**¹¹¹⁰⁴: ☐ No-No Referral ☐ No-Medical Reason ☐ No-Pt Reason/Preference
☐ No-Health Care System Reason ☐ Yes

 → If Alive, **Discharge Location**¹¹¹⁰⁵: ☐ Home ☐ Extended care/transitional care unit/Rehab ☐ Other acute care hospital
☐ Skilled nursing facility ☐ Other ☐ Left against medical advice (AMA)

 → If Other Acute Care Hospital, **Transfer Time**¹¹¹⁰⁶: _____

 → If Other Acute Care Hospital, **Transfer for PCI**¹¹¹⁰⁷: ☐ No ☐ Yes

 → If Other Acute Care Hospital, **Transfer for CABG**¹¹¹⁰⁸: ☐ No ☐ Yes

 → If Alive, **Hospice Care**¹¹¹¹⁰: ☐ No ☐ Yes

 → If Deceased, **Cause of Death**¹¹¹⁵⁰: ☐ Cardiac ☐ Non-cardiac

 → If Deceased, **Time of Death**¹¹¹⁵¹: _____

**K. OPTIONAL ELEMENTS (FOR AMI CORE MEASURE REPORTING ONLY)**

Point of Origin ¹²⁰⁰⁰ :		<input type="radio"/> Non-health care facility <input type="radio"/> Clinic <input type="radio"/> Transfer from a hospital (different facility) <input type="radio"/> Transfer from a skilled nursing facility (SNF) or intermediate care facility (ICF) <input type="radio"/> Transfer from another health care facility <input type="radio"/> Emergency room	<input type="radio"/> Court/law enforcement <input type="radio"/> Information not available <input type="radio"/> D: Transfer from one distinct unit of the hospital to another distinct unit of the same hospital resulting in a separate claim to the Payor <input type="radio"/> E: Transfer from ambulatory surgery center <input type="radio"/> F: Transfer from hospice and is under a hospice plan of care or enrolled in a hospice program
Transfer from Another ED ¹²⁰¹⁰ :		<input type="radio"/> No <input type="radio"/> Yes	
CMS Comfort Measures Timing ¹²⁰²⁰ :		<input type="radio"/> Day 0 or 1 <input type="radio"/> Day 2 or after <input type="radio"/> Timing unclear <input type="radio"/> Not documented/UTD	
Principal Diagnosis Code ¹²⁰⁹⁰ :		Principal Procedure Code ¹²¹⁰⁰ :	Date ¹²¹⁰¹ :
Other Diagnosis Code(s) ¹²¹¹⁰⁻¹² :			
Other Procedure Code(s) ¹²¹²⁰⁻²¹ :		Date(s) ¹²¹²²⁻²³ :	
Physician 1 ¹²¹³⁰ :		Physician 2 ¹²¹³¹ :	
CMS Discharge Status ¹²¹⁴⁰ :	<input type="radio"/> D/C – Home or self care <input type="radio"/> D/C – Short term general hospital <input type="radio"/> D/C – To a skilled nursing facility (SNF) with Medicare certification in anticipation of covered skilled care <input type="radio"/> D/C – Intermediate care facility <input type="radio"/> D/C – Institution not defined elsewhere in this code list <input type="radio"/> D/C – Home under care of organized home health service organization in anticipation of covered skilled care <input type="radio"/> Left against medical advice or discontinued care <input type="radio"/> Expired <input type="radio"/> Expired in a medical facility (e.g. hospital, SNF, ICF, or freestanding hospice)		
	<input type="radio"/> D/C – Federal health care facility <input type="radio"/> Hospice – Home <input type="radio"/> Hospice – Medical facility <input type="radio"/> D/C – Hospital-based Medicare-approved swing bed <input type="radio"/> D/C – Inpatient rehabilitation facility (IRF) including rehabilitation-distinct part units of a hospital <input type="radio"/> D/C – Medicare-certified long term care hospital (LTCH) <input type="radio"/> D/C – Nursing facility certified under Medicaid but not certified under Medicare <input type="radio"/> D/C – To a psychiatric hospital or a psychiatric-distinct part unit of a hospital <input type="radio"/> D/C – Critical access hospital (CAH)		

CathPCI Registry®		NCDR® CathPCI Registry® v4.4 Diagnostic Catheterization and Percutaneous Coronary Intervention Registry	
A. DEMOGRAPHICS			
Last Name ²⁰⁰⁰ :		First Name ²⁰¹⁰ :	
Middle Name ²⁰²⁰ :			
SSN ²⁰³⁰ :	- - □ SSN N/A ²⁰³¹	Patient ID ²⁰⁴⁰ :	(auto) Other ID ²⁰⁴⁵ :
Birth Date ²⁰⁵⁰ :		Sex ²⁰⁶⁰ : <input type="radio"/> Male <input type="radio"/> Female	
Race:		<input type="checkbox"/> White ²⁰⁷⁰ <input type="checkbox"/> Black/African American ²⁰⁷¹ <input type="checkbox"/> Asian ²⁰⁷² (check all that apply) <input type="checkbox"/> American Indian/Alaskan Native ²⁰⁷³ <input type="checkbox"/> Native Hawaiian/Pacific Islander ²⁰⁷⁴	
Hispanic or Latino Ethnicity ²⁰⁷⁶ : <input type="radio"/> No <input type="radio"/> Yes			
B. EPISODE OF CARE			
Arrival Date/Time ^{3000,3001} :		Patient Zip Code ³⁰⁰⁵ : □ Zip Code N/A ³⁰⁰⁶	
Admit Source ³⁰¹⁰ : <input type="radio"/> Emergency department <input type="radio"/> Transfer in from another acute care facility <input type="radio"/> Other			
Insurance Payors: (check all that apply) <input type="checkbox"/> Private Health Insurance ³⁰²⁰ <input type="checkbox"/> Medicare ³⁰²¹ <input type="checkbox"/> Medicaid ³⁰²² <input type="checkbox"/> Military Health Care ³⁰²³ <input type="checkbox"/> State-Specific Plan (non-Medicaid) ³⁰²⁴ <input type="checkbox"/> Indian Health Service ³⁰²⁵ <input type="checkbox"/> Non-US Insurance ³⁰²⁶ <input type="checkbox"/> None ³⁰²⁷			
HIC # ³⁰³⁰ :			
C. HISTORY AND RISK FACTORS (ON ARRIVAL TO CATHPCI FACILITY)			
Current/Recent Smoker (< 1 year) ⁴⁰⁰⁰ :		<input type="radio"/> No <input type="radio"/> Yes	
Hypertension ⁴⁰⁰⁵ :		<input type="radio"/> No <input type="radio"/> Yes	
Dyslipidemia ⁴⁰¹⁰ :		<input type="radio"/> No <input type="radio"/> Yes	
Family History of Premature CAD ⁴⁰¹⁵ :		<input type="radio"/> No <input type="radio"/> Yes	
Prior MI ⁴⁰²⁰ :		<input type="radio"/> No <input type="radio"/> Yes	
Prior Heart Failure ⁴⁰²⁵ :		<input type="radio"/> No <input type="radio"/> Yes	
Prior Valve Surgery/Procedure ⁴⁰³⁰ :		<input type="radio"/> No <input type="radio"/> Yes	
Prior PCI ⁴⁰³⁵ :		<input type="radio"/> No <input type="radio"/> Yes	
→If Yes, Most Recent PCI Date ⁴⁰⁴⁰ :		→If Yes, Diabetes Therapy ⁴⁰⁹⁰ : <input type="radio"/> None <input type="radio"/> Diet <input type="radio"/> Oral <input type="radio"/> Insulin <input type="radio"/> Other	
Prior CABG ⁴⁰⁴⁵ :		<input type="radio"/> No <input type="radio"/> Yes	
→If Yes, Most Recent CABG Date ⁴⁰⁵⁰ :			
D. CATH LAB VISIT (COMPLETE FOR EACH CATH LAB VISIT)			
CLINICAL EVALUATION LEADING TO THE PROCEDURE			
CAD Presentation ⁵⁰⁰⁰ : <input type="radio"/> No Sxs, no angina (14 days) <input type="radio"/> Sx unlikely to be ischemic (14 days) <input type="radio"/> Stable angina (42 days) <input type="radio"/> Unstable angina (60 days) <input type="radio"/> Non-STEMI (7 days) <input type="radio"/> STEMI (7 days)			
→If STEMI or Non-STEMI, Symptom Onset Date/Time ^{5005,5006} (7 days): □ Time Estimated ⁵⁰⁰⁷ □ Time Not Available ⁵⁰⁰⁸			
→If STEMI, Thrombolytics ⁵⁰¹⁰ : <input type="radio"/> No <input type="radio"/> Yes →If Yes, Start Date/Time ^{5015,5016} :			
Anginal Classification w/in 2 Weeks ⁵⁰²⁰ : <input type="radio"/> No symptoms <input type="radio"/> CCS I <input type="radio"/> CCS II <input type="radio"/> CCS III <input type="radio"/> CCS IV			
Anti-Anginal meds w/in 2 Weeks ⁵⁰²⁵ : <input type="radio"/> No <input type="radio"/> Yes → If Yes, Type (check all that apply): <input type="checkbox"/> Beta Blockers ⁵⁰²⁶ <input type="checkbox"/> Ca Channel Blockers ⁵⁰²⁷ <input type="checkbox"/> Long Acting Nitrates ⁵⁰²⁸ <input type="checkbox"/> Ranolazine ⁵⁰²⁹ <input type="checkbox"/> Other ⁵⁰³⁰			
Heart Failure w/in 2 Weeks ⁵⁰⁴⁰ : <input type="radio"/> No <input type="radio"/> Yes			
→If Yes, NYHA Class w/in 2 Weeks ⁵⁰⁴⁵ : <input type="radio"/> Class I <input type="radio"/> Class II <input type="radio"/> Class III <input type="radio"/> Class IV			
Cardiomyopathy or LV Systolic Dysfunction ⁵⁰⁵⁰ :		<input type="radio"/> No <input type="radio"/> Yes	
Pre-operative Evaluation Before Non-Cardiac Surgery ⁵⁰⁵⁵ :		<input type="radio"/> No <input type="radio"/> Yes	
Cardiogenic Shock w/in 24 Hours ⁵⁰⁶⁰ :		<input type="radio"/> No <input type="radio"/> Yes	
Cardiac Arrest w/in 24 Hours ⁵⁰⁶⁵ :		<input type="radio"/> No <input type="radio"/> Yes	

CathPCI Registry®				NCDR® CathPCI Registry® v4.4 Diagnostic Catheterization and Percutaneous Coronary Intervention Registry			
Stress or Imaging Studies Performed ⁵¹⁰⁰ :				<input type="radio"/> No <input type="radio"/> Yes → If Yes, Specify Test Performed:			
Test Performed	No	Yes		Result			Risk/Extent Of Ischemia
Standard Exercise Stress Test ^{5200,5201,5202} : (w/o imaging)	<input type="radio"/>	<input type="radio"/>	→ If Yes,	<input type="radio"/> Negative <input type="radio"/> Indeterminant	<input type="radio"/> Positive <input type="radio"/> Unavailable	→ If Positive,	<input type="radio"/> Low <input type="radio"/> Intermediate <input type="radio"/> High <input type="radio"/> Unavailable
Stress Echocardiogram ^{5210,5211,5212} :	<input type="radio"/>	<input type="radio"/>	→ If Yes,	<input type="radio"/> Negative <input type="radio"/> Indeterminant	<input type="radio"/> Positive <input type="radio"/> Unavailable	→ If Positive,	<input type="radio"/> Low <input type="radio"/> Intermediate <input type="radio"/> High <input type="radio"/> Unavailable
Stress Testing w/SPECT MPI ^{5220,5221,5222} :	<input type="radio"/>	<input type="radio"/>	→ If Yes,	<input type="radio"/> Negative <input type="radio"/> Indeterminant	<input type="radio"/> Positive <input type="radio"/> Unavailable	→ If Positive,	<input type="radio"/> Low <input type="radio"/> Intermediate <input type="radio"/> High <input type="radio"/> Unavailable
Stress Testing w/CMR ^{5230,5231,5232} :	<input type="radio"/>	<input type="radio"/>	→ If Yes,	<input type="radio"/> Negative <input type="radio"/> Indeterminant	<input type="radio"/> Positive <input type="radio"/> Unavailable	→ If Positive,	<input type="radio"/> Low <input type="radio"/> Intermediate <input type="radio"/> High <input type="radio"/> Unavailable
Cardiac CTA ^{5240,5241} :	<input type="radio"/>	<input type="radio"/>	→ If Yes,	<input type="radio"/> No disease <input type="radio"/> Indeterminant	<input type="radio"/> 1VD <input type="radio"/> Unavailable	<input type="radio"/> 2VD <input type="radio"/> 3VD	
Coronary Calcium Score ⁵²⁵⁰ :	<input type="radio"/>	<input type="radio"/>	→ If Yes,	Calcium Score: ⁵²⁵¹ _____			
PROCEDURE INFORMATION							
Procedure Date/Time ^{5300/5301} :				Fluoro Time/Dose ^{5320,5321} : _____ minutes OR _____ mGy			
PCI ⁵³⁰⁵ :				Contrast Volume ⁵³²⁵ :			
Diagnostic Cath ⁵³¹⁰ :							
Other Procedure (in conj w/Dx Cath or PCI) ⁵³¹⁵ :							
MECHANICAL VENTRICULAR SUPPORT							
IABP ⁵³³⁰ : <input type="radio"/> No <input type="radio"/> Yes							
→ If Yes, Timing ⁵³³⁵ : <input type="radio"/> In place at start of procedure <input type="radio"/> Inserted during procedure and prior to PCI <input type="radio"/> Inserted after PCI has begun							
Other Mechanical Ventricular Support ⁵³⁴⁰ : <input type="radio"/> No <input type="radio"/> Yes							
→ If Yes, Timing ⁵³⁴⁵ : <input type="radio"/> In place at start of procedure <input type="radio"/> Inserted during procedure and prior to PCI <input type="radio"/> Inserted after PCI has begun							
ARTERIAL ACCESS:							
Arterial Access Site ⁵³⁵⁰ : <input type="radio"/> Femoral <input type="radio"/> Brachial <input type="radio"/> Radial <input type="radio"/> Other							
Closure Method(s) ⁵³⁵⁵ :		1		<input type="checkbox"/> Method Not Documented ⁵³⁵⁶			
		2					
		3					
		4					
E. DIAGNOSTIC CATHETERIZATION PROCEDURE (COMPLETE FOR EACH DIAGNOSTIC CATH)							
Operator's Name ^{6000, 6005, 6010} :				Operator's NPI ⁶⁰¹⁵ :			
Diagnostic Coronary Angiography ⁶⁰²⁰ : <input type="radio"/> No <input type="radio"/> Yes							
Left Heart Cath ⁶⁰²⁵ : <input type="radio"/> No <input type="radio"/> Yes							
Cardiac Transplant Evaluation ⁶⁰³⁰ : <input type="radio"/> No <input type="radio"/> Yes							
→ If Yes, Type ⁶⁰³⁵ : <input type="radio"/> Donor for cardiac transplant <input type="radio"/> Candidate to receive a cardiac transplant <input type="radio"/> Post cardiac transplant follow up							
Diag Cath Status ⁶⁰⁴⁰ : <input type="radio"/> Elective <input type="radio"/> Urgent <input type="radio"/> Emergency <input type="radio"/> Salvage							
Rx Recommendation ⁶⁰⁴⁵ : (after diagnostic cath) <input type="radio"/> None <input type="radio"/> Medical therapy and/or counseling <input type="radio"/> PCI w/o planned CABG <input type="radio"/> CABG (including planned hybrid CABG/PCI procedures) <input type="radio"/> Other cardiac therapy without CABG or PCI							

F. BEST ESTIMATE OF CORONARY ANATOMY (COMPLETE FOR EACH CATH LAB VISIT)

Dominance⁶¹⁰⁰: ☐ Left ☐ Right ☐ Co-dominant

Coronary Territory	Native Artery Percent Stenosis in ≥2mm vessels	Grafts Supplying Coronary Territory (Note 1) Percent Stenosis
Left Main	_____ % ⁶¹¹⁰ <input type="checkbox"/> Not Available ⁶¹¹¹	
Prox LAD	_____ % ⁶¹²⁰ <input type="checkbox"/> Not Available ⁶¹²¹	_____ % ⁶¹⁷⁰ <input type="checkbox"/> Not Available ⁶¹⁷¹
Mid/Distal LAD, Diag Branches	_____ % ⁶¹³⁰ <input type="checkbox"/> Not Available ⁶¹³¹	_____ % ⁶¹⁸⁰ <input type="checkbox"/> Not Available ⁶¹⁸¹
Circ, OMs, LPDA, LPL Branches	_____ % ⁶¹⁴⁰ <input type="checkbox"/> Not Available ⁶¹⁴¹	_____ % ⁶¹⁹⁰ <input type="checkbox"/> Not Available ⁶¹⁹¹
RCA, RPDA, RPL, AM Branches	_____ % ⁶¹⁵⁰ <input type="checkbox"/> Not Available ⁶¹⁵¹	_____ % ⁶²⁰⁰ <input type="checkbox"/> Not Available ⁶²⁰¹
Ramus	_____ % ⁶¹⁶⁰ <input type="checkbox"/> Not Available ⁶¹⁶¹	_____ % ⁶²¹⁰ <input type="checkbox"/> Not Available ⁶²¹¹

G. PCI PROCEDURE (COMPLETE FOR EACH CATH LAB VISIT IN WHICH A PCI WAS ATTEMPTED OR PERFORMED)

Operator's Name^{7000,7005,7010}:Operator's NPI⁷⁰¹⁵:PCI Status⁷⁰²⁰: ☐ Elective ☐ Urgent ☐ Emergency ☐ SalvagePre-PCI LVEF⁷⁰²⁵: _____ % ☐ Pre-PCI LVEF Not Assessed⁷⁰²⁶Cardiogenic Shock at Start of PCI⁷⁰³⁰: ☐ No ☐ Yes

PCI Indication⁷⁰³⁵: ☐ Immediate PCI for STEMI ☐ PCI for STEMI (Unstable, >12 hrs from Sx onset)
☐ PCI for STEMI (Stable, >12 from hrs Sx onset) ☐ PCI for STEMI (stable after successful full-dose Thrombolysis)
☐ Rescue PCI for STEMI (after failed full-dose lytics) ☐ PCI for high risk Non-STEMI or unstable angina
☐ Staged PCI ☐ Other

→ If Immediate PCI for STEMI, STEMI or STEMI Equivalent First Noted⁷⁰⁴⁰: ☐ First ECG ☐ Subsequent ECG→ If Subsequent ECG, Subsequent ECG with STEMI or STEMI Equivalent Date/Time^{7045, 7046}: _____→ If Immediate PCI for STEMI, First Device Activation Date/Time^{7050,7051}: _____→ If Immediate PCI for STEMI, Transferred In for Immediate PCI for STEMI⁷⁰⁵⁵: ☐ No ☐ Yes→ If Yes, Date/Time ED Presentation at Referring Facility^{7060,7061}: _____→ If Immediate PCI for STEMI, Non-System Reason for Delay in PCI⁷⁰⁶⁵:

- ☐ Difficult vascular access ☐ Cardiac arrest and/or need for intubation before PCI
☐ Patient delays in providing consent for the procedure ☐ Difficulty crossing the culprit lesion during the PCI procedure
☐ Other ☐ None

PROCEDURE MEDICATIONS (ADMINISTERED WITHIN 24 HOURS PRIOR TO AND DURING THE PCI PROCEDURE)

Category	Medication ⁹⁵⁰⁰	Administered ⁹⁵¹⁰
Anticoagulants	Fondaparinux	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Low Molecular Weight Heparin (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Unfractionated Heparin (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Aspirin	Aspirin (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Direct Thrombin Inhibitors	Bivalirudin	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Direct Thrombin Inhibitor (other)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Glycoprotein IIb/IIIa Inhibitors	GP IIb/IIIa (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Thienopyridines	Clopidogrel	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Ticlopidine	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Prasugrel	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Ticagrelor	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded

Note 1: CABG Date⁹⁰²⁰ must be less than Procedure Date/Time^{5300/5301} or Prior CABG⁴⁰⁴⁵ = "Yes" to complete these elements.

H. LESIONS AND DEVICES (COMPLETE FOR EACH PCI ATTEMPTED OR PERFORMED)

Lesion Counter ⁷¹⁰⁰ :	1	2
Segment Number(s) ⁷¹⁰⁵ :	_____, _____, _____, _____, _____	_____, _____, _____, _____, _____
If CAD Presentation ⁵⁰⁰⁰ is 'STEMI', 'Non-STEMI', or 'Unstable angina', Culprit Lesion ⁷¹¹⁰ :	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Unknown	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Unknown
Stenosis Immediately Prior to Rx ⁷¹¹⁵ :	_____ %	_____ %
→ If 100%, Chronic Total Occlusion ⁷¹²⁰ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
→ If 40-70%, IVUS ⁷¹²⁵ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
→ If 40-70%, FFR ⁷¹³⁰ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
→ If Yes, FFR Ratio ⁷¹³⁵ :	_____	_____
Pre-procedure TIMI Flow ⁷¹⁴⁰ :	<input type="radio"/> 0 <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3	<input type="radio"/> 0 <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3
Prev Treated Lesion ⁷¹⁴⁵ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
→ If Yes, Timeframe ⁷¹⁵⁰ :	<input type="radio"/> < 1 month <input type="radio"/> 1-5 months <input type="radio"/> 6-12 months	<input type="radio"/> < 1 month <input type="radio"/> 1-5 months <input type="radio"/> 6-12 months
→ If Yes, Treated with Stent ⁷¹⁵⁵ :	<input type="radio"/> 1-2 years <input type="radio"/> >2 years <input type="radio"/> Time unknown	<input type="radio"/> 1-2 years <input type="radio"/> >2 years <input type="radio"/> Time unknown
→ If Yes, In-Stent Restenosis ⁷¹⁶⁰ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
→ If Yes, In-Stent Thrombosis ⁷¹⁶⁵ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
Stent Type ⁷¹⁷⁰ :	<input type="radio"/> DES <input type="radio"/> Non-DES <input type="radio"/> Type unknown	<input type="radio"/> DES <input type="radio"/> Non-DES <input type="radio"/> Type unknown
Lesion in Graft ⁷¹⁷⁵ :	<input type="radio"/> Not in Graft <input type="radio"/> Vein <input type="radio"/> LIMA <input type="radio"/> Other artery	<input type="radio"/> Not in Graft <input type="radio"/> Vein <input type="radio"/> LIMA <input type="radio"/> Other artery
→ If Vein, LIMA, Other, Location in Graft ⁷¹⁸⁰ :	<input type="radio"/> Aortic <input type="radio"/> Body <input type="radio"/> Distal	<input type="radio"/> Aortic <input type="radio"/> Body <input type="radio"/> Distal
Lesion Complexity ⁷¹⁸⁵ :	<input type="radio"/> Non-High/Non-C <input type="radio"/> High/C	<input type="radio"/> Non-High/Non-C <input type="radio"/> High/C
Lesion Length (mm) ⁷¹⁹⁰ :	_____ mm	_____ mm
Thrombus Present ⁷¹⁹⁵ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
Bifurcation Lesion ⁷²⁰⁰ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
Guidewire Across Lesion ⁷²⁰⁵ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes
→ If Yes, Stenosis Post-Procedure ⁷²¹⁰ :	_____ %	_____ %
→ If Yes, Post-Procedure TIMI Flow ⁷²¹⁵ :	<input type="radio"/> 0 <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3	<input type="radio"/> 0 <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3
→ If Yes, Device(s) Deployed ⁷²²⁰ :	<input type="radio"/> No <input type="radio"/> Yes	<input type="radio"/> No <input type="radio"/> Yes

Intracoronary Device(s) Used ⁷²²⁵		Associated Lesion(s) ⁷¹⁰⁰	Diameter ⁷²³⁵	Length ⁷²⁴⁰
1		_____, _____, _____		
2		_____, _____, _____		
3		_____, _____, _____		
4		_____, _____, _____		
5		_____, _____, _____		

INTRAPROCEDURE EVENTS **Significant Dissection**⁷²⁴⁵: ☐ No ☐ Yes **Perforation**⁷²⁵⁰: ☐ No ☐ Yes

I. LABS (COMPLETE FOR EACH CATH LAB VISIT IN WHICH A PCI WAS ATTEMPTED OR PERFORMED)

Pre-Procedure (performed at your facility)	Post-Procedure (post-procedure only)
CK-MB ⁷³⁰⁰ _____ ng/mL <input type="checkbox"/> CK Not Applicable ⁷³⁰¹ <input type="checkbox"/> CK Drawn and Normal ⁷³⁰²	CK-MB ⁷³²⁵ _____ ng/mL <input type="checkbox"/> CK Not Applicable ⁷³²⁶ (peak value 6-24 hrs) <input type="checkbox"/> CK Drawn and Normal ⁷³²⁷
Troponin I ⁷³⁰⁵ _____ ng/mL <input type="checkbox"/> Not Drawn ⁷³⁰⁶	Troponin I ⁷³³⁰ _____ ng/mL <input type="checkbox"/> Not Drawn ⁷³³¹ (peak value 6-24 hrs)
Troponin T ⁷³¹⁰ _____ ng/mL <input type="checkbox"/> Not Drawn ⁷³¹¹	Troponin T ⁷³³⁵ _____ ng/mL <input type="checkbox"/> Not Drawn ⁷³³⁶ (peak value 6-24 hrs)
Creatinine ⁷³¹⁵ _____ mg/dL <input type="checkbox"/> Not Drawn ⁷³¹⁶	Creatinine ⁷³⁴⁰ _____ mg/dL <input type="checkbox"/> Not Drawn ⁷³⁴¹ (highest value)
Hemoglobin ⁷³²⁰ _____ g/dL <input type="checkbox"/> Not Drawn ⁷³²¹	Hemoglobin ⁷³⁴⁵ _____ g/dL <input type="checkbox"/> Not Drawn ⁷³⁴⁶ (lowest w/in 72 hrs)

J. INTRA AND POST-PROCEDURE EVENTS (COMPLETE FOR EACH CATH LAB VISIT)

Myocardial Infarction ⁸⁰⁰⁰ : (Positive Biomarkers)	<input type="radio"/> No <input type="radio"/> Yes	Bleeding Event w/in 72 Hours ⁸⁰⁵⁰ :	<input type="radio"/> No <input type="radio"/> Yes
Cardiogenic Shock ⁸⁰⁰⁵ :	<input type="radio"/> No <input type="radio"/> Yes	→If Yes, Bleeding at Access Site ⁸⁰⁵⁵ :	<input type="radio"/> No <input type="radio"/> Yes
Heart Failure ⁸⁰¹⁰ :	<input type="radio"/> No <input type="radio"/> Yes	→If Yes, Hematoma at Access Site ⁸⁰⁶⁰ :	<input type="radio"/> No <input type="radio"/> Yes
CVA/Stroke ⁸⁰¹⁵ :	<input type="radio"/> No <input type="radio"/> Yes	→If Yes, Size ⁸⁰⁶¹ : <input type="radio"/> <3cm <input type="radio"/> 3-5cm <input type="radio"/> >5-10 <input type="radio"/> >10cm	
→If Yes, Hemorrhagic Stroke ⁸⁰²¹ :	<input type="radio"/> No <input type="radio"/> Yes	→If Yes, Retroperitoneal Bleeding ⁸⁰⁷⁰ :	<input type="radio"/> No <input type="radio"/> Yes
Tamponade ⁸⁰²⁵ :	<input type="radio"/> No <input type="radio"/> Yes	→If Yes, GI Bleed ⁸⁰⁸⁰ :	<input type="radio"/> No <input type="radio"/> Yes
New Requirement for Dialysis ⁸⁰³⁰ :	<input type="radio"/> No <input type="radio"/> Yes	→If Yes, GU Bleed ⁸⁰⁹⁰ :	<input type="radio"/> No <input type="radio"/> Yes
Other Vascular Complications Req Rx ⁸⁰³⁵ :	<input type="radio"/> No <input type="radio"/> Yes	→If Yes, Other Bleed ⁸¹⁰⁰ :	<input type="radio"/> No <input type="radio"/> Yes
RBC/Whole Blood Transfusion ⁸⁰⁴⁰ :	<input type="radio"/> No <input type="radio"/> Yes		
→If Yes, Hgb Prior to Transfusion ⁸⁰⁴¹ :	_____ g/dL		

K. DISCHARGE (COMPLETE THIS SECTION FOR EACH EPISODE OF CARE)

CABG ⁹⁰⁰⁰ :	<input type="radio"/> No <input type="radio"/> Yes
→ If Yes, CABG Status ⁹⁰⁰⁵ :	<input type="radio"/> Elective <input type="radio"/> Urgent <input type="radio"/> Emergency <input type="radio"/> Salvage
→ If Yes, CABG Indication ⁹⁰¹⁰ :	<input type="radio"/> PCI complication <input type="radio"/> PCI failure without clinical deterioration <input type="radio"/> Treatment of CAD without PCI immediately preceding CABG <input type="radio"/> PCI/CABG hybrid procedure
→If Yes, Location ⁹⁰¹⁵ :	<input type="radio"/> At your facility <input type="radio"/> Transferred to other facility
→If At your facility, CABG Date/Time ^{9020,9021} :	
Other Major Surgery ⁹⁰²⁵ :	<input type="radio"/> No <input type="radio"/> Yes
LVEF ⁹⁰³⁰ :	% <input type="checkbox"/> LVEF Not Assessed ⁹⁰³¹
Discharge Date ⁹⁰³⁵ :	
Discharge Status ⁹⁰⁴⁰ :	<input type="radio"/> Alive <input type="radio"/> Deceased
→If Alive, Discharge Location ⁹⁰⁴⁵ :	<input type="radio"/> Home <input type="radio"/> Extended care/TCU/rehab <input type="radio"/> Other acute care hospital <input type="radio"/> Nursing home <input type="radio"/> Hospice <input type="radio"/> Other <input type="radio"/> Left against medical advice (AMA)
→If Alive, Cardiac Rehabilitation Referral ⁹⁰⁵⁰ :	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Ineligible
→If Deceased, Death in Lab ⁹⁰⁵⁵ :	<input type="radio"/> No <input type="radio"/> Yes
→If Deceased, Primary Cause of Death ⁹⁰⁶⁰ :	<input type="radio"/> Cardiac <input type="radio"/> Neurologic <input type="radio"/> Renal <input type="radio"/> Vascular <input type="radio"/> Infection <input type="radio"/> Valvular <input type="radio"/> Pulmonary <input type="radio"/> Unknown <input type="radio"/> Other
Hospital Status ⁹⁰⁶⁵ :	<input type="radio"/> Outpatient <input type="radio"/> Outpatient converted to inpatient <input type="radio"/> Inpatient

DISCHARGE MEDICATIONS (PRESCRIBED AT DISCHARGE – COMPLETE FOR EACH EPISODE OF CARE IN WHICH A PCI WAS ATTEMPTED OR PERFORMED)

Category	Medication ⁹⁵⁰⁵	Administered ⁹⁵¹⁰
Discharge medications are not required for patients who expired or were discharged to 'Other acute care Hospital', 'Hospice', or 'AMA'.		
ACE Inhibitors	ACE Inhibitor (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
ARBs	ARB (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Aspirin	Aspirin (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Beta Blockers	Beta Blocker (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Lipid Lowering Agents	Statin (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Non-Statin (any)	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
Thienopyridines	Clopidogrel	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Ticlopidine	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Prasugrel	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded
	Ticagrelor	<input type="radio"/> No <input type="radio"/> Yes <input type="radio"/> Contraindicated <input type="radio"/> Blinded

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0. Purpose

To describe and quantify the amount of variation in patients having referred to Cardiac Rehab in the Action Registry in 2012

1. Section 1b.2

1.1: Quarterly Rates

CR										
	Total	Timeframe								P-Value
	n = 223037	2011Q1 n = 23466	2011Q2 n = 25149	2011Q3 n = 25496	2011Q4 n = 26641	2012Q1 n = 29560	2012Q2 n = 29539	2012Q3 n = 31167	2012Q4 n = 32019	
Cardiac Rehab Referral	167955 (75.3%)	17182 (73.2%)	18884 (75.1%)	19187 (75.3%)	20340 (76.3%)	22529 (76.2%)	22529 (76.3%)	23317 (74.8%)	23987 (74.9%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.										

1.2 Descriptive Statistics at hospital level (Hospitals with 10 or more eligible patients)

2011

Analysis Variable : P Proportion Referral							
Number Hospitals	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
551	0.6892096	0	0.4931507	0.8153846	0.9500000	1.0000000	0.4568493

By Decile:

10 th Percentile	20 th Percentile	30 th Percentile	40 th Percentile	50 th Percentile	60 th Percentile	70 th Percentile	80 th Percentile	90 th Percentile
0.087719	0.38323	0.6	0.73810	0.81538	0.89139	0.928	0.96522	0.98641

2012

Analysis Variable : P Proportion Referral							
Number Hospitals	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
703	0.6698336	0	0.4657763	0.8014184	0.9456522	1.0000000	0.4798759

By Decile:

10 th Percentile	20 th Percentile	30 th Percentile	40 th Percentile	50 th Percentile	60 th Percentile	70 th Percentile	80 th Percentile	90 th Percentile
0.065217	0.31429	0.59091	0.69369	0.80142	0.87302	0.92537	0.95876	0.98701

2. 1b.4 Disparities

2.0 Distributions by Group (Requires 10 or more of subgroup of interest)

2011

label	Number Patients	Number of Sites	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
Male	66795	532	70.52%	0.00%	53.55%	83.82%	95.72%	100.0%	42.17%
Female	33485	506	68.70%	0.00%	50.00%	80.48%	94.12%	100.0%	44.12%
Age<60	41104	510	73.16%	0.00%	59.38%	86.33%	96.55%	100.0%	37.18%
age60-79	26438	480	72.98%	0.00%	56.89%	85.83%	96.12%	100.0%	39.23%
age70-79	18213	432	70.40%	0.00%	54.49%	82.27%	94.55%	100.0%	40.06%
Age>=80	12921	387	64.93%	0.00%	41.67%	75.00%	91.67%	100.0%	50.00%
PrivateIns	57167	522	70.89%	0.00%	54.55%	84.00%	95.00%	100.0%	40.45%
Medicare	23699	449	68.89%	0.00%	50.63%	80.00%	93.75%	100.0%	43.12%
Medicaid	3090	158	72.22%	0.00%	53.85%	85.93%	100.0%	100.0%	46.15%
OtherInsurance	1401	76	75.94%	0.00%	62.50%	86.93%	95.64%	100.0%	33.14%
NoInsurance	11495	356	76.38%	0.00%	64.64%	89.47%	98.11%	100.0%	33.46%
RaceWhite	86287	543	69.50%	0.00%	51.11%	82.61%	94.93%	100.0%	43.82%
RaceBlack	10472	258	67.21%	0.00%	44.83%	78.57%	94.74%	100.0%	49.91%
RaceOther	1999	89	69.30%	0.00%	52.94%	80.00%	96.30%	100.0%	43.36%
NonTeachingHosp	52432	335	66.84%	0.00%	43.67%	81.20%	94.05%	100.0%	50.38%

label	Number Patients	Number of Sites	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
TeachingHosp	48235	216	72.15%	0.00%	56.13%	82.25%	95.45%	100.0%	39.32%
RuralHosp	14474	97	65.99%	0.00%	40.68%	77.63%	93.75%	100.0%	53.07%
SuburbanHosp	30192	179	66.34%	0.00%	37.94%	81.54%	93.24%	100.0%	55.30%
UrbanHosp	56001	275	71.63%	0.00%	54.02%	83.12%	96.30%	100.0%	42.27%

2012

label	Number Patients	Number of Sites	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
Male	81027	690	68.61%	0.00%	50.29%	82.05%	94.72%	100.0%	44.44%
Female	40692	640	66.51%	0.00%	48.81%	77.78%	94.03%	100.0%	45.21%
Age<60	49489	648	70.41%	0.00%	57.14%	85.20%	95.65%	100.0%	38.51%
age60-79	32614	620	71.09%	0.00%	57.28%	83.33%	95.55%	100.0%	38.28%
age70-79	22237	546	69.87%	0.00%	54.84%	80.32%	95.05%	100.0%	40.21%
Age>=80	15101	473	65.95%	0.00%	46.34%	74.07%	92.94%	100.0%	46.60%
PrivateIns	69818	654	70.04%	0.00%	55.69%	82.35%	95.49%	100.0%	39.80%
Medicare	28110	583	66.88%	0.00%	48.00%	78.85%	93.18%	100.0%	45.18%
Medicaid	3619	184	72.47%	0.00%	58.33%	81.82%	95.83%	100.0%	37.49%
OtherInsurance	1669	88	75.15%	0.00%	61.72%	89.12%	100.0%	100.0%	38.28%

label	Number Patients	Number of Sites	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
NoInsurance	13901	445	76.27%	0.00%	68.18%	87.50%	98.21%	100.0%	30.03%
RaceWhite	103479	693	67.81%	0.00%	50.00%	80.56%	94.54%	100.0%	44.54%
RaceBlack	13162	320	68.24%	0.00%	48.74%	80.68%	93.88%	100.0%	45.14%
RaceOther	2968	122	68.05%	0.00%	53.33%	77.10%	93.33%	100.0%	40.00%
NonTeachingHosp	66176	435	63.85%	0.00%	34.62%	76.79%	93.17%	100.0%	58.55%
TeachingHosp	55989	268	72.07%	0.00%	60.10%	83.48%	95.80%	100.0%	35.70%
RuralHosp	17638	115	65.48%	0.00%	53.08%	73.33%	92.36%	100.0%	39.28%
SuburbanHosp	36756	240	66.79%	0.00%	43.42%	80.96%	94.78%	100.0%	51.36%
UrbanHosp	67771	348	67.62%	0.00%	46.96%	80.95%	94.62%	100.0%	47.66%

2.1: Disparities by Gender 2012

	Total n = 122285	male		P-Value
		Male n = 81201	Female n = 41084	
CR				
Cardiac Rehab Referral	92362 (75.5%)	62725 (77.2%)	29637 (72.1%)	< 0.001
Continuous variables compared using Student's T-test. Categorical variables compared using chi-square or Fisher's exact test.				

2.2: Disparities by Race 2012

	Total	racecat			P-Value
	n = 122285	1 Caucasian n = 103641	2 Af Am n = 14329	3 Other n = 4315	
CR					
Cardiac Rehab Referral	92362 (75.5%)	79246 (76.5%)	10308 (71.9%)	2808 (65.1%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.					

2.3: Disparities by Insurance 2012

	Total	inscat					P-Value
	n = 122285	1 Private n = 70170	2 Medicare n = 28803	3 Medicaid n = 5273	4 Other n = 2949	5 None n = 15090	
CR							
Cardiac Rehab Referral	92362 (75.5%)	54457 (77.6%)	20205 (70.1%)	3713 (70.4%)	2192 (74.3%)	11795 (78.2%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.							

2.4: Disparities by Hospital Teaching status

	Total	IsTeaching		P-Value
	n = 122285	Teaching Hosp n = 56023	Non-Teaching Hosp n = 66262	
CR				
Cardiac Rehab Referral	92362 (75.5%)	44626 (79.7%)	47736 (72.0%)	< 0.001
Continuous variables compared using Student's T-test. Categorical variables compared using chi-square or Fisher's exact test.				

2.5: Disparities by Hospital Community

	Total	CommunityDesc			P-Value
	n = 122285	Rural n = 17667	Suburban n = 36800	Urban n = 67818	
CR					
Cardiac Rehab Referral	92362 (75.5%)	13524 (76.5%)	27467 (74.6%)	51371 (75.7%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.					

3. 1.3 Dates

The primary analysis include patients in the ACTION registry 1/1/2012—12/31/2012, with additional data from 1/1/2011-12/31/2011

4. 1.5 Description of sites 2012

CR	
	Total
	n = 703
CommunityDesc	
Rural	115 (16.4%)
Suburban	240 (34.1%)
Urban	348 (49.5%)
ProfitTypeDesc	
Government	16 (2.3%)
Private/Community	617 (87.8%)
University	70 (10.0%)
IsTeaching	268 (38.1%)
CensusRegionDesc	
Midwest Region	192 (27.4%)
Northeast Region	86 (12.3%)
South Region	326 (46.4%)
West Region	98 (14.0%)
Missing	1
IsPublic	310 (44.1%)

5. 1.6 Description of the patient Population 2012

CR				
	Total	Cardiac Rehab Referral		P-Value
	n = 122285	Refer n = 92362	Not Refer n = 29923	
age	63.3 ± 13.4	62.7 ± 13.1	65.0 ± 14.1	< 0.001
Male Gender	81201 (66.4%)	62725 (67.9%)	18476 (61.7%)	< 0.001
racecat				< 0.001
1 Caucasian	103641 (84.8%)	79246 (85.8%)	24395 (81.5%)	
2 Af Am	14329 (11.7%)	10308 (11.2%)	4021 (13.4%)	
3 Other	4315 (3.5%)	2808 (3.0%)	1507 (5.0%)	
inscat				< 0.001
1 Private	70170 (57.4%)	54457 (59.0%)	15713 (52.5%)	
2 Medicare	28803 (23.6%)	20205 (21.9%)	8598 (28.7%)	
3 Medicaid	5273 (4.3%)	3713 (4.0%)	1560 (5.2%)	
4 Other	2949 (2.4%)	2192 (2.4%)	757 (2.5%)	
5 None	15090 (12.3%)	11795 (12.8%)	3295 (11.0%)	
smoker	44483 (36.4%)	34869 (37.8%)	9614 (32.1%)	< 0.001
Missing (.)	29	24	5	
Prior PAD	10471 (8.6%)	7561 (8.2%)	2910 (9.7%)	< 0.001
Missing (.)	89	58	31	
Prior CVD	12809 (10.5%)	9090 (9.8%)	3719 (12.4%)	< 0.001
Missing (.)	59	34	25	
Prior PCI	24470 (25.1%)	18713 (24.6%)	5757 (26.7%)	< 0.001
Missing (.)	24776	16442	8334	
Prior MI	23881 (24.5%)	18021 (23.7%)	5860 (27.1%)	< 0.001
Missing (.)	24773	16443	8330	
Prior HF	10256 (10.5%)	6955 (9.2%)	3301 (15.3%)	< 0.001
Missing (.)	24908	16546	8362	
Prior CABG	12791 (13.1%)	9378 (12.4%)	3413 (15.8%)	< 0.001
Missing (.)	24788	16453	8335	
Currently on Dialysis	2603 (2.1%)	1620 (1.8%)	983 (3.3%)	< 0.001
Missing (.)	121	68	53	

CR				
	Total	Cardiac Rehab Referral		P-Value
	n = 122285	Refer n = 92362	Not Refer n = 29923	
Hypertension Missing (.)	87317 (73.1%) 39	65575 (72.1%) 23	21742 (76.5%) 16	< 0.001
Diabetes Missing (.)	38500 (32.3%) 71	28390 (31.2%) 41	10110 (35.6%) 30	< 0.001
Continuous variables compared using Student's T-test. Categorical variables compared using chi-square or Fisher's exact test.				

6. 2a2.1-2a2.4 Level of Reliability

Reliability of the computed measure score was measured as the ratio of signal to noise. The signal in this case is the proportion of the variability in measured performance that can be explained by real differences in physician performance. Reliability at the level of the specific physician is given by:

Reliability = Variance (physician-to-physician) / [Variance (physician-to-physician) + Variance (physician-specific-error)]

Reliability is the ratio of the physician-to-physician variance divided by the sum of the physician-to-physician variance plus the error variance specific to a physician. A reliability of zero implies that all the variability in a measure is attributable to measurement error. A reliability of one implies that all the variability is attributable to real differences in physician performance.

Reliability testing was performed by using a beta-binomial model. The beta-binomial model assumes the physician performance score is a binomial random variable conditional on the physician's true value that comes from the beta distribution. The beta distribution is usually defined by two parameters, alpha and beta. Alpha and beta can be thought of as intermediate calculations to get to the needed variance estimates.

Reliability is estimated five different points: at the minimum number of quality reporting events for the measure; at the mean number of quality reporting events per physician; and at the 25th, 50th and 75th percentiles of the number of quality reporting events.

Data shown below

Level	Signal-to-Noise

All, >10 Procedures	.988
>Q1	.993
>Q2	.995
>Q3	.997
>Average	.996

This measure has excellent reliability when evaluated at the minimum level of quality reporting events and higher reliability at the median number of events (50th percentile), and at average and greater number of quality events.

7. Section 2b3 Exclusions

Patients were only excluded if they died within the admission or were noted as “ineligible” for rehab.

In 2012, of the 141,237 patients that survived discharge with complete data, 18,952 (13.4%) were marked as ineligible. Of the 665 Hospitals that met the minimum procedure requirement (>9) 99 had NO exclusions. Of the remaining 566 hospitals the mean exclusion rate was 16.3%

8. Section 2b5

8.1 2b5.1

Need info here....There are very few differences by patient characteristics.

8.2 2b5.2

A large amount of variability was noted among physicians. In 2012 the range was 0-100% with the inter-quartile range being 47% to 95%. This yielded a Median Rate Ratio of 9.75 (8.49,11.12). The Median Rate Ratio measures the variation between clusters by comparing 2 persons from two randomly chosen different clusters. A MRR of 9.75 indicates a large amount of variation among the clusters.

9. Section 2b7: Missing Data

This missing data rate of our primary variable was extremely low at .59% (n=872)

Comment [KFK1]: Larsen K, Merlo J. Appropriate assessment of neighborhood effects on individual health: integrating random and fixed effects in multilevel logistic regression. Am J Epidemiol. 2005 Jan 1;161(1):81-8. PubMed PMID: 15615918.

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0. Purpose

To describe and quantify the amount of variation in patients having referred to Cardiac Rehab in the CathPCI Registry in 2012

1. Section 1b.2

1.1: Quarterly Rates

CR										
	Total	timeframe								P-Value
	n = 1239643	2011Q1 n = 155758	2011Q2 n = 160182	2011Q3 n = 150383	2011Q4 n = 150222	2012Q1 n = 160470	2012Q2 n = 157748	2012Q3 n = 153750	2012Q4 n = 151130	
Cardiac Rehabilitation Referral	751418 (60.6%)	91978 (59.1%)	95081 (59.4%)	90458 (60.2%)	90789 (60.4%)	98217 (61.2%)	97234 (61.6%)	94487 (61.5%)	93174 (61.7%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.										

1.2 Descriptive Statistics at hospital level (Hospitals with 10 or more eligible patients)

2011

Analysis Variable : P Proportion CR Referral							
N	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
1284	0.5790880	0	0.1825848	0.7016373	0.9323594	1.0000000	0.7497746

10 th Percentile	20 th Percentile	30 th Percentile	40 th Percentile	50 th Percentile	60 th Percentile	70 th Percentile	80 th Percentile	90 th Percentile
0.015444	0.089655	0.30233	0.50794	0.70164	0.81661	0.90278	0.95455	0.98374

2012:

Analysis Variable : P Proportion CR Reffer							
N	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
1360	0.5936149	0	0.1774152	0.7233546	0.9422948	1.0000000	0.7648796

By Decile:

10 th Percentile	20 th Percentile	30 th Percentile	40 th Percentile	50 th Percentile	60 th Percentile	70 th Percentile	80 th Percentile	90 th Percentile
0.019311	0.097453	0.33059	0.56213	0.72335	0.84518	0.91913	0.95949	0.98632

1. 1b.4 Disparities

2.0 Distributions by Group (Requires 10 or more of subgroup of interest)

2011:

Obs	label	Number Patients	Number of Sites	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
1	Male	418817	1279	58.14%	0.00%	18.75%	70.70%	93.20%	100.0%	74.45%
2	Female	197457	1253	57.86%	0.00%	18.10%	70.24%	93.22%	100.0%	75.13%
3	PrivateIns	393853	1269	58.42%	0.00%	19.00%	71.69%	93.46%	100.0%	74.46%
4	Medicare	141784	1204	57.02%	0.00%	17.52%	68.15%	92.54%	100.0%	75.02%
5	Medicaid	21708	676	58.52%	0.00%	18.90%	70.00%	94.12%	100.0%	75.22%
6	OtherInsurance	11320	410	58.84%	0.00%	22.22%	69.69%	95.12%	100.0%	72.90%
7	NoInsurance	40918	965	60.31%	0.00%	22.03%	73.33%	94.74%	100.0%	72.70%
8	RaceWhite	540649	1277	58.04%	0.00%	17.85%	70.59%	93.35%	100.0%	75.50%
9	RaceBlack	49280	760	54.57%	0.00%	11.80%	62.26%	92.57%	100.0%	80.77%
10	RaceOther	22476	481	53.37%	0.00%	10.96%	60.87%	91.67%	100.0%	80.71%
11	NonTeachingHosp	306651	780	57.64%	0.00%	16.70%	69.37%	93.30%	100.0%	76.60%
12	TeachingHosp	309852	504	58.32%	0.00%	20.03%	71.36%	93.02%	100.0%	72.99%
13	RuralHosp	74643	223	60.78%	0.00%	23.86%	76.42%	93.70%	100.0%	69.84%
14	SuburbanHosp	188660	460	56.90%	0.00%	15.62%	69.57%	92.13%	100.0%	76.51%
15	UrbanHosp	353200	601	57.62%	0.00%	17.68%	69.27%	93.70%	100.0%	76.02%

2012:

Obs	label	Number Patients	Number of Sites	Mean	Minimum	Lower Quartile	Median	Upper Quartile	Maximum	Quartile Range
1	Male	424404	1356	59.53%	0.00%	17.96%	72.43%	94.48%	100.0%	76.52%
2	Female	198395	1324	59.35%	0.00%	17.61%	71.65%	94.44%	100.0%	76.83%
3	PrivateIns	399823	1353	59.85%	0.00%	18.28%	73.33%	94.58%	100.0%	76.30%
4	Medicare	140152	1274	58.26%	0.00%	16.67%	69.43%	93.75%	100.0%	77.08%
5	Medicaid	20965	712	58.95%	0.00%	20.00%	70.00%	94.12%	100.0%	74.12%
6	OtherInsurance	11382	423	61.22%	0.00%	22.50%	75.00%	94.87%	100.0%	72.37%
7	NoInsurance	43446	1041	62.26%	0.00%	27.27%	75.00%	95.79%	100.0%	68.52%
8	RaceWhite	542831	1358	59.38%	0.00%	16.88%	72.35%	94.08%	100.0%	77.21%
9	RaceBlack	50455	803	57.24%	0.00%	16.00%	68.18%	93.55%	100.0%	77.55%
10	RaceOther	25315	510	55.69%	0.00%	13.33%	66.67%	93.33%	100.0%	80.00%
11	NonTeachingHosp	312720	838	58.58%	0.00%	15.13%	72.33%	94.05%	100.0%	78.92%
12	TeachingHosp	310333	522	60.62%	0.00%	24.13%	72.34%	94.34%	100.0%	70.21%
13	RuralHosp	81081	250	61.94%	0.00%	23.33%	76.97%	94.58%	100.0%	71.24%
14	SuburbanHosp	190613	489	58.10%	0.00%	16.09%	72.00%	94.15%	100.0%	78.05%
15	UrbanHosp	351359	621	59.32%	0.00%	17.93%	71.73%	94.00%	100.0%	76.07%

2.1: Disparities by Gender

	Total	Sex		P-Value
	n = 623098	Male n = 424459	Female n = 198639	
C Rehab				
Cardiac Rehabilitation Referral	383112 (61.49%)	261946 (61.71%)	121166 (61.00%)	< 0.001
Continuous variables compared using Student's T-test. Categorical variables compared using chi-square or Fisher's exact test.				

2.2: Disparities by Race

	Total	racecat			P-Value
	n = 623098	1 Caucasian n = 542871	2 Af Am n = 52261	3 Other n = 27966	
C Rehab					
Cardiac Rehabilitation Referral	383112 (61.49%)	340224 (62.67%)	29994 (57.39%)	12894 (46.11%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.					

2.3: Disparities by Insurance

	Total	inscat					P-Value
	n = 623098	1 Private n = 399887	2 Medicare n = 140623	3 Medicaid n = 23515	4 Other n = 14177	5 None n = 44896	
C Rehab							
Cardiac Rehabilitation Referral	383112 (61.49%)	249706 (62.44%)	82008 (58.32%)	13741 (58.44%)	8689 (61.29%)	28968 (64.52%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.							

2.4: Disparities by Hospital Teaching status

	Total	Teaching Hospital		P-Value
	n = 623098	1 n = 310334	0 n = 312764	
C Rehab				
Cardiac Rehabilitation Referral	383112 (61.49%)	191840 (61.82%)	191272 (61.16%)	< 0.001
Continuous variables compared using Student's T-test. Categorical variables compared using chi-square or Fisher's exact test.				

2.5: Disparities by Hospital Community

	Total	Hospital Location			P-Value
	n = 623098	RURAL n = 81090	SUBURBAN n = 190630	URBAN n = 351378	
C Rehab					
Cardiac Rehabilitation Referral	383112 (61.49%)	51938 (64.05%)	118013 (61.91%)	213161 (60.66%)	< 0.001
Continuous variables compared using one-way analysis of variance. Categorical variables compared using chi-square or Fisher's exact test.					

3. 1.3 Dates

The primary analysis include patients in the ACTION registry 1/1/2012—12/31/2012, we also used data from 1/1/2011—12/31/2011 as temporal comparisons

4. 1.5 Description of sites (all sites in 2012)

	Total n = 1371
AUC	
Hospital Location	
RURAL	252 (18.4%)
SUBURBAN	493 (36.0%)
URBAN	626 (45.7%)
Participant Type	
GOVERNMENT	21 (1.5%)
PRIVATE/COMMUNITY	1236 (90.2%)
UNIVERSITY	114 (8.3%)
Teaching Hospital	523 (38.1%)

	Total
	n = 1371
Public Hospital	496 (36.2%)
Census Region	
MIDWEST REGION	395 (28.8%)
NORTHEAST REGION	182 (13.3%)
SOUTH REGION	525 (38.3%)
WEST REGION	268 (19.6%)
Missing	1

5. 1.6 Description of the patient Population

Rehab				
	Total	Cardiac Rehabilitation Referral		P-Value
	n = 623098	Yes n = 383112	No n = 239986	
History				
Age	64.6 ± 12.0	64.3 ± 12.0	65.1 ± 12.0	< 0.001
Sex				< 0.001
Male	424459 (68.1%)	261946 (68.4%)	162513 (67.7%)	
Female	198639 (31.9%)	121166 (31.6%)	77473 (32.3%)	
IABP	12198 (2.0%)	7705 (2.0%)	4493 (1.9%)	< 0.001
Missing (.)	164	85	79	
Current/Recent Smoker (w/in 1 year)	172783 (27.7%)	110266 (28.8%)	62517 (26.1%)	< 0.001
Missing (.)	351	195	156	
Hypertension	512238 (82.2%)	311186 (81.3%)	201052 (83.8%)	< 0.001
Missing (.)	199	129	70	

Rehab				
	Total	Cardiac Rehabilitation Referral		P-Value
	n = 623098	Yes n = 383112	No n = 239986	
Dyslipidemia Missing (.)	489637 (78.7%) 595	299362 (78.2%) 373	190275 (79.4%) 222	< 0.001
Family History of Premature CAD Missing (.)	155296 (24.9%) 246	96057 (25.1%) 141	59239 (24.7%) 105	< 0.001
Prior MI Missing (.)	188626 (30.3%) 160	114869 (30.0%) 80	73757 (30.7%) 80	< 0.001
Prior Heart Failure Missing (.)	74910 (12.0%) 271	44360 (11.6%) 180	30550 (12.7%) 91	< 0.001
Prior Valve Surgery/Procedure Missing (.)	9336 (1.5%) 339	5403 (1.4%) 212	3933 (1.6%) 127	< 0.001
Prior PCI Missing (.)	253945 (40.8%) 154	152328 (39.8%) 68	101617 (42.4%) 86	< 0.001
Prior CABG Missing (.)	111609 (17.9%) 99	67268 (17.6%) 55	44341 (18.5%) 44	< 0.001
Currently on Dialysis Missing (.)	14746 (2.4%) 578	7698 (2.0%) 354	7048 (2.9%) 224	< 0.001
Cerebrovascular Disease Missing (.)	76660 (12.3%) 267	46559 (12.2%) 174	30101 (12.5%) 93	< 0.001
Peripheral Arterial Disease Missing (.)	76367 (12.3%) 267	45187 (11.8%) 175	31180 (13.0%) 92	< 0.001
Chronic Lung Disease Missing (.)	93876 (15.1%) 269	57218 (14.9%) 181	36658 (15.3%) 88	< 0.001
Diabetes Mellitus Missing (.)	231186 (37.1%) 300	138108 (36.1%) 97	93078 (38.8%) 203	< 0.001
Cath Lab Visit				

Rehab				
	Total	Cardiac Rehabilitation Referral		P-Value
	n = 623098	Yes n = 383112	No n = 239986	
PCI Indication				< 0.001
Immediate PCI for STEMI	91297 (14.7%)	63260 (16.5%)	28037 (11.7%)	
PCI for STEMI (Unstable, >12 hrs from Sx onset)	5512 (0.9%)	3630 (0.9%)	1882 (0.8%)	
PCI for STEMI (Stable, >12 hrs from Sx onset)	2621 (0.4%)	1672 (0.4%)	949 (0.4%)	
PCI for STEMI (Stable after successful full-dose Thrombolysis)	2129 (0.3%)	1481 (0.4%)	648 (0.3%)	
Rescue PCI for STEMI (after failed full-dose lytics)	3115 (0.5%)	2308 (0.6%)	807 (0.3%)	
PCI for high risk Non-STEMI or unstable angina	324113 (52.0%)	203550 (53.1%)	120563 (50.3%)	
Staged PCI	43430 (7.0%)	24502 (6.4%)	18928 (7.9%)	
Other	150724 (24.2%)	82636 (21.6%)	68088 (28.4%)	
Missing (.)	157	73	84	
CAD Presentation				< 0.001
No symptom, no angina	38290 (6.1%)	21232 (5.5%)	17058 (7.1%)	
Symptom unlikely to be ischemic	13990 (2.2%)	7734 (2.0%)	6256 (2.6%)	
Stable angina	89099 (14.3%)	49158 (12.8%)	39941 (16.7%)	
Unstable angina	249446 (40.0%)	149336 (39.0%)	100110 (41.7%)	
Non-STEMI	129825 (20.8%)	84659 (22.1%)	45166 (18.8%)	
ST-Elevation MI (STEMI) or equivalent	102284 (16.4%)	70931 (18.5%)	31353 (13.1%)	
Missing (.)	164	62	102	
Anginal Classification w/in 2 Weeks				< 0.001
No symptoms	58945 (9.5%)	32652 (8.5%)	26293 (11.0%)	
CCS I	22585 (3.6%)	11160 (2.9%)	11425 (4.8%)	
CCS II	90921 (14.6%)	49037 (12.8%)	41884 (17.5%)	
CCS III	226193 (36.3%)	140557 (36.7%)	85636 (35.7%)	
CCS IV	223642 (35.9%)	149273 (39.0%)	74369 (31.0%)	
Missing (.)	812	433	379	
Anti-Anginal Medication w/in 2 Weeks	450685 (72.4%)	276280 (72.1%)	174405 (72.7%)	< 0.001
Missing (.)	187	110	77	
Heart Failure w/in 2 Weeks	62229 (10.0%)	37442 (9.8%)	24787 (10.3%)	< 0.001
Missing (.)	264	135	129	
Cardiomyopathy or Left Ventricular Systolic Dysfunction	65458 (10.5%)	40176 (10.5%)	25282 (10.5%)	0.544
Missing (.)	150	87	63	
Pre-operative Evaluation Before Non-Cardiac Surgery	11296 (1.8%)	6354 (1.7%)	4942 (2.1%)	< 0.001
Missing (.)	214	121	93	

Rehab				
	Total	Cardiac Rehabilitation Referral		P-Value
	n = 623098	Yes n = 383112	No n = 239986	
Cardiogenic Shock w/in 24 Hours Missing (.)	8729 (1.4%) 110	5608 (1.5%) 63	3121 (1.3%) 47	< 0.001
Cardiac Arrest w/in 24 Hours Missing (.)	10045 (1.6%) 180	6685 (1.7%) 101	3360 (1.4%) 79	< 0.001
Pre-PCI Left Ventricular Ejection Fraction Missing	52.5 ± 12.3 183357	52.5 ± 12.2 113926	52.6 ± 12.5 69431	0.012
Procedure Information				
Contrast Volume Missing	190.6 ± 87.3 1680	192.0 ± 86.7 966	188.4 ± 88.2 714	< 0.001
Fluoroscopy Time Missing	14.8 ± 11.6 8457	14.6 ± 11.5 5441	15.1 ± 11.8 3016	< 0.001
Outcomes				
Myocardial Infarction (Biomarker Positive) Missing (.)	12321 (2.0%) 195	7092 (1.9%) 122	5229 (2.2%) 73	< 0.001
Cardiogenic Shock Missing (.)	4560 (0.7%) 184	2826 (0.7%) 113	1734 (0.7%) 71	0.496
Heart Failure Missing (.)	5795 (0.9%) 191	3673 (1.0%) 118	2122 (0.9%) 73	0.003
CVA/Stroke Missing (.)	1079 (0.2%) 196	656 (0.2%) 122	423 (0.2%) 74	0.642
Other Vascular Complications Requiring Treatment Missing (.)	2357 (0.4%) 200	1450 (0.4%) 127	907 (0.4%) 73	0.972
RBC/Whole Blood Transfusion Missing (.)	12607 (2.0%) 200	7824 (2.0%) 121	4783 (2.0%) 79	0.180
Continuous variables compared using Student's T-test. Categorical variables compared using chi-square or Fisher's exact test.				

6. 2a2.1-2a2.4 Level of Reliability

Reliability of the computed measure score was measured as the ratio of signal to noise. The signal in this case is the proportion of the variability in measured performance that can be explained by real differences in physician performance. Reliability at the level of the specific physician is given by:

Reliability = Variance (physician-to-physician) / [Variance (physician-to-physician) + Variance (physician-specific-error)]

Reliability is the ratio of the physician-to-physician variance divided by the sum of the physician-to-physician variance plus the error variance specific to a physician. A reliability of zero implies that all the variability in a measure is attributable to measurement error. A reliability of one implies that all the variability is attributable to real differences in physician performance.

Reliability testing was performed by using a beta-binomial model. The beta-binomial model assumes the physician performance score is a binomial random variable conditional on the physician's true value that comes from the beta distribution. The beta distribution is usually defined by two parameters, alpha and beta. Alpha and beta can be thought of as intermediate calculations to get to the needed variance estimates.

Reliability is estimated five different points: at the minimum number of quality reporting events for the measure; at the mean number of quality reporting events per physician; and at the 25th, 50th and 75th percentiles of the number of quality reporting events.

Data shown below

Level	Signal-to-Noise 2012
All, >10 Procedures	.996
>Q1	.998
>Q2	.999
>Q3	.999
>Average	.999

This measure has excellent reliability when evaluated at the minimum level of quality reporting events and higher reliability at the median number of events (50th percentile), and at average and greater number of quality events.

7. Section 2b3 Exclusions

Patients were only excluded if they died within the admission or were noted as “ineligible” for rehab.

In 2012, of the 650928 PCI's that survived discharge with complete data, 27830 (4.28%) were marked as ineligible or missing. Of the 1360 Hospitals that met the minimum procedure requirement (>9) 955 had NO exclusions. Of the remaining 405 hospitals the mean exclusion rate was 6.4%

8. Section 2b5

8.1 2b5.1

Need lingo here....There are very few differences by patient characteristics.

8.2 2b5.2

A large amount of variability was noted among physicians. In 2012 the range was 0-100% with the inter-quartile range being 17.7% to 94.2%. This yielded a Median Odds Ratio of 17.6 (16.5,18.8) The Median Odds Ratio measures the variation between clusters by comparing 2 persons from two randomly chosen different clusters. A MOR of 17.6 indicates a large amount of variation among the clusters.

Comment [KFK1]: Larsen K, Merlo J. Appropriate assessment of neighborhood effects on individual health: integrating random and fixed effects in multilevel logistic regression. Am J Epidemiol. 2005 Jan 1;161(1):81-8. PubMed PMID: 15615918.

9. Section 2b7: Missing Data

This missing data rate of our primary variable was extremely low in 2012 at .14% (n=931)



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**AACVPR/ACCF/AHA
Testing Project Data Collection Form
Cohort-Inpatient**

*Please track the amount of time taken to perform data abstraction and report at the end of the form. Provide information for the index hospitalization. Referral must be noted within the time of the index hospitalization.

Hospital ID¹⁵²⁰:

Subject ID¹⁵⁰⁰:

Provider NPI¹⁵⁵⁰:

A. PATIENT DEMOGRAPHICS

Sex²⁰⁶⁰: ☐ Male ☐ Female

Age at discharge²⁰⁵⁰: _____

Race: (Check all that apply)

- ☐ White²⁰⁷⁰ ☐ Black/African American²⁰⁷¹ ☐ Asian²⁰⁷²
☐ American Indian/Alaska Native²⁰⁷³ ☐ Native Hawaiian/Pacific Islander²⁰⁷⁴ ☐ Hispanic or Latino Ethnicity²⁰⁷⁶

B. QUALIFYING CARDIAC DIAGNOSES/EVENTS THAT QUALIFY PATIENT FOR CARDIAC REHAB ABSTRACTION: (If more than 1 event within 30 calendar days, check multiple events/diagnoses)

- ☐ Myocardial Infarction⁵⁰⁰⁰ ☐ PCI - Stent⁵⁰¹⁵
☐ Coronary Artery Bypass Graft⁵⁰¹⁰ ☐ PCI - Other (non-stent) Intervention⁵⁰³⁵
☐ Cardiac Valve Surgery⁵⁰²⁰ ☐ Stable Angina⁴⁰⁵⁵
☐ Heart Transplantation⁵⁰³⁰ ☐ No Qualifying Event/Diagnosis Identified (if checked, then form is complete)⁵⁰⁴⁰

C. CARDIAC REHAB REFERRAL STATUS FOR HOSPITALIZATION EVENT (IF MORE THAN 1 EVENT IS CHECKED IN ITEM B, USE THE EVENT WHICH OCCURRED FIRST DURING THE INDEX HOSPITALIZATION)

If Alive, Cardiac Rehab Referral⁵⁰³⁰:

- ☐ Yes, documentation that patient was referred to CR for this event/diagnosis (if checked, please complete section D)
☐ No, referral not documented, but medical exception documented for this qualifying event/diagnosis (if checked, please skip to section E)
☐ No, referral not documented, but patient exception documented for this qualifying event/diagnosis (if checked, please skip to section E)
☐ No, referral not documented, but health care system exception documented for this qualifying event/diagnosis (if checked, please skip to section E)
☐ No, referral not documented and no exceptions documented (if checked, please skip to section E)

Exception Reason
(Describe): _____

D. COMMUNICATION OF CARDIAC REHAB REFERRAL: (Check all that apply)

- ☐ Documentation (written/electronic) that the necessary CR referral information was given to patient
☐ Documentation (written/electronic) that receiving CR site was sent patient's referral information

E. DATA COLLECTION CHALLENGES/GENERAL FEEDBACK

What data collection challenges or other comments did you encounter/have (any feedback on the specifics of this record would be appreciated)?:

Total time taken: _____ mins

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Reliability of Abstracting Performance Measures: Results of the Cardiac Rehabilitation Referral and Reliability (CR3) Project

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Abstract:	<p>Background: Assessment of the reliability of performance measure (PM) abstraction is an important step in PM validation. Reliability has not been previously assessed for abstracting PM's for the referral of patients to cardiac rehabilitation and secondary prevention (CR/SP) programs. To help validate these PM's, we carried out a multicenter assessment of their reliability.</p> <p>Methods and Results: Hospitals and clinical practices from around the U.S. were invited to participate in the CR3 Project. Twenty-nine hospitals and 23 outpatient centers expressed interest in participating. Seven hospitals and 6 outpatient centers met participation criteria and submitted completed data. Site coordinators identified 35 patients whose charts were reviewed by 2 site abstractors twice, one week apart. Percent agreement and Cohen's kappa statistic were used to describe intra- and inter-abstractor reliability for patient eligibility for CR/SP, patient exceptions for CR/SP referral, and documented referral to CR/SP. Results were obtained from within-site data, as well as from pooled data of all inpatient and all outpatient sites.</p> <p>We found that intra-abstractor reliability reflected excellent repeatability ($\geq 90\%$)</p>

	<p>agreement, $\kappa \geq 0.75$) for ratings of CR/SP eligibility, exceptions, and referral, both from pooled and site-specific analyses of inpatient and outpatient data. Similarly, the inter-abstractor agreement from pooled analysis ranged from good to excellent for the three items, although with slightly lower measures of reliability.</p> <p>Conclusions: Abstraction of PM's for CR/SP referral has high reliability, supporting the use of these PM's in quality improvement initiatives aimed at increasing CR/SP delivery to patients with cardiovascular disease.</p>
Response to Reviewers:	<p>We have made the changes in the title page, added the condensed abstract, and reformed the citations in the manuscript, as requested.</p>

**Reliability of Abstracting Performance Measures:
Results of the Cardiac Rehabilitation Referral and Reliability (CR3) Project**

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STRUCTURED ABSTRACT

BACKGROUND: Assessment of the reliability of performance measure (PM) abstraction is an important step in PM validation. Reliability has not been previously assessed for abstracting PMs for the referral of patients to cardiac rehabilitation and secondary prevention (CR/SP) programs. To help validate these PMs, we carried out a multicenter assessment of their reliability.

METHODS: Hospitals and clinical practices from around the U.S. were invited to participate in the CR3 Project. Twenty-nine hospitals and 23 outpatient centers expressed interest in participating. Seven hospitals and 6 outpatient centers met participation criteria and submitted completed data. Site coordinators identified 35 patients whose charts were reviewed by 2 site abstractors twice, 1 week apart. Percent agreement and Cohen's kappa statistic were used to describe intra- and inter-abtractor reliability for patient eligibility for CR/SP, patient exceptions for CR/SP referral, and documented referral to CR/SP.

RESULTS: Results were obtained from within-site data, as well as from pooled data of all inpatient and all outpatient sites. We found that intra-abtractor reliability reflected excellent repeatability ($\geq 90\%$ agreement, $\kappa \geq 0.75$) for ratings of CR/SP eligibility, exceptions, and referral, both from pooled and site-specific analyses of inpatient and outpatient data. Similarly, the inter-abtractor agreement from pooled analysis ranged from good to excellent for the 3 items, although with slightly lower measures of reliability.

CONCLUSIONS: Abstraction of PMs for CR/SP referral has high reliability, supporting the use of these PMs in quality improvement initiatives aimed at increasing CR/SP delivery to patients with cardiovascular disease.

CONDENSED ABSTRACT

We carried out a multicenter assessment of the reliability of abstracting cardiac rehabilitation (CR) referral performance measures (PM), an important step in PM validation. Intra- and inter-abstractor reliability was good to excellent, providing support for the use of these PMs in quality improvement initiatives aimed at increasing CR delivery.

Cardiac rehabilitation and secondary prevention (CR/SP) services are significantly associated with positive health outcomes in a variety of patients with cardiac disorders¹⁻⁷ yet only a minority of eligible patients ever participate in CR/SP.⁸⁻¹⁰ The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), American College of Cardiology Foundation (ACCF), and American Heart Association (AHA)¹¹ have developed, and the National Quality Forum (NQF) has endorsed, performance measures (PM's) for CR/SP referral to increase the delivery of CR/SP to appropriate patients (see Table 1).¹²⁻¹⁷ In addition, the Centers for Medicare and Medicaid Services (CMS) has included these measures in the Physician Quality Reporting System, and will begin reporting audits of these PMs in the outpatient setting in 2015.

Assessment of the reliability of data collection for performance measurement is an important step included in the ACCF/AHA methodology for the development and identification of high-value performance measures.^{18,19} However, to our knowledge, no studies have been published that have evaluated the reliability of collecting CR/SP performance measures. To address this need, and to respond to NQF requirements to provide such data as part of their endorsement process, we carried out a multi-site study, the Cardiac Rehabilitation Referral Reliability (CR3) Project, aimed at analyzing the reliability of abstracting the CR/SP PMs from inpatient and outpatient records.

METHODS

Hospitals and outpatient cardiology practices in the United States were identified from the ACCF, AHA, and AACVPR databases and were invited to participate. We sought a variety of hospitals and clinics, based on different geographical locations, community sizes, and

hospital/practice types/sizes (Figure 1). All 540 outpatient cardiology practices that were members of the ACCF outpatient quality and outcomes data registry (known as the PINNACLE network) as of October 1, 2011 were invited by email to participate in the CR3 Project as outpatient sites. The PINNACLE Network helps cardiovascular teams achieve practice success through quality measurement, performance improvement, and peer-to-peer learning through an interactive community that connects practices across the country. In addition, an invitation to participate in the CR3 Project as an inpatient and/or an outpatient site was sent by email to 2916 members of AACVPR, and targeted invitations were sent to 5 Board members, 6 Past Presidents, and 11 Committee Chairs of AACVPR, as well as to the CR/SP programs that were participating in the Wisconsin State Cardiac Rehabilitation Registry (70 centers) and the Montana State Cardiac Rehabilitation Registry (145 programs). Twenty-nine hospitals and 23 outpatient practices responded, expressing interest in participating in the project.

Based on available resources to carry out the CR3 Project, we initially planned to include a maximum of 12 sites in the project, with varied geographical locations and center characteristics. An additional site was added since it was able to participate without the need for CR3 Project resources, resulting in a total of 7 inpatient and 6 outpatient practices that participated in the project. Inclusion criteria included a willingness to participate, and ability to: (1) provide a study coordinator and 2 separate chart abstractors, (2) complete the project within the specified timeline, and (3) obtain local IRB clearance to carry out the project in their setting. Once each hospital and practice completed and submitted their required data, they were sent a small incentive as a token of appreciation for their participation and submission of complete project data from their site (\$200 gift card). Completed data were received from 7 hospitals and 6 outpatient cardiology practices.

Chart Abstraction

For inpatient facilities, charts of patients who had an index hospitalization (ie, a hospitalization for a cardiac event that is a qualifying diagnosis or procedure for CR/SP) between August 1, 2009 and August 1st 2010 were eligible for review and inclusion. For outpatient centers, charts of patients who had an outpatient visit between August 1, 2009 and August 1, 2010 were eligible for review and inclusion. However, since the performance measure allows as long as 12 months for a patient to complete CR/SP following a qualifying cardiac event, chart abstraction included a search for a qualifying cardiac event between August 1, 2009 and August 1, 2010, along with a search of records for up to 12 months after the cardiac event, to search for documentation of CR/SP referral during that time period.

Study sites designated 1 study coordinator and 2 chart abstractors. Each study coordinator identified 35 patients from a consecutive sample of patients: 30 patients with an eligible diagnosis for CR/SP referral, and 5 without an eligible diagnosis for CR/SP (see below for additional details). The 2 abstractors at each site reviewed the same 35 patient records that had been selected from their site twice (once at baseline, and again 1 week later). Abstractors had a range of experience reviewing charts, from less than 1 month to greater than 5 years.

Abstractors were blinded as to which patients in their sample had a qualifying diagnosis and which patients had exceptions for CR/SP. Only the site coordinator, who did not participate in the abstraction process, had access to this information. Patients considered to have qualifying events for CR/SP, as defined by CMS and therefore as specified in the performance measure, had 1 or more of the following: myocardial infarction, percutaneous coronary intervention, coronary artery bypass graft surgery, heart valve surgery, heart transplantation surgery, and chronic stable angina. Patients without a qualifying event, for the purpose of this abstraction project, were to

have had documented 1 or more of the following diagnoses that are not currently considered by CMS to be a covered indication for CR/SP:

- *For inpatient centers:* atrial fibrillation, heart failure, or syncope during the index hospitalization period under review (with no documented qualifying events for CR during that same hospitalization)
- *For outpatient centers:* atypical chest pain, palpitations, or dyspnea during the 12 months prior to the index outpatient visit (with no documented qualifying events for CR referral during that same time period).

The CR3 Project workgroup created chart abstraction forms, site coordinator instructions, abstractor instructions, a frequently asked questions document, and site tracking forms to allow the study coordinator to track and report site specific results for intra-abstractor (1 abstractor reviewing the chart 2 times) and inter-abstractor (2 abstractors reviewing 1 chart) reliability. The workgroup held a kickoff call with each center's study coordinator to train them prior to the start of the CR3 project. Thereafter, the workgroup communicated weekly with site coordinators to address any questions or operational concerns that arose. The training of site coordinators was carried out during 1-2 one-hour conference calls prior to starting the project. When coordinators had questions, they contacted the staff liaison to the CR3 working group directly by email or telephone. New questions and their corresponding answers were communicated weekly to all site coordinators. The entire project took approximately 20 weeks to complete (October 2011 through February 2012).

Definitions

The following definitions were developed for use in the study:

Eligible patients for CR/SP referral:

- Inpatient: a patient who survived the index hospitalization and who had a qualifying event/diagnosis for referral to CR/SP during the index hospitalization period under review.
- Outpatient: a patient who had a qualifying event/diagnosis for referral to CR/SP within the previous 12 months prior to the index outpatient visit.

Patients not eligible for CR/SP referral:

- Inpatient: a patient who had a cardiac event/diagnosis (atrial fibrillation, heart failure, or syncope for purposes of this study) during the index hospitalization period under review and no indication for CR/SP referral as specified in the performance measure.
- Outpatient: a patient who had a cardiac event/diagnosis (atypical chest pain, palpitations, or dyspnea for purposes of this study) during the 12 months prior to the index outpatient visit, and no indication for CR/SP referral as specified in the performance measure.

CR/SP referral:

- Inpatient: documentation in a patient's hospital medical records that the patient was referred to an outpatient CR/SP program.
- Outpatient: documentation in a patient's outpatient clinical medical records that the patient has been referred to an outpatient CR/SP program within 12 months after a qualifying event/diagnosis.

For purposes of this project, documentation in the medical record could include any of the following sources: hospital discharge summaries, office notes, clinical notes and medical records, orders (written/electronic), prescriptions (eg, contact information for CR/SP specialist), or other parts of the clinical record that documents patient information.

Exceptions

Because there are valid reasons why certain patients should not be referred to a CR/SP program, exceptions to the CR/SP measures are allowed. When a clinician is allowed to document exceptions he or she is given the flexibility to decide whether or not to institute a given intervention/process depending upon the overall benefits and risks to the patient. Exceptions allow clinicians this flexibility without the threat of being “penalized” for not referring a patient to CR/SP. Without the presence of exceptions, potential negative unintended consequences could arise such as forcing CR/SP on patients who are unstable. Furthermore, analysis of exception rates for quality improvement purposes allows providers and health systems to test the effects of process changes within their practices and communities that may facilitate CR/SP referral. Relatively few patients would be expected to qualify for an exception to CR/SP referral. Such exceptions would generally be limited to factors that may make CR/SP unsafe, ineffective, or lack of accessibility to a CR/SP program within a reasonable commuting distance.

Such exceptions would generally be limited to factors that may make CR/SP unsafe or ineffective, or that otherwise prohibit access to a CR/SP program. Examples of exceptions from referral to CR/SP include:

- Patient exceptions (eg, patient resides in a long-term nursing care facility)
- Medical exceptions (eg, presence of an acute medical condition that makes the patient unstable and unsafe for exercise training)
- System exceptions (eg, lack of an available CR/SP program within 60 minutes of travel time from the patient’s home)

Since the measures look only at whether patients were referred, not whether they enrolled, patient refusal was not considered to be an exception. If a healthcare provider recommended

CR/SP referral to a patient, the patient refused the referral, and the provider documented the patient refusal, then that encounter was judged to have met the performance measure since the provider complied with the expectation to recommend referral to CR/SP.

Data Analyses

Both Cohen's kappa (κ) statistic and percent agreement were used to measure the intra-abtractor and inter-abtractor reliability for the following qualitative ratings: (1) documented eligibility for CR/SP referral, (2) exception documented for CR/SP referral, and (3) documentation of CR/SP referral. The κ statistic is a chance-corrected index of agreement ranging from -1 to 1, with $\kappa < 0$ representing observed agreement worse than that due to chance alone. We interpreted a κ over 0.75 as excellent, 0.40 to 0.75 as fair to good, and below 0.40 as poor, following the guidelines of Fleiss et al.²⁰ Unlike the κ statistic, percent agreement does not take into account the agreement occurring by chance, but can be informative in situations for which the prevalence of a given response is very high or low and the interpretation based solely on the value of κ may be misleading. This phenomenon known as the kappa paradox^{21,22} occurs when the observed proportion of agreement is high but the value of the κ statistic is low.

For brevity, intra-abtractor reliability is reported for only 1 of the 2 abstractors (arbitrarily-designated "abstractor 1" at each site), and inter-abtractor reliability only for the initial set of ratings (ie, "time 1"). Stratifying on inpatient vs. outpatient setting, reliability was analyzed 1) on the overall group with sites pooled together, and 2) within sites and summarizing the site-specific results across the overall group. All analyses were performed using the SAS statistical software package (version 9.2, SAS Institute Inc., Cary, NC).

RESULTS

Characteristics of the 234 inpatients and 211 outpatients (total 445) included in the CR3 Project are shown in Table 2. The majority of patients from both inpatient and outpatient sites were male, white, and younger than 65 years of age. A total of 1746 chart reviews were performed for the CR3 Project (415 (93%) of the total 445 patient charts were reviewed as specified in the CR3 Project protocol, each 1 being reviewed 4 times (2 by each abstractor), while incomplete reporting of data resulted in 26 that were reviewed only 3 times each, and 4 that were each reviewed only twice).

Participating centers represented a variety of practice types and settings, including the following: Rural, suburban, or urban area locations; teaching and non-teaching centers; and single specialty and multispecialty centers. One hospital was from the Pacific Northwest, 4 from the Midwest, 1 from the Northeast, and 1 from the Southeast. Three inpatient centers used paper medical records, 5 used electronic medical records, and 2 used both. Outpatient clinics in the CR3 Project were located throughout the Midwest and in the Southeastern part of the United States. Two outpatient clinics used paper medical records and 4 used electronic medical records, while none used both.

Site abstractors involved in the CR3 Project had varying degrees of experience with chart abstraction prior to participating in the project, with 54% of abstractors having 2 years of experience or less and 23% having less than one month of experience. Among the 13 inpatient and outpatient sites, the pair of abstractors had similar levels of experience at 11 sites).

Excluding the 2 sites in which the pairs of abstractors had discordant levels of experience, we found that ratings of CR/SP eligibility, exceptions, and referral were not more reliable from abstractors having more than 2 years of experience. Interestingly, some of these ratings reflected

more favorable reliability in abstractors having less than 2 years of experience (data not shown).

In addition, we did not find a difference between the reliability of the first abstractions and the second abstractions, suggesting that there was no “learning effect” among abstractors. The mean \pm SD time per chart abstraction, reported by abstractors was 4.9 ± 3.2 minutes for inpatient abstractions and 6.8 ± 4.7 minutes for outpatient abstractions.

Reliability Outcomes

Inpatient Sites (Table 3)

Intra-abstractor reliability analysis of pooled inpatient data demonstrated excellent repeatability for ratings of CR/SP eligibility (100% agreement, $\kappa = 1.00$), CR/SP exceptions (96% agreement, $\kappa = 0.76$), and CR/SP referral (98% agreement, $\kappa = 0.95$). Based on site-specific inpatient data, each of the three CR/SP items showed high percent agreement ($\geq 90\%$) at all sites, and excellent repeatability ($\kappa \geq 0.75$) in the majority of sites (100% of sites for patient eligibility, 67% for patient exceptions, and 80% for patient referral).

Pooled analysis of inpatient sites demonstrated excellent inter-abstractor reliability analysis for ratings of CR/SP eligibility (94% agreement, $\kappa = 0.77$) and CR/SP exceptions (97% agreement, $\kappa = 0.79$), and modest agreement between abstractors for rating CR/SP referral (86% agreement, $\kappa = 0.70$). Consistent with the pooled results, site-specific analyses demonstrated excellent inter-abstractor reliability (as measured by $\kappa \geq 0.75$) in the majority of inpatient sites for ratings of eligibility (71% of sites) and exceptions (67% of sites), but in less than half (40%) of sites for the rating of CR/SP referral.

Outpatient Sites (Table 3)

Pooled analyses of the 6 outpatient sites demonstrated excellent intra-abstractor reliability for the 3 ratings of CR/SP eligibility, exceptions, and referral (agreement $\geq 95\%$, $\kappa \geq 0.88$). From site-specific analysis of intra-abstractor reliability, percent agreement $\geq 90\%$ was observed in all 6 sites for ratings of CR/SP eligibility and exceptions, and in all but 1 site for rating of CR/SP referral. Likewise, excellent repeatability ($\kappa \geq 0.75$) was demonstrated in the majority of outpatient sites (100% of sites for rating of eligibility, 67% for exceptions, and 67% for referral).

Regarding inter-abstractor reliability for outpatient sites, pooled analyses reflected excellent agreement between abstractors for ratings of both CR/SP eligibility ($\kappa = 0.78$) and CR/SP referral ($\kappa = 0.80$), and poor to fair agreement in rating patient exceptions for CR/SP referral ($\kappa = 0.43$). Similarly, according to site-specific results, excellent inter-abstractor reliability was observed in most (two-thirds) of the outpatient sites for rating CR/SP eligibility, and in none of the sites for rating CR/SP exceptions. Interestingly, despite excellent inter-abstractor agreement for rating CR/SP referral obtained from pooled analysis, site-specific results varied considerably (range of κ across six sites, -0.07 to 1.00), with excellent reliability seen in only one-third of outpatient sites (and percent agreement below 90% in half the sites).

DISCUSSION

This study demonstrates high reliability for assessing CR/SP eligibility, referral, and exceptions using the CR/SP outpatient and inpatient performance measures. Data abstraction of patient records was performed by abstractors with varying amounts of abstraction experience at a variety of inpatient and outpatient centers, suggesting generalizability of our findings.

Reliability testing is one of 3 important steps in developing high value PMs, as outlined by the ACCF/AHA Task Force on Performance Measures.¹⁹ The 3 steps include: (1) construction of the measurement set, (2) assessment of feasibility and reliability of data collection, and (3) measurement of clinician performance. Construction of the CR/SP PM set has previously been reported.¹²⁻¹⁷

Our testing generally found high reliability for comparisons between abstractors for the 3 key components of the CR/SP PM's: patient eligibility for CR/SP, patient exceptions to CR/SP referral, and patient referral to CR/SP. We included 2 measures of reliability, each shedding important light on the reliability of PM abstraction: percent agreement and the kappa statistic. "Percent agreement" is a helpful assessment of reliability, but given that over 80% of patients in the study sample were eligible for CR/SP, and more than 90% of patients were absent exceptions to CR/SP participation, the percent agreement may have been somewhat inflated, since by chance alone abstractors may have chosen the correct eligibility or exception status.

Conversely, the kappa statistic performs best when there is nearly equal chance of study outcomes. When there is a high likelihood of one of the 2 outcomes, as in our study (high likelihood of CR/SP eligibility), the results of the kappa analyses can underestimate true reliability due to a phenomenon known as the "kappa score paradox" in which there is high percent agreement, yet a low kappa score.^{21,22} Indeed, we observed this paradox in some centers. The true reliability of abstracting our PMs most likely lies between the results from the 2 methods of assessment we used. Since the "percent agreement" method generally suggests very high reliability of the CR/SP measures and the kappa statistic generally suggests moderate to high reliability, the true reliability of the CR/SP performance measure would appear overall to be high.

Data abstractors reported that data abstraction time was modest for the inpatient (4.9 minutes) and outpatient (6.8 minutes) CR/SP PMs, and reported minimal barriers to their abstraction activities. If the CR/SP PMs are included in sets of other PMs, such as the PM set for CABG surgery, for example, it is likely that efficiencies of scale will result in less time being required for the CR/SP PM assessment.

Limitations

We selected participating centers to reflect variation in the location, size, and type of centers. However, our study is based on the experience of a relatively small number of centers from around the United States that volunteered to be in the project and may not be representative other centers from different regions.

Lessons Learned

Outpatient abstraction of the CR/SP performance measure data was more time-consuming and somewhat less reliable than the abstraction of inpatient data. This is explained in large part by the fact that the review of inpatient data is limited to the time of the patient index hospitalization (ie, the time of the cardiac event that qualified them for CR/SP). Review of outpatient data is broader, including a review of records for up to 12 months previous to the outpatient visit and also a review of records for up to 12 month after the outpatient visit, due to the fact that patients are eligible for CR/SP for up to 12 months following their qualifying cardiac event.

Future Directions

Healthcare provider education through effective communication channels is critically important to help providers understand and document appropriate exceptions to CR/SP referral, as well as the key components of CR/SP referral documentation: 1) that the patient has been referred to CR/SP, 2) that the patient has been given information and guidance to help them enroll in CR/SP, and 3) that the receiving CR/SP program has been sent patient information to expedite CR/SP enrollment).

Current practices and existing ACCF and AHA registries only require documentation that the patient has been referred to a CR/SP program. Published evidence suggests that the use of additional communication components, as specified in the measures, may increase the predictive validity of the measures.²³ Going forward, with the advent of better data collection systems for CR/SP referral and the ability now to track CR/SP enrollment through the AACVPR Outpatient Cardiac Rehabilitation Registry, we expect to be able to test the hypothesis that this more detailed definition of CR/SP referral will increase enrollment in CR/SP. Furthermore, computerized decision support, made more widely available through efforts to enhance the meaningful use of electronic health records, may also provide value by increasing the ability to track and improve the appropriate utilization of CR/SP.

Reliability of CR/SP performance measure abstraction is high. Data abstractors reported minimal barriers to the abstraction process and required a relatively small amount of time per patient to carry out the abstractions. These results contribute to published evidence regarding the soundness and generalizability of the CR/SP PMs. Further work will need to be carried out to assess the impact of the CR/SP PMs on patient referral rates and patient outcomes.

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Table 1: AACVPR/ACCF/AHA performance measures for referral to a cardiac rehabilitation program from an inpatient (A) and outpatient (B) setting^{12,15}

A: Performance measure for referral to a cardiac rehabilitation program from an inpatient setting

Component	Details
Performance Measure	All patients hospitalized with a primary diagnosis of an acute myocardial infarction or chronic stable angina, or who during hospitalization have undergone coronary artery bypass graft surgery, a percutaneous coronary intervention, cardiac valve surgery, or cardiac transplantation are to be referred to an early outpatient cardiac rehabilitation/secondary prevention program.
Numerator	Number of eligible patients with a qualifying event/diagnosis who have been referred to an outpatient cardiac rehabilitation program prior to hospital discharge or have a documented medical or patient-centered reason why such a referral was not made
Denominator	Number of hospitalized patients in the reporting period hospitalized with a qualifying event/diagnosis who do not meet any of the exception criteria
Exceptions	1. Patient-oriented factors (patient discharged to a nursing care facility for long-term care, for example) 2. Medical factors (patient deemed to have a medically unstable, life-threatening condition, for example) 3. Healthcare system factors (lack of cardiac rehabilitation program near a patient's home, for example)

B: Performance measure for referral to a cardiac rehabilitation program from an outpatient setting

Component	Details
Performance Measure	All patients evaluated in an outpatient setting who within the past 12 months have experienced an acute myocardial infarction, coronary artery bypass graft surgery, a percutaneous coronary intervention, cardiac valve surgery, or cardiac transplantation, or who have chronic stable angina and have not already participated in an early outpatient cardiac rehabilitation/secondary prevention program for the qualifying event/diagnosis are to be referred to such a program.
Numerator	Number of patients in an outpatient clinical practice who have had a qualifying event/diagnosis during the previous 12 months, who have been referred to an outpatient cardiac rehabilitation program
Denominator	Number of patients in an outpatient clinical practice who have had a qualifying event/diagnosis during the previous 12 months and who do not meet any of the exception criteria, and who have not already participated in an outpatient cardiac rehabilitation program since the qualifying event.
Exceptions	1. Patient oriented factors (patient discharged to a nursing care facility for long-term care, for example) 2. Medical factors (patient deemed to have a medically unstable, life-threatening condition, for example) 3. Healthcare system factors (lack of cardiac rehabilitation program near a patient's home, for example)

Abbreviations: AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; ACCF, American College of Cardiology Foundation; AHA, American Heart Association

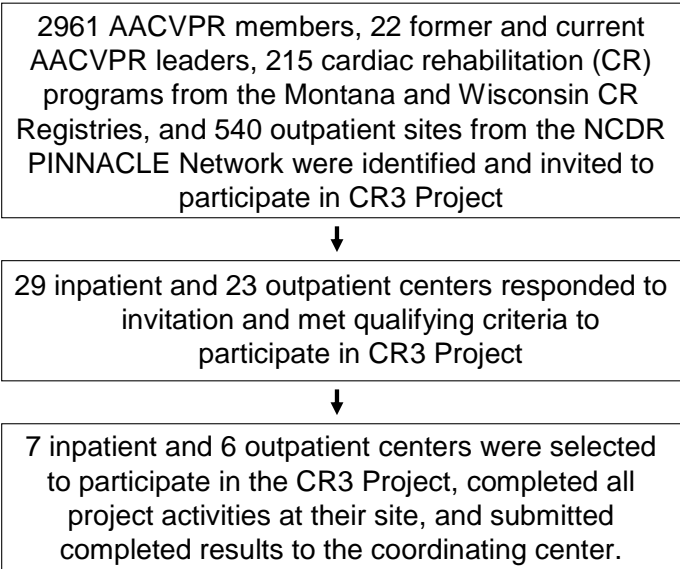
Table 2: Sociodemographic characteristics of patients in Cardiac Rehabilitation Referral
Reliability (CR3) Project

	Patients from Inpatient Sites (n = 234)	Patients from Outpatient Sites (n = 211)
Age		
18-39 years old	3%	5%
40-64 years old	40%	50%
65-79 years old	45%	33%
≥ 80 years old	12%	12%
Sex		
Female	35%	36%
Race and Ethnicity		
White	84%	84%
Black	8%	8%
Asian	0.5%	0.5%
American Indian	1%	0.5%
Native Hawaiian/Pacific Islander	0.5%	0.5%
Other	5.5%	5.5%
Hispanic Ethnicity	0.5%	1%

Table 3: Reliability testing results from pooled and site-specific data analyses from
Cardiac Rehabilitation Referral Reliability (CR3) Project for inpatient and
outpatient sites

Setting	Reliability	Item	Percent Agreement (PA)		Kappa (κ)	
			Pooled Data (#abstractions in agreement/total # abstractions)	Range Across Study Sites	Pooled Data (95% CI)	Range Across Study Sites
Inpatient	Intra-rater	eligibility	100% (232/232)	100% - 100%	1.00 (-)	1.00 - 1.00
		exception	96% (189/196)	90% - 100%	0.76 (0.60, 0.93)	0.67 - 1.00
		referral	98% (172/176)	92% - 100%	0.95(0.90, 0.99)	0.62 - 1.00
	Inter-rater	eligibility	94% (218/231)	77% - 100%	0.77 (0.65, 0.89)	0.31 - 1.00
		exception	97% (185/191)	90% - 100%	0.79 (0.63, 0.95)	0.66 - 0.91
		referral	86% (148/172)	58% - 100%	0.70 (0.59, 0.81)	0.23 - 1.00
Outpatient	Intra-rater	eligibility	98% (191/194)	97% - 100%	0.94 (0.87, 1.00)	0.88 - 1.00
		exception	99% (146/148)	92% - 100%	0.89 (0.74, 1.00)	0.70 - 1.00
		referral	95% (130/137)	68% - 100%	0.88 (0.79, 0.96)	0.39 - 1.00
	Inter-rater	eligibility	94% (190/203)	81% - 100%	0.78 (0.66, 0.89)	0.46 - 1.00
		exception	95% (139/146)	83% - 100%	0.43 (0.09, 0.78)	0.40 - 0.46
		referral	91% (124/136)	70% - 100%	0.80 (0.70, 0.91)	-0.07 - 1.00

Figure 1: Recruitment of participating centers in the Cardiac Rehabilitation Referral Reliability (CR3) Project



STRUCTURED ABSTRACT

BACKGROUND: Assessment of the reliability of performance measure (PM) abstraction is an important step in PM validation. Reliability has not been previously assessed for abstracting PMs for the referral of patients to cardiac rehabilitation and secondary prevention (CR/SP) programs. To help validate these PMs, we carried out a multicenter assessment of their reliability.

METHODS: Hospitals and clinical practices from around the U.S. were invited to participate in the CR3 Project. Twenty-nine hospitals and 23 outpatient centers expressed interest in participating. Seven hospitals and 6 outpatient centers met participation criteria and submitted completed data. Site coordinators identified 35 patients whose charts were reviewed by 2 site abstractors twice, 1 week apart. Percent agreement and Cohen's kappa statistic were used to describe intra- and inter-abtractor reliability for patient eligibility for CR/SP, patient exceptions for CR/SP referral, and documented referral to CR/SP.

RESULTS: Results were obtained from within-site data, as well as from pooled data of all inpatient and all outpatient sites. We found that intra-abtractor reliability reflected excellent repeatability ($\geq 90\%$ agreement, $\kappa \geq 0.75$) for ratings of CR/SP eligibility, exceptions, and referral, both from pooled and site-specific analyses of inpatient and outpatient data. Similarly, the inter-abtractor agreement from pooled analysis ranged from good to excellent for the 3 items, although with slightly lower measures of reliability.

CONCLUSIONS: Abstraction of PMs for CR/SP referral has high reliability, supporting the use of these PMs in quality improvement initiatives aimed at increasing CR/SP delivery to patients with cardiovascular disease.

CONDENSED ABSTRACT

We carried out a multicenter assessment of the reliability of abstracting cardiac rehabilitation (CR) referral performance measures (PM), an important step in PM validation. Intra- and inter-abtractor

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reliability was good to excellent, providing support for the use of these PM's in quality improvement initiatives aimed at increasing CR delivery.

**Reliability of Abstracting Performance Measures:
Results of the Cardiac Rehabilitation Referral and Reliability (CR3) Project**

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Keywords or phrases: Cardiac rehabilitation, referral, reliability testing, quality improvement

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Association.

Cardiac rehabilitation and secondary prevention (CR/SP) services are significantly associated with positive health outcomes in a variety of patients with cardiac disorders¹⁻⁷ yet only a minority of eligible patients ever participate in CR/SP.⁸⁻¹⁰ The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), American College of Cardiology Foundation (ACCF), and American Heart Association (AHA)¹¹ have developed, and the National Quality Forum (NQF) has endorsed, performance measures (PM's) for CR/SP referral to increase the delivery of CR/SP to appropriate patients (see Table 1).¹²⁻¹⁷ In addition, the Centers for Medicare and Medicaid Services (CMS) has included these measures in the Physician Quality Reporting System, and will begin reporting audits of these PMs in the outpatient setting in 2015.

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Assessment of the reliability of data collection for performance measurement is an important step included in the ACCF/AHA methodology for the development and identification of high-value performance measures^{18, 19}. However, to our knowledge, no studies have been published that have evaluated the reliability of collecting CR/SP performance measures. To address this need, and to respond to NQF requirements to provide such data as part of their endorsement process, we carried out a multi-site study, the Cardiac Rehabilitation Referral Reliability (CR3) Project, aimed at analyzing the reliability of abstracting the CR/SP PMs from inpatient and outpatient records.

METHODS

Hospitals and outpatient cardiology practices in the United States were identified from the ACCF, AHA, and AACVPR databases and were invited to participate. We sought a variety of hospitals and clinics, based on different geographical locations, community sizes, and

hospital/practice types/sizes (Figure 1). All 540 outpatient cardiology practices that were members of the ACCF outpatient quality and outcomes data registry (known as the PINNACLE network) as of October 1, 2011 were invited by email to participate in the CR3 Project as outpatient sites. The PINNACLE Network helps cardiovascular teams achieve practice success through quality measurement, performance improvement, and peer-to-peer learning through an interactive community that connects practices across the country. In addition, an invitation to participate in the CR3 Project as an inpatient and/or an outpatient site was sent by email to 2916 members of AACVPR, and targeted invitations were sent to 5 Board members, 6 Past Presidents, and 11 Committee Chairs of AACVPR, as well as to the CR/SP programs that were participating in the Wisconsin State Cardiac Rehabilitation Registry (70 centers) and the Montana State Cardiac Rehabilitation Registry (145 programs). Twenty-nine hospitals and 23 outpatient practices responded, expressing interest in participating in the project.

Based on available resources to carry out the CR3 Project, we initially planned to include a maximum of 12 sites in the project, with varied geographical locations and center characteristics. An additional site was added since it was able to participate without the need for CR3 Project resources, resulting in a total of 7 inpatient and 6 outpatient practices that participated in the project. Inclusion criteria included a willingness to participate, and ability to: (1) provide a study coordinator and 2 separate chart abstractors, (2) complete the project within the specified timeline, and (3) obtain local IRB clearance to carry out the project in their setting. Once each hospital and practice completed and submitted their required data, they were sent a small incentive as a token of appreciation for their participation and submission of complete project data from their site (\$200 gift card). Completed data were received from 7 hospitals and 6 outpatient cardiology practices.

Chart Abstraction

For inpatient facilities, charts of patients who had an index hospitalization (ie, a hospitalization for a cardiac event that is a qualifying diagnosis or procedure for CR/SP) between August 1, 2009 and August 1st 2010 were eligible for review and inclusion. For outpatient centers, charts of patients who had an outpatient visit between August 1, 2009 and August 1, 2010 were eligible for review and inclusion. However, since the performance measure allows as long as 12 months for a patient to complete CR/SP following a qualifying cardiac event, chart abstraction included a search for a qualifying cardiac event between August 1, 2009 and August 1, 2010, along with a search of records for up to 12 months after the cardiac event, to search for documentation of CR/SP referral during that time period.

Study sites designated 1 study coordinator and 2 chart abstractors. Each study coordinator identified 35 patients from a consecutive sample of patients: 30 patients with an eligible diagnosis for CR/SP referral, and 5 without an eligible diagnosis for CR/SP (see below for additional details). The 2 abstractors at each site reviewed the same 35 patient records that had been selected from their site twice (once at baseline, and again 1 week later). Abstractors had a range of experience reviewing charts, from less than 1 month to greater than 5 years.

Abstractors were blinded as to which patients in their sample had a qualifying diagnosis and which patients had exceptions for CR/SP. Only the site coordinator, who did not participate in the abstraction process, had access to this information. Patients considered to have qualifying events for CR/SP, as defined by CMS and therefore as specified in the performance measure, had 1 or more of the following: myocardial infarction, percutaneous coronary intervention, coronary artery bypass graft surgery, heart valve surgery, heart transplantation surgery, and chronic stable angina. Patients without a qualifying event, for the purpose of this abstraction project, were to

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10 have had documented 1 or more of the following diagnoses that are not currently considered by
11 CMS to be a covered indication for CR/SP:
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- 13 • *For inpatient centers:* atrial fibrillation, heart failure, or syncope during the index
14 hospitalization period under review (with no documented qualifying events for CR during
15 that same hospitalization)
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17 • *For outpatient centers:* atypical chest pain, palpitations, or dyspnea during the 12 months
18 prior to the index outpatient visit (with no documented qualifying events for CR referral
19 during that same time period).
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25 The CR3 Project workgroup created chart abstraction forms, site coordinator instructions,
26 abstractor instructions, a frequently asked questions document, and site tracking forms to allow
27 the study coordinator to track and report site specific results for intra-abstractor (1 abstractor
28 reviewing the chart 2 times) and inter-abstractor (2 abstractors reviewing 1 chart) reliability. The
29 workgroup held a kickoff call with each center's study coordinator to train them prior to the start
30 of the CR3 project. Thereafter, the workgroup communicated weekly with site coordinators to
31 address any questions or operational concerns that arose. The training of site coordinators was
32 carried out during 1-2 one-hour conference calls prior to starting the project. When coordinators
33 had questions, they contacted the staff liaison to the CR3 working group directly by email or
34 telephone. New questions and their corresponding answers were communicated weekly to all site
35 coordinators. The entire project took approximately 20 weeks to complete (October 2011
36 through February 2012).
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51 **Definitions**

52 The following definitions were developed for use in the study:
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Eligible patients for CR/SP referral:

- Inpatient: a patient who survived the index hospitalization and who had a qualifying event/diagnosis for referral to CR/SP during the index hospitalization period under review.
- Outpatient: a patient who had a qualifying event/diagnosis for referral to CR/SP within the previous 12 months prior to the index outpatient visit.

Patients not eligible for CR/SP referral:

- Inpatient: a patient who had a cardiac event/diagnosis (atrial fibrillation, heart failure, or syncope for purposes of this study) during the index hospitalization period under review and no indication for CR/SP referral as specified in the performance measure.
- Outpatient: a patient who had a cardiac event/diagnosis (atypical chest pain, palpitations, or dyspnea for purposes of this study) during the 12 months prior to the index outpatient visit, and no indication for CR/SP referral as specified in the performance measure.

CR/SP referral:

- Inpatient: documentation in a patient's hospital medical records that the patient was referred to an outpatient CR/SP program.
- Outpatient: documentation in a patient's outpatient clinical medical records that the patient has been referred to an outpatient CR/SP program within 12 months after a qualifying event/diagnosis.

For purposes of this project, documentation in the medical record could include any of the following sources: hospital discharge summaries, office notes, clinical notes and medical records, orders (written/electronic), prescriptions (e.g. contact information for CR/SP specialist), or other parts of the clinical record that documents patient information.

Exceptions

Because there are valid reasons why certain patients should not be referred to a CR/SP program, exceptions to the CR/SP measures are allowed. When a clinician is allowed to document exceptions he or she is given the flexibility to decide whether or not to institute a given intervention/process depending upon the overall benefits and risks to the patient. Exceptions allow clinicians this flexibility without the threat of being “penalized” for not referring a patient to CR/SP. Without the presence of exceptions, potential negative unintended consequences could arise such as forcing CR/SP on patients who are unstable. Furthermore, analysis of exception rates for quality improvement purposes allows providers and health systems to test the effects of process changes within their practices and communities that may facilitate CR/SP referral. Relatively few patients would be expected to qualify for an exception to CR/SP referral. Such exceptions would generally be limited to factors that may make CR/SP unsafe, ineffective, or lack of accessibility to a CR/SP program within a reasonable commuting distance.

Such exceptions would generally be limited to factors that may make CR/SP unsafe or ineffective, or that otherwise prohibit access to a CR/SP program. Examples of exceptions from referral to CR/SP include:

- Patient exceptions (eg, patient resides in a long-term nursing care facility)
- Medical exceptions (eg, presence of an acute medical condition that makes the patient unstable and unsafe for exercise training)
- System exceptions (eg, lack of an available CR/SP program within 60 minutes of travel time from the patient’s home)

Since the measures look only at whether patients were referred, not whether they enrolled, patient refusal was not considered to be an exception. If a healthcare provider recommended

CR/SP referral to a patient, the patient refused the referral, and the provider documented the patient refusal, then that encounter was judged to have met the performance measure since the provider complied with the expectation to recommend referral to CR/SP.

Data Analyses

Both Cohen's kappa (κ) statistic and percent agreement were used to measure the intra-abtractor and inter-abtractor reliability for the following qualitative ratings: (1) documented eligibility for CR/SP referral, (2) exception documented for CR/SP referral, and (3) documentation of CR/SP referral. The κ statistic is a chance-corrected index of agreement ranging from -1 to 1, with $\kappa < 0$ representing observed agreement worse than that due to chance alone. We interpreted a κ over 0.75 as excellent, 0.40 to 0.75 as fair to good, and below 0.40 as poor, following the guidelines of Fleiss et al.^{20,29} Unlike the κ statistic, percent agreement does not take into account the agreement occurring by chance, but can be informative in situations for which the prevalence of a given response is very high or low and the interpretation based solely on the value of κ may be misleading. This phenomenon known as the kappa paradox^{21, 22} occurs when the observed proportion of agreement is high but the value of the κ statistic is low.

For brevity, intra-abtractor reliability is reported for only 1 of the 2 abstractors (arbitrarily-designated "abstractor 1" at each site), and inter-abtractor reliability only for the initial set of ratings (ie, "time 1"). Stratifying on inpatient vs. outpatient setting, reliability was analyzed 1) on the overall group with sites pooled together, and 2) within sites and summarizing the site-specific results across the overall group. All analyses were performed using the SAS statistical software package (version 9.2, SAS Institute Inc., Cary, NC).

RESULTS

Characteristics of the 234 inpatients and 211 outpatients (total 445) included in the CR3 Project are shown in Table 2. The majority of patients from both inpatient and outpatient sites were male, white, and younger than 65 years of age. A total of 1746 chart reviews were performed for the CR3 Project (415 (93%) of the total 445 patient charts were reviewed as specified in the CR3 Project protocol, each 1 being reviewed 4 times (2 by each abstractor), while incomplete reporting of data resulted in 26 that were reviewed only 3 times each, and 4 that were each reviewed only twice).

Participating centers represented a variety of practice types and settings, including the following: Rural, suburban, or urban area locations; teaching and non-teaching centers; and single specialty and multispecialty centers. One hospital was from the Pacific Northwest, 4 from the Midwest, 1 from the Northeast, and 1 from the Southeast. Three inpatient centers used paper medical records, 5 used electronic medical records, and 2 used both. Outpatient clinics in the CR3 Project were located throughout the Midwest and in the Southeastern part of the United States. Two outpatient clinics used paper medical records and 4 used electronic medical records, while none used both.

Site abstractors involved in the CR3 Project had varying degrees of experience with chart abstraction prior to participating in the project, with 54% of abstractors having 2 years of experience or less and 23% having less than one month of experience. Among the 13 inpatient and outpatient sites, the pair of abstractors had similar levels of experience at 11 sites). Excluding the 2 sites in which the pairs of abstractors had discordant levels of experience, we found that ratings of CR/SP eligibility, exceptions, and referral were not more reliable from abstractors having more than 2 years of experience. Interestingly, some of these ratings reflected

more favorable reliability in abstractors having less than 2 years of experience (data not shown).

In addition, we did not find a difference between the reliability of the first abstractions and the second abstractions, suggesting that there was no “learning effect” among abstractors. The mean \pm SD time per chart abstraction, reported by abstractors was 4.9 \pm 3.2 minutes for inpatient abstractions and 6.8 \pm 4.7 minutes for outpatient abstractions.

Reliability Outcomes

Inpatient Sites (Table 3)

Intra-abstractor reliability analysis of pooled inpatient data demonstrated excellent repeatability for ratings of CR/SP eligibility (100% agreement, κ =1.00), CR/SP exceptions (96% agreement, κ =0.76), and CR/SP referral (98% agreement, κ =0.95). Based on site-specific inpatient data, each of the three CR/SP items showed high percent agreement (\geq 90%) at all sites, and excellent repeatability ($\kappa \geq$ 0.75) in the majority of sites (100% of sites for patient eligibility, 67% for patient exceptions, and 80% for patient referral).

Pooled analysis of inpatient sites demonstrated excellent inter-abstractor reliability analysis for ratings of CR/SP eligibility (94% agreement, κ =0.77) and CR/SP exceptions (97% agreement, κ =0.79), and modest agreement between abstractors for rating CR/SP referral (86% agreement, κ =0.70). Consistent with the pooled results, site-specific analyses demonstrated excellent inter-abstractor reliability (as measured by $\kappa \geq$ 0.75) in the majority of inpatient sites for ratings of eligibility (71% of sites) and exceptions (67% of sites), but in less than half (40%) of sites for the rating of CR/SP referral.

Outpatient Sites (Table 3)

Pooled analyses of the 6 outpatient sites demonstrated excellent intra-abstractor reliability for the 3 ratings of CR/SP eligibility, exceptions, and referral (agreement $\geq 95\%$, $\kappa \geq 0.88$). From site-specific analysis of intra-abstractor reliability, percent agreement $\geq 90\%$ was observed in all 6 sites for ratings of CR/SP eligibility and exceptions, and in all but 1 site for rating of CR/SP referral. Likewise, excellent repeatability ($\kappa \geq 0.75$) was demonstrated in the majority of outpatient sites (100% of sites for rating of eligibility, 67% for exceptions, and 67% for referral).

Regarding inter-abstractor reliability for outpatient sites, pooled analyses reflected excellent agreement between abstractors for ratings of both CR/SP eligibility ($\kappa = 0.78$) and CR/SP referral ($\kappa = 0.80$), and poor to fair agreement in rating patient exceptions for CR/SP referral ($\kappa = 0.43$). Similarly, according to site-specific results, excellent inter-abstractor reliability was observed in most (two-thirds) of the outpatient sites for rating CR/SP eligibility, and in none of the sites for rating CR/SP exceptions. Interestingly, despite excellent inter-abstractor agreement for rating CR/SP referral obtained from pooled analysis, site-specific results varied considerably (range of κ across six sites, -0.07 to 1.00), with excellent reliability seen in only one-third of outpatient sites (and percent agreement below 90% in half the sites).

DISCUSSION

This study demonstrates high reliability for assessing CR/SP eligibility, referral, and exceptions using the CR/SP outpatient and inpatient performance measures. Data abstraction of patient records was performed by abstractors with varying amounts of abstraction experience at a variety of inpatient and outpatient centers, suggesting generalizability of our findings.

Reliability testing is one of 3 important steps in developing high value PMs, as outlined by the ACCF/AHA Task Force on Performance Measures¹⁹. The 3 steps include: (1) construction of the measurement set, (2) assessment of feasibility and reliability of data collection, and (3) measurement of clinician performance. Construction of the CR/SP PM set has previously been reported¹²⁻¹⁷.

Our testing generally found high reliability for comparisons between abstractors for the 3 key components of the CR/SP PM's: patient eligibility for CR/SP, patient exceptions to CR/SP referral, and patient referral to CR/SP. We included 2 measures of reliability, each shedding important light on the reliability of PM abstraction: percent agreement and the kappa statistic. "Percent agreement" is a helpful assessment of reliability, but given that over 80% of patients in the study sample were eligible for CR/SP, and more than 90% of patients were absent exceptions to CR/SP participation, the percent agreement may have been somewhat inflated, since by chance alone abstractors may have chosen the correct eligibility or exception status.

Conversely, the kappa statistic performs best when there is nearly equal chance of study outcomes. When there is a high likelihood of one of the 2 outcomes, as in our study (high likelihood of CR/SP eligibility), the results of the kappa analyses can underestimate true reliability due to a phenomenon known as the "kappa score paradox" in which there is high percent agreement, yet a low kappa score^{21, 22}. Indeed, we observed this paradox in some centers. The true reliability of abstracting our PMs most likely lies between the results from the 2 methods of assessment we used. Since the "percent agreement" method generally suggests very high reliability of the CR/SP measures and the kappa statistic generally suggests moderate to high reliability, the true reliability of the CR/SP performance measure would appear overall to be high.

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Data abstractors reported that data abstraction time was modest for the inpatient (4.9 minutes) and outpatient (6.8 minutes) CR/SP PMs, and reported minimal barriers to their abstraction activities. If the CR/SP PMs are included in sets of other PM's, such as the PM set for CABG surgery, for example, it is likely that efficiencies of scale will result in less time being required for the CR/SP PM assessment.

Limitations

We selected participating centers to reflect variation in the location, size, and type of centers. However, our study is based on the experience of a relatively small number of centers from around the United States that volunteered to be in the project and may not be representative other centers from different regions.

Lessons Learned

Outpatient abstraction of the CR/SP performance measure data was more time-consuming and somewhat less reliable than the abstraction of inpatient data. This is explained in large part by the fact that the review of inpatient data is limited to the time of the patient index hospitalization (ie, the time of the cardiac event that qualified them for CR/SP). Review of outpatient data is broader, including a review of records for up to 12 months previous to the outpatient visit and also a review of records for up to 12 month after the outpatient visit, due to the fact that patients are eligible for CR/SP for up to 12 months following their qualifying cardiac event.

Future Directions

Healthcare provider education through effective communication channels is critically important to help providers understand and document appropriate exceptions to CR/SP referral, as well as the key components of CR/SP referral documentation: 1) that the patient has been referred to CR/SP, 2) that the patient has been given information and guidance to help them enroll in CR/SP, and 3) that the receiving CR/SP program has been sent patient information to expedite CR/SP enrollment).

Current practices and existing ACCF and AHA registries only require documentation that the patient has been referred to a CR/SP program. Published evidence suggests that the use of additional communication components, as specified in the measures, may increase the predictive validity of the measures.^{23,23} Going forward, with the advent of better data collection systems for CR/SP referral and the ability now to track CR/SP enrollment through the AACVPR Outpatient Cardiac Rehabilitation Registry, we expect to be able to test the hypothesis that this more detailed definition of CR/SP referral will increase enrollment in CR/SP. Furthermore, computerized decision support, made more widely available through efforts to enhance the meaningful use of electronic health records, may also provide value by increasing the ability to track and improve the appropriate utilization of CR/SP.

Reliability of CR/SP performance measure abstraction is high. Data abstractors reported minimal barriers to the abstraction process and required a relatively small amount of time per patient to carry out the abstractions. These results contribute to published evidence regarding the soundness and generalizability of the CR/SP PMs. Further work will need to be carried out to assess the impact of the CR/SP PMs on patient referral rates and patient outcomes.

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Comment [maw2]: Please review correct citation format from the Information for Authors for the Journal of Cardiopulmonary Rehabilitation and Prevention and edit as appropriate

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Abstract:

Background: Assessment of the reliability of performance measure (PM) abstraction is an important step in PM validation. Reliability has not been previously assessed for abstracting PM's for the referral of patients to cardiac rehabilitation and secondary prevention (CR/SP) programs. To help validate these PM's, we carried out a multicenter assessment of their reliability.

Methods and Results: Hospitals and clinical practices from around the U.S. were invited to participate in the CR3 Project. Twenty-nine hospitals and 23 outpatient centers expressed interest in participating. Seven hospitals and 6 outpatient centers met participation criteria and submitted completed data. Site coordinators identified 35 patients whose charts were reviewed by 2 site abstractors twice, one week apart. Percent agreement and Cohen's kappa statistic were used to describe intra- and inter-abstractor reliability for patient eligibility for CR/SP, patient exceptions for CR/SP referral, and documented referral to CR/SP. Results were obtained from within-site data, as well as from pooled data of all inpatient and all outpatient sites.

We found that intra-abstractor reliability reflected excellent repeatability ($\geq 90\%$ agreement, $\kappa \geq 0.75$) for ratings of CR/SP eligibility, exceptions, and referral, both from pooled and site-specific analyses of inpatient and outpatient data. Similarly, the inter-

abstractor agreement from pooled analysis ranged from good to excellent for the three items, although with slightly lower measures of reliability.

Conclusions: Abstraction of PM's for CR/SP referral has high reliability, supporting the use of these PM's in quality improvement initiatives aimed at increasing CR/SP delivery to patients with cardiovascular disease.

Reliability of Abstracting Performance Measures: Results of the Cardiac Rehabilitation Referral and Reliability (CR3) Project

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Figure 1:

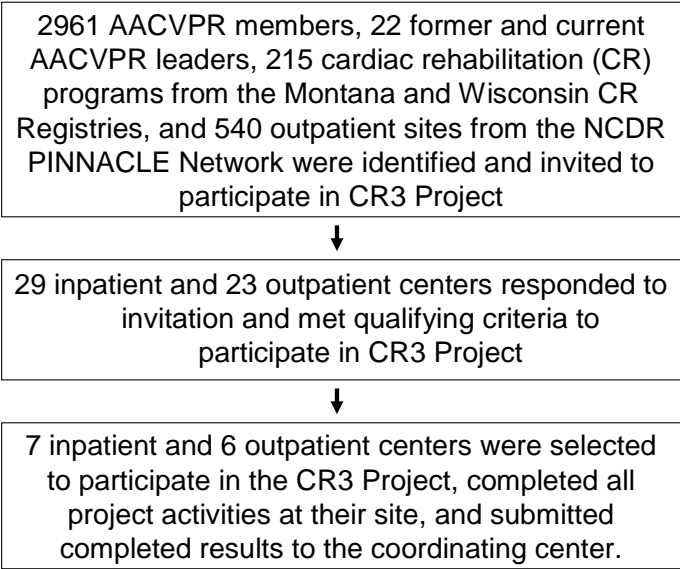


Table 1: AACVPR/ACCF/AHA performance measures for referral to a cardiac rehabilitation program from an in-patient (A) and out-patient (B) setting (12, 15)

A: Performance measure for referral to a cardiac rehabilitation program from an in-patient setting

Component	Details
Performance Measure	All patients hospitalized with a primary diagnosis of an acute myocardial infarction or chronic stable angina, or who during hospitalization have undergone coronary artery bypass graft surgery, a percutaneous coronary intervention, cardiac valve surgery, or cardiac transplantation are to be referred to an early outpatient cardiac rehabilitation/secondary prevention program.
Numerator	Number of eligible patients with a qualifying event/diagnosis who have been referred to an outpatient cardiac rehabilitation program prior to hospital discharge or have a documented medical or patient-centered reason why such a referral was not made
Denominator	Number of hospitalized patients in the reporting period hospitalized with a qualifying event/diagnosis who do not meet any of the exception criteria
Exceptions	<ul style="list-style-type: none"> (1) Patient-oriented factors (patient discharged to a nursing care facility for long-term care, for example) (2) Medical factors (patient deemed to have a medically unstable, life-threatening condition, for example) (3) Healthcare system factors (lack of cardiac rehabilitation program near a patient's home, for example)

B: Performance measure for referral to a cardiac rehabilitation program from an out-patient setting

Component	Details
Performance Measure	All patients evaluated in an outpatient setting who within the past 12 months have experienced an acute myocardial infarction, coronary artery bypass graft surgery, a percutaneous coronary intervention, cardiac valve surgery, or cardiac transplantation, or who have chronic stable angina and have not already participated in an early outpatient cardiac rehabilitation/secondary prevention program for the qualifying event/diagnosis are to be referred to such a program.
Numerator	Number of patients in an outpatient clinical practice who have had a qualifying event/diagnosis during the previous 12 months, who have been referred to an outpatient cardiac rehabilitation program
Denominator	Number of patients in an outpatient clinical practice who have had a qualifying event/diagnosis during the previous 12 months and who do not meet any of the exception criteria, and who have not already participated in an outpatient cardiac rehabilitation program since the qualifying event.
Exceptions	<ul style="list-style-type: none"> (1) Patient oriented factors (patient discharged to a nursing care facility for long-term care, for example) (2) Medical factors (patient deemed to have a medically unstable, life-threatening condition, for example) (3) Healthcare system factors (lack of cardiac rehabilitation program near a patient's home, for example)

Table 2: Sociodemographic characteristics of patients in CR3 Project

	Patients from Inpatient Sites (n = 234)	Patients from Outpatient Sites (n = 211)
Age		
18-39 years old	3%	5%
40-64 years old	40%	50%
65-79 years old	45%	33%
≥ 80 years old	12%	12%
Sex		
Female	35%	36%
Race and Ethnicity		
White	84%	84%
Black	8%	8%
Asian	0.5%	0.5%
American Indian	1%	0.5%
Native Hawaiian/Pacific Islander	0.5%	0.5%
Other	5.5%	5.5%
Hispanic Ethnicity	0.5%	1%

Table 3: Reliability testing results from pooled and site-specific data analyses from CR3 Project for inpatient and outpatient sites

Setting	Reliability	Item	Percent Agreement (PA)		Kappa (κ)	
			Pooled Data (#abstractions in agreement/total # abstractions)	Range Across Study Sites	Pooled Data (95% CI)	Range Across Study Sites
Inpatient	Intra-rater	eligibility	100% (232/232)	100% - 100%	1.00 (-)	1.00 - 1.00
		exception	96% (189/196)	90% - 100%	0.76 (0.60, 0.93)	0.67 - 1.00
		referral	98% (172/176)	92% - 100%	0.95(0.90, 0.99)	0.62 - 1.00
	Inter-rater	eligibility	94% (218/231)	77% - 100%	0.77 (0.65, 0.89)	0.31 - 1.00
		exception	97% (185/191)	90% - 100%	0.79 (0.63, 0.95)	0.66 - 0.91
		referral	86% (148/172)	58% - 100%	0.70 (0.59, 0.81)	0.23 - 1.00
Outpatient	Intra-rater	eligibility	98% (191/194)	97% - 100%	0.94 (0.87, 1.00)	0.88 - 1.00
		exception	99% (146/148)	92% - 100%	0.89 (0.74, 1.00)	0.70 - 1.00
		referral	95% (130/137)	68% - 100%	0.88 (0.79, 0.96)	0.39 - 1.00
	Inter-rater	eligibility	94% (190/203)	81% - 100%	0.78 (0.66, 0.89)	0.46 - 1.00
		exception	95% (139/146)	83% - 100%	0.43 (0.09, 0.78)	0.40 - 0.46
		referral	91% (124/136)	70% - 100%	0.80 (0.70, 0.91)	-0.07 - 1.00



July 3, 2013

Mark Williams, PhD
Editor-in-Chief
Journal of Cardiopulmonary Rehabilitation and Prevention

Dear Dr. Williams:

We are submitting to you an original manuscript entitled, “Reliability of Abstracting Performance Measures: Results of the Cardiac Rehabilitation Referral and Reliability (CR3) Project”.

This manuscript describes a recently completed project aimed at assessing the reliability of abstracting the AACVPR/ACCF/AHA Cardiac Rehabilitation Referral Performance Measures. This paper is important for your readers for the following reasons:

First, with the emergence of performance measures in the field of medicine today, it is important that proper methods are followed that identify high value performance measures. This study describes efforts to do just that—to measure the reliability of a set of performance measures aimed at improving the delivery of cardiac rehabilitation/secondary prevention services.

Second, to our knowledge, this is the first paper to study the reliability of abstracting the cardiac rehabilitation performance measures.

Third, this paper comes at a time when performance measures for cardiac rehabilitation/secondary prevention are gaining support and interest from the Centers for Medicare and Medicaid Services, and other national healthcare organizations. These cardiac rehabilitation performance measures, in fact, are to be implemented in an outpatient setting by CMS beginning in 2014.

Of note, the data included in this manuscript have not been presented at national meetings, nor have they been published in any form in another journal. The data were submitted, however, to the National Quality Forum earlier this year for consideration of endorsement of the measures by that organization. (Representatives of NQF have completed their review of these measures, and have voted to formally endorse them.)

Funding for statistical support for the CR3 Project was provided by the Division of Cardiovascular Diseases at the Mayo Clinic in Rochester, Minnesota. Funding for the site incentives used in the CR3 Project was provided by the AACVPR, ACCF, and AHA.

All authors have read and approved of the manuscript. The authors have no conflicts of interest to disclose with the exception of the following:

David Goff: Operations Committee Member for a clinical trial of a glucose lowering medication marketed by Merck, and DSMB Member for a clinical trial of a glucose lowering medication marketed by Takeda (both modest), and stipend for CME meeting presentation (Merck, small).

All individuals who are recognized in the acknowledgement section below have given their approval to be included.

Acknowledgements

We thank the following sites and site coordinators for their help in carrying out the CR3 Project: **Susan Carter**, *Bloomington Hospital Cardiopulmonary Rehabilitation, Advanced Heart Care Center & Pacemaker Clinic, Indiana University Health, Bloomington, IN*; **Kathy Lee Bishop**, *Emory HeartWise Risk Reduction Program, School of Medicine, Emory University School of Physical Therapy, Atlanta, GA*; **Cathleen Biga and Claudia Eaton**, *Illinois Heart and Vascular, Woodridge, IL*; **Kerry Stewart and Debra Franckowiak**, *Johns Hopkins Bayview Medical Center, Baltimore, MD*; **Quinn Pack**, *Mayo Clinic, Rochester, MN*; **Carol Boe**, *Meriter Wellness Center, Meriter Hospital, Madison, WI*; **Michael Shapiro and Courtney Nichols**, *Oregon Health & Science University, Division of Cardiovascular Medicine, Portland, OR*; **Sue Webb and Jennifer Bullington**, *Phoebe Putney Memorial Hospital, Outpatient Cardiac Rehabilitation, Albany, GA*; **Jan Foresman and Lisa Riggs**, *St. Luke's Health System, Kansas City, MO*; **Karen Boyd**, *University Hospitals, Case Medical Center, Center for Clinical Research and Technology, Cleveland, OH*; **Patricia Loundsbury**, *University of Iowa Heart & Vascular Center, Iowa City, IA*; and **Carolyn Palka and Theresa Gracik**, *University of Michigan Health System, Ann Arbor, MI*.

Thank you for your kind consideration of this manuscript for your journal.

Sincerely,

A handwritten signature in black ink, appearing to read 'Randal J. Thomas'.

Randal J. Thomas, MD, MS
Director, Cardiovascular Health Clinic
Mayo Clinic
Rochester, MN 55905
(507) 284-8087

Introduction

Cardiac rehabilitation and secondary prevention (CR/SP) services are significantly associated with positive health outcomes in a variety of patients with cardiac disorders[1-7] yet only a minority of eligible patients ever participate in CR/SP[8-10]. The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), American College of Cardiology Foundation (ACCF), and American Heart Association (AHA) [11] have developed, and the National Quality Forum (NQF) has endorsed, performance measures (PM's) for CR/SP referral to increase the delivery of CR/SP to appropriate patients (see Table 1)[12-17]. In addition, the Centers for Medicare and Medicaid Services (CMS) has included these measures in the Physician Quality Reporting System, and will begin reporting audits of these PM's in the outpatient setting in 2015.

Assessment of the reliability of data collection for performance measurement is an important step included in the ACCF/AHA methodology for the development and identification of high-value performance measures [18, 19]. However, to our knowledge, no studies have been published that have evaluated the reliability of collecting CR/SP performance measures. To address this need, and to respond to NQF requirements to provide such data as part of their endorsement process, we carried out a multi-site study, the Cardiac Rehabilitation Referral Reliability (CR3) Project, aimed at analyzing the reliability of abstracting the CR/SP PM's from inpatient and outpatient records.

Methods

Participating Hospitals and Practices

Hospitals and outpatient cardiology practices in the United States were identified from the ACCF, AHA, and AACVPR databases and were invited to participate. We sought a variety of hospitals and clinics, based on different geographical locations, community sizes, and hospital/practice types/sizes (see Figure 1). All 540 outpatient practices that were members of the PINNACLE network data registry through the ACCF as of October 1, 2011 were invited by email to participate in the CR3 Project as outpatient sites. The PINNACLE Network helps cardiovascular teams achieve practice success through quality measurement, performance improvement, and peer-to-peer learning through an interactive community that connects practices across the country. In addition, an invitation to participate in the CR3 Project as an inpatient and/or an outpatient site was sent by email to 2916 members of AACVPR, and targeted invitations were sent to 5 Board members, 6 Past Presidents, and 11 Committee Chairs of AACVPR, as well as to the CR/SP programs that were participating in the Wisconsin State Cardiac Rehabilitation Registry (70 centers) and the Montana State Cardiac Rehabilitation Registry (145 programs). Twenty-nine hospitals and 23 outpatient practices responded, expressing interest in participating in the project.

Based on available resources to carry out the CR3 Project, we initially planned to include a maximum of 12 sites in the project, with varied geographical locations

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4 and center characteristics. An additional site was added since it was able to
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6 participate without the need for CR3 Project resources, resulting in a total of 7
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8 inpatient and 6 outpatient practices that participated in the project. Inclusion
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10 criteria included a willingness to participate, and ability to: (1) provide a study
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12 coordinator and 2 separate chart abstractors, (2) complete the project within the
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14 specified timeline, and (3) obtain local IRB clearance to carry out the project in
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16 their setting. Once each hospital and practice completed and submitted their
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18 required data, they were sent a small token of appreciation (\$200 gift card).
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20 Completed data were received from 7 hospitals and 6 outpatient cardiology
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22 practices.
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31 *Chart Abstraction*

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33 For inpatient facilities, charts of patients who had an index hospitalization
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35 between August 1, 2009 and August 1st 2010 were eligible for review and
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37 inclusion. For outpatient centers, charts of patients who had an outpatient visit
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39 between August 1, 2009 and August 1, 2010 were eligible for review and
40
41 inclusion. However, since the performance measure allows as long as 12 months
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43 for a patient to complete CR/SP following a qualifying cardiac event, chart
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45 abstraction included a search for a qualifying cardiac event between August 1,
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47 2009 and August 1, 2010, along with a search of records for up to 12 months
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49 after the cardiac event, to search for documentation of CR/SP referral during that
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51 time period.
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Study sites designated one study coordinator and two chart abstractors. Each study coordinator identified 35 patients from a consecutive sample of patients: 30 patients with an eligible diagnosis for CR/SP referral, and 5 without an eligible diagnosis for CR/SP (see below for additional details). The two abstractors at each site reviewed the same 35 patient records that had been selected from their site twice (once at baseline, and again one week later). Abstractors had a range of experience reviewing charts, from less than one month to greater than 5 years.

Abstractors were blinded as to which patients in their sample had a qualifying diagnosis and which patients had exceptions for CR/SP. Only the site coordinator, who did not participate in the abstraction process, had access to this information. Patients considered to have qualifying events for CR/SP, as defined by CMS and therefore as specified in the performance measure, had one or more of the following: myocardial infarction, percutaneous coronary intervention, coronary artery bypass graft surgery, heart valve surgery, heart transplantation surgery, and chronic stable angina. Patients without a qualifying event, for the purpose of this abstraction project, were to have had documented one or more of the following diagnoses that are not currently considered by CMS to be a covered indication for CR/SP:

- *For inpatient centers:* atrial fibrillation, heart failure, or syncope during the index hospitalization period under review (with no documented qualifying events for CR during that same hospitalization)

- *For outpatient centers:* atypical chest pain, palpitations, or dyspnea during the 12 months prior to the index outpatient visit (with no documented qualifying events for CR referral during that same time period).

The CR3 Project workgroup created chart abstraction forms, site coordinator instructions, abstractor instructions, a frequently asked questions document, and site tracking forms to allow the study coordinator to track and report site specific results for intra-abstractor (1 abstractor reviewing the chart two times) and inter-abstractor (2 abstractors reviewing 1 chart) reliability. The workgroup held a kickoff call with each center's study coordinator to train them prior to the start of the CR3 project. Thereafter, the workgroup communicated weekly with site coordinators to address any questions or operational concerns that arose. The training of site coordinators was carried out during 1-2 one-hour conference calls prior to starting the project. When coordinators had questions, they contacted the staff liaison to the CR3 working group directly by email or telephone. New questions and their corresponding answers were communicated weekly to all site coordinators. The entire project took approximately 20 weeks to complete (October 2011 through February 2012).

Definitions

The following definitions were developed for use in the study:

Eligible patients for CR/SP referral:

- Inpatient: a patient who survived the index hospitalization and who had a qualifying event/diagnosis for referral to CR/SP during the index hospitalization period under review.
- Outpatient: a patient who had a qualifying event/diagnosis for referral to CR/SP within the previous 12 months prior to the index outpatient visit.

Patients not eligible for CR/SP referral:

- Inpatient: a patient who had a cardiac event/diagnosis (atrial fibrillation, heart failure, or syncope for purposes of this study) during the index hospitalization period under review and no indication for CR/SP referral as specified in the performance measure.
- Outpatient: a patient who had a cardiac event/diagnosis (atypical chest pain, palpitations, or dyspnea for purposes of this study) during the 12 months prior to the index outpatient visit, and no indication for CR/SP referral as specified in the performance measure.

CR/SP referral:

- Inpatient: documentation in a patient's hospital medical records that the patient was referred to an outpatient CR/SP program.
- Outpatient: documentation in a patient's outpatient clinical medical records that the patient has been referred to an outpatient CR/SP program within 12 months after a qualifying event/diagnosis.

For purposes of this project, documentation in the medical record could include any of the following sources: hospital discharge summaries, office notes, clinical notes and medical records, orders (written/electronic), prescriptions (e.g. contact information for CR/SP specialist), or other parts of the clinical record that documents patient information.

Exceptions:

Because there are valid reasons why certain patients should not be referred to a CR/SP program, exceptions to the CR/SP measures are allowed. When a clinician is allowed to document exceptions he or she is given the flexibility to decide whether or not to institute a given intervention/process depending upon the overall benefits and risks to the patient. Exceptions allow clinicians this flexibility without the threat of being “penalized” for not referring a patient to CR/SP. Without the presence of exceptions, potential negative unintended consequences could arise such as forcing CR/SP on patients who are unstable. Furthermore, analysis of exception rates for quality improvement purposes allows providers and health systems to test the effects of process changes within their practices and communities that may facilitate CR/SP referral. Relatively few patients would be expected to qualify for an exception to CR/SP referral. Such exceptions would generally be limited to factors that may make CR/SP unsafe, ineffective, or lack of accessibility to a CR/SP program within a reasonable commuting distance.

Such exceptions would generally be limited to factors that may make CR/SP unsafe or ineffective, or that otherwise prohibit access to a CR/SP program (e.g., long commuting distance from a CR/SP program).

Examples of exceptions from referral to CR/SP include:

- Patient exceptions (e.g., patient resides in a long-term nursing care facility)
- Medical exceptions (e.g., presence of an acute medical condition that makes the patient unstable and unsafe for exercise training)
- System exceptions (e.g., lack of an available CR/SP program within 60 minutes of travel time from the patient's home)

Since the measures look only at whether patients were referred, not whether they enrolled, patient refusal was not considered to be an exception. If a healthcare provider recommended CR/SP referral to a patient, the patient refused the referral, and the provider documented the patient refusal, then that encounter was judged to have met the performance measure since the provider complied with the expectation to recommend referral to CR/SP.

Data analyses

Both Cohen's kappa (κ) statistic and percent agreement were used to measure the intra-abstractor and inter-abstractor reliability for the following qualitative ratings: (1) documented eligibility for CR/SP referral, (2) exception documented

for CR/SP referral, and (3) documentation of CR/SP referral. The κ statistic is a chance-corrected index of agreement ranging from -1 to 1, with $\kappa < 0$ representing observed agreement worse than that due to chance alone. We interpreted a κ over 0.75 as excellent, 0.40 to 0.75 as fair to good, and below 0.40 as poor, following the guidelines of Fleiss et al[20]. Unlike the κ statistic, percent agreement does not take into account the agreement occurring by chance, but can be informative in situations for which the prevalence of a given response is very high or low and the interpretation based solely on the value of κ may be misleading. This phenomenon known as the kappa paradox[21, 22] occurs when the observed proportion of agreement is high but the value of the κ statistic is low.

For brevity, intra-abtractor reliability is reported for only one of the two abstractors (arbitrarily-designated “abtractor 1” at each site), and inter-abtractor reliability only for the initial set of ratings (i.e., “time 1”). Stratifying on inpatient vs. outpatient setting, reliability was analyzed 1) on the overall group with sites pooled together, and 2) within sites and summarizing the site-specific results across the overall group. All analyses were performed using the SAS statistical software package (version 9.2, SAS Institute Inc., Cary, NC).

Results

Descriptive Characteristics

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4 Characteristics of the 234 inpatients and 211 outpatients (total 445) included in
5
6 the CR3 Project are shown in Table 2. The majority of patients from both
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8 inpatient and outpatient sites were male, white and younger than 65 years of
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10 age. A total of 1746 chart reviews were performed for the CR3 Project (415
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12 (93%) of the total 445 patient charts were reviewed as specified in the CR3
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14 Project protocol, each one being reviewed 4 times (2 by each abstractor), while
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16 incomplete reporting of data resulted in 26 that were reviewed only 3 times each,
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18 and 4 that were each reviewed only twice).

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26 Participating centers represented a variety of practice types and settings,
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28 including the following: Rural, suburban or urban area locations; teaching and
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30 non-teaching centers; and single specialty and multi-specialty centers. One
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32 hospital was from the Pacific Northwest, four from the Midwest, one from the
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34 Northeast, and one from the Southeast. Three inpatient centers used paper
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36 medical records, five used electronic medical records, and two used both.
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40 Outpatient clinics in the CR3 Project were located throughout the Midwest and in
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42 the Southeastern part of the United States. Two outpatient clinics used paper
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44 medical records and four used electronic medical records, while none used both.
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50 Site abstractors involved in the CR3 Project had varying degrees of experience
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52 with chart abstraction prior to participating in the project, with 54% of abstractors
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54 having 2 years of experience or less and 23% having less than one month of
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56 experience. Among the 13 inpatient and outpatient sites, the pair of abstractors
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4 had similar levels of experience at 11 sites (both abstractors had less than 2
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6 years of experience at 6 sites, and both had more than 2 years of experience at 5
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8 sites). Excluding the 2 sites in which the pairs of abstractors had discordant
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10 levels of experience, we found that ratings of CR/SP eligibility, exceptions, and
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12 referral were not more reliable from abstractors having more than 2 years of
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14 experience. Interestingly, some of these ratings reflected more favorable
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16 reliability in abstractors having less than 2 years of experience (data not shown).
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18 The mean \pm SD time per chart abstraction, reported by abstractors was 4.9 ± 3.2
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20 minutes for inpatient abstractions and 6.8 ± 4.7 minutes for outpatient
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22 abstractions.
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31 *Reliability Outcomes*

32 *Inpatient Sites (See Table 3)*

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34 Intra-abtractor reliability analysis of pooled inpatient data demonstrated
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36 excellent repeatability for ratings of CR/SP eligibility (100% agreement, $\kappa = 1.00$),
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38 CR/SP exceptions (96% agreement, $\kappa = 0.76$), and CR/SP referral (98%
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40 agreement, $\kappa = 0.95$). Based on site-specific inpatient data, each of the three
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42 CR/SP items showed high percent agreement ($\geq 90\%$) at all sites, and excellent
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44 repeatability ($\kappa \geq 0.75$) in the majority of sites (100% of sites for patient eligibility,
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46 67% for patient exceptions, and 80% for patient referral).
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55 Pooled analysis of inpatient sites demonstrated excellent inter-abtractor
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57 reliability analysis for ratings of CR/SP eligibility (94% agreement, $\kappa = 0.77$) and
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CR/SP exceptions (97% agreement, $\kappa = 0.79$), and modest agreement between abstractors for rating CR/SP referral (86% agreement, $\kappa = 0.70$). Consistent with the pooled results, site-specific analyses demonstrated excellent inter-abstractor reliability (as measured by $\kappa \geq 0.75$) in the majority of inpatient sites for ratings of eligibility (71% of sites) and exceptions (67% of sites), but in less than half (40%) of sites for the rating of CR/SP referral.

Outpatient Sites (See Table 3)

Pooled analyses of the six outpatient sites demonstrated excellent intra-abstractor reliability for the three ratings of CR/SP eligibility, exceptions, and referral (agreement $\geq 95\%$, $\kappa \geq 0.88$). From site-specific analysis of intra-abstractor reliability, percent agreement $\geq 90\%$ was observed in all six sites for ratings of CR/SP eligibility and exceptions, and in all but one site for rating of CR/SP referral. Likewise, excellent repeatability ($\kappa \geq 0.75$) was demonstrated in the majority of outpatient sites (100% of sites for rating of eligibility, 67% for exceptions, and 67% for referral).

Regarding inter-abstractor reliability for outpatient sites, pooled analyses reflected excellent agreement between abstractors for ratings of both CR/SP eligibility ($\kappa = 0.78$) and CR/SP referral ($\kappa = 0.80$), and poor to fair agreement in rating patient exceptions for CR/SP referral ($\kappa = 0.43$). Similarly, according to site-specific results, excellent inter-abstractor reliability was observed in most (two-thirds) of the outpatient sites for rating CR/SP eligibility, and in none of the sites

for rating CR/SP exceptions. Interestingly, despite excellent inter-abstractor agreement for rating CR/SP referral obtained from pooled analysis, site-specific results varied considerably (range of κ across six sites, -0.07 to 1.00), with excellent reliability seen in only one-third of outpatient sites (and percent agreement below 90% in half the sites).

Discussion

This study demonstrates high reliability for assessing CR/SP eligibility, referral, and exceptions using the CR/SP outpatient and inpatient performance measures. Data abstraction of patient records was performed by abstractors with varying amounts of abstraction experience at a variety of inpatient and outpatient centers, suggesting generalizability of our findings.

Reliability testing is one of 3 important steps in developing high value PM's, as outlined by the ACCF/AHA Task Force on Performance Measures[19]. The 3 steps include: (1) construction of the measurement set, (2) assessment of feasibility and reliability of data collection, and (3) measurement of clinicians' performance. Construction of the CR/SP PM set has previously been reported[12-17].

Our testing generally found high reliability for comparisons between abstractors for the 3 key components of the CR/SP PM's: patient eligibility for CR/SP, patient

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4 exceptions to CR/SP referral, and patient referral to CR/SP. We included two
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6 measures of reliability, each shedding important light on the reliability of PM
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8 abstraction: percent agreement and the kappa statistic. “Percent agreement” is
9
10 a helpful assessment of reliability, but given that over 80% of patients in the
11
12 study sample were eligible for CR/SP, and more than 90% of patients were
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14 absent exceptions to CR/SP participation, the percent agreement may have been
15
16 somewhat inflated, since by chance alone abstractors may have chosen the
17
18 correct eligibility or exception status.
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26 Conversely, the kappa statistic performs best when there is nearly equal chance
27
28 of study outcomes. When there is a high likelihood of one of the two outcomes,
29
30 as in our study (high likelihood of CR/SP eligibility), the results of the kappa
31
32 analyses can underestimate true reliability due to a phenomenon known as the
33
34 “kappa score paradox” in which there is high percent agreement, yet a low kappa
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36 score[21, 22]. Indeed, we observed this paradox in some centers. The true
37
38 reliability of abstracting our PM’s most likely lies between the results from the two
39
40 methods of assessment we used. Since the “percent agreement” method
41
42 generally suggests very high reliability of the CR/SP measures and the kappa
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44 statistic generally suggests moderate to high reliability, the true reliability of the
45
46 CR/SP performance measure would appear overall to be high.
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54
55 Data abstractors reported that data abstraction time was modest for the in-patient
56
57 (4.9 minutes) and out-patient (6.8 minutes) CR/SP PM’s, and reported minimal
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4 barriers to their abstraction activities. If the CR/SP PM's are included in sets of
5
6 other PM's, such as the PM set for CABG surgery, for example, it is likely that
7
8 efficiencies of scale will result in less time being required for the CR/SP PM
9
10 assessment.
11
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15 16 *Lessons Learned* 17

18
19 Outpatient abstraction of the CR/SP performance measure data was more time-
20
21 consuming and somewhat less reliable than the abstraction of inpatient data.
22

23
24 This is explained in large part by the fact that the review of inpatient data is
25
26 limited to the time of the patient's index hospitalization (i.e., the time of the
27
28 cardiac event that qualified them for CR/SP). Review of outpatient data is
29
30 broader, including a review of records for up to 12 months previous to the
31
32 outpatient visit and also a review of records for up to 12 month after the
33
34 outpatient visit, due to the fact that patients are eligible for CR/SP for up to 12
35
36 months following their qualifying cardiac event.
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42 43 *Future Directions* 44

45
46 Healthcare provider education through effective communication channels is
47
48 critically important to help providers understand and document appropriate
49
50 exceptions to CR/SP referral, as well as the key components of CR/SP referral
51
52 documentation: 1) that the patient has been referred to CR/SP, 2) that the patient
53
54 has been given information and guidance to help them enroll in CR/SP, and 3)
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4 that the receiving CR/SP program has been sent patient information to expedite
5
6 CR/SP enrollment).
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11 Current practices and existing ACCF and AHA registries only require
12
13 documentation that the patient has been referred to a CR/SP program. Published
14
15 evidence suggests that the use of additional communication components, as
16
17 specified in the measures, may increase the predictive validity of the measures
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19 [23]. Going forward, with the advent of better data collection systems for CR/SP
20
21 referral and the ability now to track CR/SP enrollment through the AACVPR
22
23 Outpatient Cardiac Rehabilitation Registry we expect to be able to test the
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25 hypothesis that this more detailed definition of CR/SP referral will increase
26
27 enrollment in CR/SP. Furthermore, computerized decision support, made more
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29 widely available through efforts to enhance the meaningful use of electronic
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31 health records, may also provide value by increasing the ability to track and
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33 improve the appropriate utilization of CR/SP.
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43 Reliability of CR/SP performance measure abstraction is high. Data abstractors
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45 reported minimal barriers to the abstraction process and required a relatively
46
47 small amount of time per patient to carry out the abstractions. These results
48
49 contribute to published evidence regarding the soundness and generalizability of
50
51 the CR/SP PM's. Further work will need to be carried out to assess the impact of
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53 the CR/SP PM's on patient referral rates and patient outcomes.
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Figure 1: Performance measures for referral to cardiac rehabilitation/secondary prevention programs from the in-patient (A) and out-patient (B) settings

Figure 2: Recruitment of participating centers in the CR3 Project

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September 24, 2013

Mark Williams, PhD
Editor-in-Chief
Journal of Cardiopulmonary Rehabilitation and Prevention

Dear Dr. Williams:

We are submitting the revisions that you requested for our original manuscript entitled, "Reliability of Abstracting Performance Measures: Results of the Cardiac Rehabilitation Referral and Reliability (CR3) Project". Please see the attachment that contains a point-by-point explanation of our responses to the reviewers' requests.

Thank you for your kind consideration of this manuscript for your journal.

Sincerely,

A handwritten signature in black ink, appearing to read 'Randal J. Thomas'.

Randal J. Thomas, MD, MS
Director, Cardiovascular Health Clinic
Mayo Clinic
Rochester, MN 55905
(507) 284-8087

Introduction

Cardiac rehabilitation and secondary prevention (CR/SP) services are significantly associated with positive health outcomes in a variety of patients with cardiac disorders[1-7] yet only a minority of eligible patients ever participate in CR/SP[8-10]. The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), American College of Cardiology Foundation (ACCF), and American Heart Association (AHA) [11] have developed, and the National Quality Forum (NQF) has endorsed, performance measures (PM's) for CR/SP referral to increase the delivery of CR/SP to appropriate patients (see Table 1)[12-17]. In addition, the Centers for Medicare and Medicaid Services (CMS) has included these measures in the Physician Quality Reporting System, and will begin reporting audits of these PM's in the outpatient setting in 2015.

Assessment of the reliability of data collection for performance measurement is an important step included in the ACCF/AHA methodology for the development and identification of high-value performance measures [18, 19]. However, to our knowledge, no studies have been published that have evaluated the reliability of collecting CR/SP performance measures. To address this need, and to respond to NQF requirements to provide such data as part of their endorsement process, we carried out a multi-site study, the Cardiac Rehabilitation Referral Reliability (CR3) Project, aimed at analyzing the reliability of abstracting the CR/SP PM's from inpatient and outpatient records.

Methods

Participating Hospitals and Practices

Hospitals and outpatient cardiology practices in the United States were identified from the ACCF, AHA, and AACVPR databases and were invited to participate.

We sought a variety of hospitals and clinics, based on different geographical locations, community sizes, and hospital/practice types/sizes (see Figure 1). All

540 outpatient cardiology practices that were members of the ACCF's outpatient quality and outcomes data registry (known as the PINNACLE network) ~~data~~

~~registry through the ACCF~~ as of October 1, 2011 were invited by email to

participate in the CR3 Project as outpatient sites. The PINNACLE Network helps cardiovascular teams achieve practice success through quality measurement, performance improvement, and peer-to-peer learning through an interactive community that connects practices across the country. In addition, an invitation to participate in the CR3 Project as an inpatient and/or an outpatient site was sent by email to 2916 members of AACVPR, and targeted invitations were sent to 5 Board members, 6 Past Presidents, and 11 Committee Chairs of AACVPR, as well as to the CR/SP programs that were participating in the Wisconsin State Cardiac Rehabilitation Registry (70 centers) and the Montana State Cardiac Rehabilitation Registry (145 programs). Twenty-nine hospitals and 23 outpatient practices responded, expressing interest in participating in the project.

Based on available resources to carry out the CR3 Project, we initially planned to include a maximum of 12 sites in the project, with varied geographical locations and center characteristics. An additional site was added since it was able to participate without the need for CR3 Project resources, resulting in a total of 7 inpatient and 6 outpatient practices that participated in the project. Inclusion criteria included a willingness to participate, and ability to: (1) provide a study coordinator and 2 separate chart abstractors, (2) complete the project within the specified timeline, and (3) obtain local IRB clearance to carry out the project in their setting. Once each hospital and practice completed and submitted their required data, they were sent a small incentive as a token of appreciation for their participation and submission of complete project data from their site (\$200 gift card). Completed data were received from 7 hospitals and 6 outpatient cardiology practices.

Chart Abstraction

For inpatient facilities, charts of patients who had an index hospitalization (i.e., a hospitalization for a cardiac event that is a qualifying diagnosis or procedure for CR/SP) between August 1, 2009 and August 1st 2010 were eligible for review and inclusion. For outpatient centers, charts of patients who had an outpatient visit between August 1, 2009 and August 1, 2010 were eligible for review and inclusion. However, since the performance measure allows as long as 12 months for a patient to complete CR/SP following a qualifying cardiac event, chart abstraction included a search for a qualifying cardiac event between August 1,

2009 and August 1, 2010, along with a search of records for up to 12 months after the cardiac event, to search for documentation of CR/SP referral during that time period.

Study sites designated one study coordinator and two chart abstractors. Each study coordinator identified 35 patients from a consecutive sample of patients: 30 patients with an eligible diagnosis for CR/SP referral, and 5 without an eligible diagnosis for CR/SP (see below for additional details). The two abstractors at each site reviewed the same 35 patient records that had been selected from their site twice (once at baseline, and again one week later). Abstractors had a range of experience reviewing charts, from less than one month to greater than 5 years.

Abstractors were blinded as to which patients in their sample had a qualifying diagnosis and which patients had exceptions for CR/SP. Only the site coordinator, who did not participate in the abstraction process, had access to this information. Patients considered to have qualifying events for CR/SP, as defined by CMS and therefore as specified in the performance measure, had one or more of the following: myocardial infarction, percutaneous coronary intervention, coronary artery bypass graft surgery, heart valve surgery, heart transplantation surgery, and chronic stable angina. Patients without a qualifying event, for the purpose of this abstraction project, were to have had documented one or more of the following diagnoses that are not currently considered by CMS to be a covered indication for CR/SP:

- *For inpatient centers:* atrial fibrillation, heart failure, or syncope during the index hospitalization period under review (with no documented qualifying events for CR during that same hospitalization)
- *For outpatient centers:* atypical chest pain, palpitations, or dyspnea during the 12 months prior to the index outpatient visit (with no documented qualifying events for CR referral during that same time period).

The CR3 Project workgroup created chart abstraction forms, site coordinator instructions, abstractor instructions, a frequently asked questions document, and site tracking forms to allow the study coordinator to track and report site specific results for intra-abstractor (1 abstractor reviewing the chart two times) and inter-abstractor (2 abstractors reviewing 1 chart) reliability. The workgroup held a kickoff call with each center's study coordinator to train them prior to the start of the CR3 project. Thereafter, the workgroup communicated weekly with site coordinators to address any questions or operational concerns that arose. The training of site coordinators was carried out during 1-2 one-hour conference calls prior to starting the project. When coordinators had questions, they contacted the staff liaison to the CR3 working group directly by email or telephone. New questions and their corresponding answers were communicated weekly to all site coordinators. The entire project took approximately 20 weeks to complete (October 2011 through February 2012).

Definitions

The following definitions were developed for use in the study:

Eligible patients for CR/SP referral:

- Inpatient: a patient who survived the index hospitalization and who had a qualifying event/diagnosis for referral to CR/SP during the index hospitalization period under review.
- Outpatient: a patient who had a qualifying event/diagnosis for referral to CR/SP within the previous 12 months prior to the index outpatient visit.

Patients not eligible for CR/SP referral:

- Inpatient: a patient who had a cardiac event/diagnosis (atrial fibrillation, heart failure, or syncope for purposes of this study) during the index hospitalization period under review and no indication for CR/SP referral as specified in the performance measure.
- Outpatient: a patient who had a cardiac event/diagnosis (atypical chest pain, palpitations, or dyspnea for purposes of this study) during the 12 months prior to the index outpatient visit, and no indication for CR/SP referral as specified in the performance measure.

CR/SP referral:

- Inpatient: documentation in a patient's hospital medical records that the patient was referred to an outpatient CR/SP program.

- Outpatient: documentation in a patient's outpatient clinical medical records that the patient has been referred to an outpatient CR/SP program within 12 months after a qualifying event/diagnosis.

For purposes of this project, documentation in the medical record could include any of the following sources: hospital discharge summaries, office notes, clinical notes and medical records, orders (written/electronic), prescriptions (e.g. contact information for CR/SP specialist), or other parts of the clinical record that documents patient information.

Exceptions:

Because there are valid reasons why certain patients should not be referred to a CR/SP program, exceptions to the CR/SP measures are allowed. When a clinician is allowed to document exceptions he or she is given the flexibility to decide whether or not to institute a given intervention/process depending upon the overall benefits and risks to the patient. Exceptions allow clinicians this flexibility without the threat of being "penalized" for not referring a patient to CR/SP. Without the presence of exceptions, potential negative unintended consequences could arise such as forcing CR/SP on patients who are unstable. Furthermore, analysis of exception rates for quality improvement purposes allows providers and health systems to test the effects of process changes within their practices and communities that may facilitate CR/SP referral. Relatively few patients would be expected to qualify for an exception to CR/SP referral. Such

exceptions would generally be limited to factors that may make CR/SP unsafe, ineffective, or lack of accessibility to a CR/SP program within a reasonable commuting distance.

Such exceptions would generally be limited to factors that may make CR/SP unsafe or ineffective, or that otherwise prohibit access to a CR/SP program. ~~(e.g., long commuting distance from a CR/SP program).~~

Examples of exceptions from referral to CR/SP include:

- Patient exceptions (e.g., patient resides in a long-term nursing care facility)
- Medical exceptions (e.g., presence of an acute medical condition that makes the patient unstable and unsafe for exercise training)
- System exceptions (e.g., lack of an available CR/SP program within 60 minutes of travel time from the patient's home)

Since the measures look only at whether patients were referred, not whether they enrolled, patient refusal was not considered to be an exception. If a healthcare provider recommended CR/SP referral to a patient, the patient refused the referral, and the provider documented the patient refusal, then that encounter was judged to have met the performance measure since the provider complied with the expectation to recommend referral to CR/SP.

Data analyses

Both Cohen's kappa (κ) statistic and percent agreement were used to measure the intra-abstractor and inter-abstractor reliability for the following qualitative ratings: (1) documented eligibility for CR/SP referral, (2) exception documented for CR/SP referral, and (3) documentation of CR/SP referral. The κ statistic is a chance-corrected index of agreement ranging from -1 to 1, with $\kappa < 0$ representing observed agreement worse than that due to chance alone. We interpreted a κ over 0.75 as excellent, 0.40 to 0.75 as fair to good, and below 0.40 as poor, following the guidelines of Fleiss et al[20]. Unlike the κ statistic, percent agreement does not take into account the agreement occurring by chance, but can be informative in situations for which the prevalence of a given response is very high or low and the interpretation based solely on the value of κ may be misleading. This phenomenon known as the kappa paradox[21, 22] occurs when the observed proportion of agreement is high but the value of the κ statistic is low.

For brevity, intra-abstractor reliability is reported for only one of the two abstractors (arbitrarily-designated "abstractor 1" at each site), and inter-abstractor reliability only for the initial set of ratings (i.e., "time 1"). Stratifying on inpatient vs. outpatient setting, reliability was analyzed 1) on the overall group with sites pooled together, and 2) within sites and summarizing the site-specific results across the overall group. All analyses were performed using the SAS statistical software package (version 9.2, SAS Institute Inc., Cary, NC).

Results

Descriptive Characteristics

Characteristics of the 234 inpatients and 211 outpatients (total 445) included in the CR3 Project are shown in Table 2. The majority of patients from both inpatient and outpatient sites were male, white and younger than 65 years of age. A total of 1746 chart reviews were performed for the CR3 Project (415 (93%) of the total 445 patient charts were reviewed as specified in the CR3 Project protocol, each one being reviewed 4 times (2 by each abstractor), while incomplete reporting of data resulted in 26 that were reviewed only 3 times each, and 4 that were each reviewed only twice).

Participating centers represented a variety of practice types and settings, including the following: Rural, suburban or urban area locations; teaching and non-teaching centers; and single specialty and multi-specialty centers. One hospital was from the Pacific Northwest, four from the Midwest, one from the Northeast, and one from the Southeast. Three inpatient centers used paper medical records, five used electronic medical records, and two used both.

Outpatient clinics in the CR3 Project were located throughout the Midwest and in the Southeastern part of the United States. Two outpatient clinics used paper medical records and four used electronic medical records, while none used both.

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4 Site abstractors involved in the CR3 Project had varying degrees of experience
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6 with chart abstraction prior to participating in the project, with 54% of abstractors
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8 having 2 years of experience or less and 23% having less than one month of
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10 experience. Among the 13 inpatient and outpatient sites, the pair of abstractors
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12 had similar levels of experience at 11 sites ~~(both abstractors had less than 2~~
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14 ~~years of experience at 6 sites, and both had more than 2 years of experience at 5~~
15
16 ~~sites)~~. Excluding the 2 sites in which the pairs of abstractors had discordant
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18 levels of experience, we found that ratings of CR/SP eligibility, exceptions, and
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20 referral were not more reliable from abstractors having more than 2 years of
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22 experience. Interestingly, some of these ratings reflected more favorable
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24 reliability in abstractors having less than 2 years of experience (data not shown).
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31 In addition, we did not find a difference between the reliability of the first
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33 abstractions and the second abstractions, suggesting that there was no “learning
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35 effect” among abstractors.
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41 The mean \pm SD time per chart abstraction, reported by abstractors was 4.9 ± 3.2
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43 minutes for inpatient abstractions and 6.8 ± 4.7 minutes for outpatient
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45 abstractions.
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50 *Reliability Outcomes*

51 *Inpatient Sites (See Table 3)*

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53 Intra-abstractor reliability analysis of pooled inpatient data demonstrated
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55 excellent repeatability for ratings of CR/SP eligibility (100% agreement, $\kappa = 1.00$),
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CR/SP exceptions (96% agreement, $\kappa = 0.76$), and CR/SP referral (98% agreement, $\kappa = 0.95$). Based on site-specific inpatient data, each of the three CR/SP items showed high percent agreement ($\geq 90\%$) at all sites, and excellent repeatability ($\kappa \geq 0.75$) in the majority of sites (100% of sites for patient eligibility, 67% for patient exceptions, and 80% for patient referral).

Pooled analysis of inpatient sites demonstrated excellent inter-abtractor reliability analysis for ratings of CR/SP eligibility (94% agreement, $\kappa = 0.77$) and CR/SP exceptions (97% agreement, $\kappa = 0.79$), and modest agreement between abstractors for rating CR/SP referral (86% agreement, $\kappa = 0.70$). Consistent with the pooled results, site-specific analyses demonstrated excellent inter-abtractor reliability (as measured by $\kappa \geq 0.75$) in the majority of inpatient sites for ratings of eligibility (71% of sites) and exceptions (67% of sites), but in less than half (40%) of sites for the rating of CR/SP referral.

Outpatient Sites (See Table 3)

Pooled analyses of the six outpatient sites demonstrated excellent intra-abtractor reliability for the three ratings of CR/SP eligibility, exceptions, and referral (agreement $\geq 95\%$, $\kappa \geq 0.88$). From site-specific analysis of intra-abtractor reliability, percent agreement $\geq 90\%$ was observed in all six sites for ratings of CR/SP eligibility and exceptions, and in all but one site for rating of CR/SP referral. Likewise, excellent repeatability ($\kappa \geq 0.75$) was demonstrated in the

majority of outpatient sites (100% of sites for rating of eligibility, 67% for exceptions, and 67% for referral).

Regarding inter-abtractor reliability for outpatient sites, pooled analyses reflected excellent agreement between abstractors for ratings of both CR/SP eligibility ($\kappa = 0.78$) and CR/SP referral ($\kappa = 0.80$), and poor to fair agreement in rating patient exceptions for CR/SP referral ($\kappa = 0.43$). Similarly, according to site-specific results, excellent inter-abtractor reliability was observed in most (two-thirds) of the outpatient sites for rating CR/SP eligibility, and in none of the sites for rating CR/SP exceptions. Interestingly, despite excellent inter-abtractor agreement for rating CR/SP referral obtained from pooled analysis, site-specific results varied considerably (range of κ across six sites, -0.07 to 1.00), with excellent reliability seen in only one-third of outpatient sites (and percent agreement below 90% in half the sites).

Discussion

This study demonstrates high reliability for assessing CR/SP eligibility, referral, and exceptions using the CR/SP outpatient and inpatient performance measures. Data abstraction of patient records was performed by abstractors with varying amounts of abstraction experience at a variety of inpatient and outpatient centers, suggesting generalizability of our findings.

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4 Reliability testing is one of 3 important steps in developing high value PM's, as
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6 outlined by the ACCF/AHA Task Force on Performance Measures[19]. The 3
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8 steps include: (1) construction of the measurement set, (2) assessment of
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10 feasibility and reliability of data collection, and (3) measurement of clinicians'
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12 performance. Construction of the CR/SP PM set has previously been
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14 reported[12-17].
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24 Our testing generally found high reliability for comparisons between abstractors
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26 for the 3 key components of the CR/SP PM's: patient eligibility for CR/SP, patient
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28 exceptions to CR/SP referral, and patient referral to CR/SP. We included two
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30 measures of reliability, each shedding important light on the reliability of PM
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32 abstraction: percent agreement and the kappa statistic. "Percent agreement" is
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34 a helpful assessment of reliability, but given that over 80% of patients in the
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36 study sample were eligible for CR/SP, and more than 90% of patients were
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38 absent exceptions to CR/SP participation, the percent agreement may have been
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40 somewhat inflated, since by chance alone abstractors may have chosen the
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42 correct eligibility or exception status.
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51 Conversely, the kappa statistic performs best when there is nearly equal chance
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53 of study outcomes. When there is a high likelihood of one of the two outcomes,
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55 as in our study (high likelihood of CR/SP eligibility), the results of the kappa
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57 analyses can underestimate true reliability due to a phenomenon known as the
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“kappa score paradox” in which there is high percent agreement, yet a low kappa score[21, 22]. Indeed, we observed this paradox in some centers. The true reliability of abstracting our PM’s most likely lies between the results from the two methods of assessment we used. Since the “percent agreement” method generally suggests very high reliability of the CR/SP measures and the kappa statistic generally suggests moderate to high reliability, the true reliability of the CR/SP performance measure would appear overall to be high.

Data abstractors reported that data abstraction time was modest for the in-patient (4.9 minutes) and out-patient (6.8 minutes) CR/SP PM’s, and reported minimal barriers to their abstraction activities. If the CR/SP PM’s are included in sets of other PM’s, such as the PM set for CABG surgery, for example, it is likely that efficiencies of scale will result in less time being required for the CR/SP PM assessment.

Limitations

We selected participating centers to reflect variation in the location, size, and type of centers. However, our study is based on the experience of a relatively small number of centers from around the United States that volunteered to be in the project and may not be representative other centers from different regions.

Lessons Learned

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4 Outpatient abstraction of the CR/SP performance measure data was more time-
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6 consuming and somewhat less reliable than the abstraction of inpatient data.
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8 This is explained in large part by the fact that the review of inpatient data is
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10 limited to the time of the patient's index hospitalization (i.e., the time of the
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12 cardiac event that qualified them for CR/SP). Review of outpatient data is
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14 broader, including a review of records for up to 12 months previous to the
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16 outpatient visit and also a review of records for up to 12 month after the
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18 outpatient visit, due to the fact that patients are eligible for CR/SP for up to 12
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20 months following their qualifying cardiac event.
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28 *Future Directions*

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31 Healthcare provider education through effective communication channels is
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33 critically important to help providers understand and document appropriate
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35 exceptions to CR/SP referral, as well as the key components of CR/SP referral
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37 documentation: 1) that the patient has been referred to CR/SP, 2) that the patient
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39 has been given information and guidance to help them enroll in CR/SP, and 3)
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41 that the receiving CR/SP program has been sent patient information to expedite
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43 CR/SP enrollment).
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51 Current practices and existing ACCF and AHA registries only require
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53 documentation that the patient has been referred to a CR/SP program. Published
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55 evidence suggests that the use of additional communication components, as
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57 specified in the measures, may increase the predictive validity of the measures
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[23]. Going forward, with the advent of better data collection systems for CR/SP referral and the ability now to track CR/SP enrollment through the AACVPR Outpatient Cardiac Rehabilitation Registry we expect to be able to test the hypothesis that this more detailed definition of CR/SP referral will increase enrollment in CR/SP. Furthermore, computerized decision support, made more widely available through efforts to enhance the meaningful use of electronic health records, may also provide value by increasing the ability to track and improve the appropriate utilization of CR/SP.

Reliability of CR/SP performance measure abstraction is high. Data abstractors reported minimal barriers to the abstraction process and required a relatively small amount of time per patient to carry out the abstractions. These results contribute to published evidence regarding the soundness and generalizability of the CR/SP PM's. Further work will need to be carried out to assess the impact of the CR/SP PM's on patient referral rates and patient outcomes.

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~~Figure 1: Performance measures for referral to cardiac rehabilitation/secondary prevention programs from the in-patient (A) and out-patient (B) settings~~

Figure 21: Recruitment of participating centers in the CR3 Project

**Reliability of Abstracting Performance Measures:
Results of the Cardiac Rehabilitation Referral and Reliability (CR3) Project**

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STRUCTURED ABSTRACT

BACKGROUND: Assessment of the reliability of performance measure (PM) abstraction is an important step in PM validation. Reliability has not been previously assessed for abstracting PMs for the referral of patients to cardiac rehabilitation and secondary prevention (CR/SP) programs. To help validate these PMs, we carried out a multicenter assessment of their reliability.

METHODS: Hospitals and clinical practices from around the U.S. were invited to participate in the CR3 Project. Twenty-nine hospitals and 23 outpatient centers expressed interest in participating. Seven hospitals and 6 outpatient centers met participation criteria and submitted completed data. Site coordinators identified 35 patients whose charts were reviewed by 2 site abstractors twice, 1 week apart. Percent agreement and Cohen's kappa statistic were used to describe intra- and inter-abstractor reliability for patient eligibility for CR/SP, patient exceptions for CR/SP referral, and documented referral to CR/SP.

RESULTS: Results were obtained from within-site data, as well as from pooled data of all inpatient and all outpatient sites. We found that intra-abstractor reliability reflected excellent repeatability ($\geq 90\%$ agreement, $\kappa \geq 0.75$) for ratings of CR/SP eligibility, exceptions, and referral, both from pooled and site-specific analyses of inpatient and outpatient data. Similarly, the inter-abstractor agreement from pooled analysis ranged from good to excellent for the 3 items, although with slightly lower measures of reliability.

CONCLUSIONS: Abstraction of PMs for CR/SP referral has high reliability, supporting the use of these PMs in quality improvement initiatives aimed at increasing CR/SP delivery to patients with cardiovascular disease.

CONDENSED ABSTRACT

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Cardiac rehabilitation and secondary prevention (CR/SP) services are significantly associated with positive health outcomes in a variety of patients with cardiac disorders¹⁻⁷ yet only a minority of eligible patients ever participate in CR/SP.⁸⁻¹⁰ The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), American College of Cardiology Foundation (ACCF), and American Heart Association (AHA)¹¹ have developed, and the National Quality Forum (NQF) has endorsed, performance measures (PM's) for CR/SP referral to increase the delivery of CR/SP to appropriate patients (see Table 1).¹²⁻¹⁷ In addition, the Centers for Medicare and Medicaid Services (CMS) has included these measures in the Physician Quality Reporting System, and will begin reporting audits of these PMs in the outpatient setting in 2015.

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Assessment of the reliability of data collection for performance measurement is an important step included in the ACCF/AHA methodology for the development and identification of high-value performance measures [18, 19]. However, to our knowledge, no studies have been published that have evaluated the reliability of collecting CR/SP performance measures. To address this need, and to respond to NQF requirements to provide such data as part of their endorsement process, we carried out a multi-site study, the Cardiac Rehabilitation Referral Reliability (CR3) Project, aimed at analyzing the reliability of abstracting the CR/SP PMs from inpatient and outpatient records.

METHODS

Hospitals and outpatient cardiology practices in the United States were identified from the ACCF, AHA, and AACVPR databases and were invited to participate. We sought a variety of hospitals and clinics, based on different geographical locations, community sizes, and

hospital/practice types/sizes (Figure 1). All 540 outpatient cardiology practices that were members of the ACCF outpatient quality and outcomes data registry (known as the PINNACLE network) as of October 1, 2011 were invited by email to participate in the CR3 Project as outpatient sites. The PINNACLE Network helps cardiovascular teams achieve practice success through quality measurement, performance improvement, and peer-to-peer learning through an interactive community that connects practices across the country. In addition, an invitation to participate in the CR3 Project as an inpatient and/or an outpatient site was sent by email to 2916 members of AACVPR, and targeted invitations were sent to 5 Board members, 6 Past Presidents, and 11 Committee Chairs of AACVPR, as well as to the CR/SP programs that were participating in the Wisconsin State Cardiac Rehabilitation Registry (70 centers) and the Montana State Cardiac Rehabilitation Registry (145 programs). Twenty-nine hospitals and 23 outpatient practices responded, expressing interest in participating in the project.

Based on available resources to carry out the CR3 Project, we initially planned to include a maximum of 12 sites in the project, with varied geographical locations and center characteristics. An additional site was added since it was able to participate without the need for CR3 Project resources, resulting in a total of 7 inpatient and 6 outpatient practices that participated in the project. Inclusion criteria included a willingness to participate, and ability to: (1) provide a study coordinator and 2 separate chart abstractors, (2) complete the project within the specified timeline, and (3) obtain local IRB clearance to carry out the project in their setting. Once each hospital and practice completed and submitted their required data, they were sent a small incentive as a token of appreciation for their participation and submission of complete project data from their site (\$200 gift card). Completed data were received from 7 hospitals and 6 outpatient cardiology practices.

Chart Abstraction

For inpatient facilities, charts of patients who had an index hospitalization (ie, a hospitalization for a cardiac event that is a qualifying diagnosis or procedure for CR/SP) between August 1, 2009 and August 1st 2010 were eligible for review and inclusion. For outpatient centers, charts of patients who had an outpatient visit between August 1, 2009 and August 1, 2010 were eligible for review and inclusion. However, since the performance measure allows as long as 12 months for a patient to complete CR/SP following a qualifying cardiac event, chart abstraction included a search for a qualifying cardiac event between August 1, 2009 and August 1, 2010, along with a search of records for up to 12 months after the cardiac event, to search for documentation of CR/SP referral during that time period.

Study sites designated 1 study coordinator and 2 chart abstractors. Each study coordinator identified 35 patients from a consecutive sample of patients: 30 patients with an eligible diagnosis for CR/SP referral, and 5 without an eligible diagnosis for CR/SP (see below for additional details). The 2 abstractors at each site reviewed the same 35 patient records that had been selected from their site twice (once at baseline, and again 1 week later). Abstractors had a range of experience reviewing charts, from less than 1 month to greater than 5 years.

Abstractors were blinded as to which patients in their sample had a qualifying diagnosis and which patients had exceptions for CR/SP. Only the site coordinator, who did not participate in the abstraction process, had access to this information. Patients considered to have qualifying events for CR/SP, as defined by CMS and therefore as specified in the performance measure, had 1 or more of the following: myocardial infarction, percutaneous coronary intervention, coronary artery bypass graft surgery, heart valve surgery, heart transplantation surgery, and chronic stable angina. Patients without a qualifying event, for the purpose of this abstraction project, were to

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10 have had documented 1 or more of the following diagnoses that are not currently considered by
11 CMS to be a covered indication for CR/SP:
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- 13 • *For inpatient centers:* atrial fibrillation, heart failure, or syncope during the index
14 hospitalization period under review (with no documented qualifying events for CR during
15 that same hospitalization)
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17 • *For outpatient centers:* atypical chest pain, palpitations, or dyspnea during the 12 months
18 prior to the index outpatient visit (with no documented qualifying events for CR referral
19 during that same time period).
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25 The CR3 Project workgroup created chart abstraction forms, site coordinator instructions,
26 abstractor instructions, a frequently asked questions document, and site tracking forms to allow
27 the study coordinator to track and report site specific results for intra-abstractor (1 abstractor
28 reviewing the chart 2 times) and inter-abstractor (2 abstractors reviewing 1 chart) reliability. The
29 workgroup held a kickoff call with each center's study coordinator to train them prior to the start
30 of the CR3 project. Thereafter, the workgroup communicated weekly with site coordinators to
31 address any questions or operational concerns that arose. The training of site coordinators was
32 carried out during 1-2 one-hour conference calls prior to starting the project. When coordinators
33 had questions, they contacted the staff liaison to the CR3 working group directly by email or
34 telephone. New questions and their corresponding answers were communicated weekly to all site
35 coordinators. The entire project took approximately 20 weeks to complete (October 2011
36 through February 2012).
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51 **Definitions**

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53 The following definitions were developed for use in the study:
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Eligible patients for CR/SP referral:

- Inpatient: a patient who survived the index hospitalization and who had a qualifying event/diagnosis for referral to CR/SP during the index hospitalization period under review.
- Outpatient: a patient who had a qualifying event/diagnosis for referral to CR/SP within the previous 12 months prior to the index outpatient visit.

Patients not eligible for CR/SP referral:

- Inpatient: a patient who had a cardiac event/diagnosis (atrial fibrillation, heart failure, or syncope for purposes of this study) during the index hospitalization period under review and no indication for CR/SP referral as specified in the performance measure.
- Outpatient: a patient who had a cardiac event/diagnosis (atypical chest pain, palpitations, or dyspnea for purposes of this study) during the 12 months prior to the index outpatient visit, and no indication for CR/SP referral as specified in the performance measure.

CR/SP referral:

- Inpatient: documentation in a patient's hospital medical records that the patient was referred to an outpatient CR/SP program.
- Outpatient: documentation in a patient's outpatient clinical medical records that the patient has been referred to an outpatient CR/SP program within 12 months after a qualifying event/diagnosis.

For purposes of this project, documentation in the medical record could include any of the following sources: hospital discharge summaries, office notes, clinical notes and medical records, orders (written/electronic), prescriptions (e.g. contact information for CR/SP specialist), or other parts of the clinical record that documents patient information.

Exceptions

Because there are valid reasons why certain patients should not be referred to a CR/SP program, exceptions to the CR/SP measures are allowed. When a clinician is allowed to document exceptions he or she is given the flexibility to decide whether or not to institute a given intervention/process depending upon the overall benefits and risks to the patient. Exceptions allow clinicians this flexibility without the threat of being “penalized” for not referring a patient to CR/SP. Without the presence of exceptions, potential negative unintended consequences could arise such as forcing CR/SP on patients who are unstable. Furthermore, analysis of exception rates for quality improvement purposes allows providers and health systems to test the effects of process changes within their practices and communities that may facilitate CR/SP referral. Relatively few patients would be expected to qualify for an exception to CR/SP referral. Such exceptions would generally be limited to factors that may make CR/SP unsafe, ineffective, or lack of accessibility to a CR/SP program within a reasonable commuting distance.

Such exceptions would generally be limited to factors that may make CR/SP unsafe or ineffective, or that otherwise prohibit access to a CR/SP program. Examples of exceptions from referral to CR/SP include:

- Patient exceptions (eg, patient resides in a long-term nursing care facility)
- Medical exceptions (eg, presence of an acute medical condition that makes the patient unstable and unsafe for exercise training)
- System exceptions (eg, lack of an available CR/SP program within 60 minutes of travel time from the patient’s home)

Since the measures look only at whether patients were referred, not whether they enrolled, patient refusal was not considered to be an exception. If a healthcare provider recommended

CR/SP referral to a patient, the patient refused the referral, and the provider documented the patient refusal, then that encounter was judged to have met the performance measure since the provider complied with the expectation to recommend referral to CR/SP.

Data Analyses

Both Cohen's kappa (κ) statistic and percent agreement were used to measure the intra-abstractor and inter-abstractor reliability for the following qualitative ratings: (1) documented eligibility for CR/SP referral, (2) exception documented for CR/SP referral, and (3) documentation of CR/SP referral. The κ statistic is a chance-corrected index of agreement ranging from -1 to 1, with $\kappa < 0$ representing observed agreement worse than that due to chance alone. We interpreted a κ over 0.75 as excellent, 0.40 to 0.75 as fair to good, and below 0.40 as poor, following the guidelines of Fleiss et al.²⁰ Unlike the κ statistic, percent agreement does not take into account the agreement occurring by chance, but can be informative in situations for which the prevalence of a given response is very high or low and the interpretation based solely on the value of κ may be misleading. This phenomenon known as the kappa paradox[21, 22] occurs when the observed proportion of agreement is high but the value of the κ statistic is low.

For brevity, intra-abstractor reliability is reported for only 1 of the 2 abstractors (arbitrarily-designated "abstractor 1" at each site), and inter-abstractor reliability only for the initial set of ratings (ie, "time 1"). Stratifying on inpatient vs. outpatient setting, reliability was analyzed 1) on the overall group with sites pooled together, and 2) within sites and summarizing the site-specific results across the overall group. All analyses were performed using the SAS statistical software package (version 9.2, SAS Institute Inc., Cary, NC).

RESULTS

Characteristics of the 234 inpatients and 211 outpatients (total 445) included in the CR3 Project are shown in Table 2. The majority of patients from both inpatient and outpatient sites were male, white, and younger than 65 years of age. A total of 1746 chart reviews were performed for the CR3 Project (415 (93%) of the total 445 patient charts were reviewed as specified in the CR3 Project protocol, each 1 being reviewed 4 times (2 by each abstractor), while incomplete reporting of data resulted in 26 that were reviewed only 3 times each, and 4 that were each reviewed only twice).

Participating centers represented a variety of practice types and settings, including the following: Rural, suburban, or urban area locations; teaching and non-teaching centers; and single specialty and multispecialty centers. One hospital was from the Pacific Northwest, 4 from the Midwest, 1 from the Northeast, and 1 from the Southeast. Three inpatient centers used paper medical records, 5 used electronic medical records, and 2 used both. Outpatient clinics in the CR3 Project were located throughout the Midwest and in the Southeastern part of the United States. Two outpatient clinics used paper medical records and 4 used electronic medical records, while none used both.

Site abstractors involved in the CR3 Project had varying degrees of experience with chart abstraction prior to participating in the project, with 54% of abstractors having 2 years of experience or less and 23% having less than one month of experience. Among the 13 inpatient and outpatient sites, the pair of abstractors had similar levels of experience at 11 sites). Excluding the 2 sites in which the pairs of abstractors had discordant levels of experience, we found that ratings of CR/SP eligibility, exceptions, and referral were not more reliable from abstractors having more than 2 years of experience. Interestingly, some of these ratings reflected

more favorable reliability in abstractors having less than 2 years of experience (data not shown).

In addition, we did not find a difference between the reliability of the first abstractions and the second abstractions, suggesting that there was no “learning effect” among abstractors. The mean \pm SD time per chart abstraction, reported by abstractors was 4.9 ± 3.2 minutes for inpatient abstractions and 6.8 ± 4.7 minutes for outpatient abstractions.

Reliability Outcomes

Inpatient Sites (Table 3)

Intra-abstractor reliability analysis of pooled inpatient data demonstrated excellent repeatability for ratings of CR/SP eligibility (100% agreement, $\kappa = 1.00$), CR/SP exceptions (96% agreement, $\kappa = 0.76$), and CR/SP referral (98% agreement, $\kappa = 0.95$). Based on site-specific inpatient data, each of the three CR/SP items showed high percent agreement ($\geq 90\%$) at all sites, and excellent repeatability ($\kappa \geq 0.75$) in the majority of sites (100% of sites for patient eligibility, 67% for patient exceptions, and 80% for patient referral).

Pooled analysis of inpatient sites demonstrated excellent inter-abstractor reliability analysis for ratings of CR/SP eligibility (94% agreement, $\kappa = 0.77$) and CR/SP exceptions (97% agreement, $\kappa = 0.79$), and modest agreement between abstractors for rating CR/SP referral (86% agreement, $\kappa = 0.70$). Consistent with the pooled results, site-specific analyses demonstrated excellent inter-abstractor reliability (as measured by $\kappa \geq 0.75$) in the majority of inpatient sites for ratings of eligibility (71% of sites) and exceptions (67% of sites), but in less than half (40%) of sites for the rating of CR/SP referral.

Outpatient Sites (Table 3)

Pooled analyses of the 6 outpatient sites demonstrated excellent intra-abstractor reliability for the 3 ratings of CR/SP eligibility, exceptions, and referral (agreement $\geq 95\%$, $\kappa \geq 0.88$). From site-specific analysis of intra-abstractor reliability, percent agreement $\geq 90\%$ was observed in all 6 sites for ratings of CR/SP eligibility and exceptions, and in all but 1 site for rating of CR/SP referral. Likewise, excellent repeatability ($\kappa \geq 0.75$) was demonstrated in the majority of outpatient sites (100% of sites for rating of eligibility, 67% for exceptions, and 67% for referral).

Regarding inter-abstractor reliability for outpatient sites, pooled analyses reflected excellent agreement between abstractors for ratings of both CR/SP eligibility ($\kappa = 0.78$) and CR/SP referral ($\kappa = 0.80$), and poor to fair agreement in rating patient exceptions for CR/SP referral ($\kappa = 0.43$). Similarly, according to site-specific results, excellent inter-abstractor reliability was observed in most (two-thirds) of the outpatient sites for rating CR/SP eligibility, and in none of the sites for rating CR/SP exceptions. Interestingly, despite excellent inter-abstractor agreement for rating CR/SP referral obtained from pooled analysis, site-specific results varied considerably (range of κ across six sites, -0.07 to 1.00), with excellent reliability seen in only one-third of outpatient sites (and percent agreement below 90% in half the sites).

DISCUSSION

This study demonstrates high reliability for assessing CR/SP eligibility, referral, and exceptions using the CR/SP outpatient and inpatient performance measures. Data abstraction of patient records was performed by abstractors with varying amounts of abstraction experience at a variety of inpatient and outpatient centers, suggesting generalizability of our findings.

Reliability testing is one of 3 important steps in developing high value PMs, as outlined by the ACCF/AHA Task Force on Performance Measures[19]. The 3 steps include: (1) construction of the measurement set, (2) assessment of feasibility and reliability of data collection, and (3) measurement of clinician performance. Construction of the CR/SP PM set has previously been reported[12-17].

Our testing generally found high reliability for comparisons between abstractors for the 3 key components of the CR/SP PM's: patient eligibility for CR/SP, patient exceptions to CR/SP referral, and patient referral to CR/SP. We included 2 measures of reliability, each shedding important light on the reliability of PM abstraction: percent agreement and the kappa statistic. "Percent agreement" is a helpful assessment of reliability, but given that over 80% of patients in the study sample were eligible for CR/SP, and more than 90% of patients were absent exceptions to CR/SP participation, the percent agreement may have been somewhat inflated, since by chance alone abstractors may have chosen the correct eligibility or exception status.

Conversely, the kappa statistic performs best when there is nearly equal chance of study outcomes. When there is a high likelihood of one of the 2 outcomes, as in our study (high likelihood of CR/SP eligibility), the results of the kappa analyses can underestimate true reliability due to a phenomenon known as the "kappa score paradox" in which there is high percent agreement, yet a low kappa score[21, 22]. Indeed, we observed this paradox in some centers. The true reliability of abstracting our PMs most likely lies between the results from the 2 methods of assessment we used. Since the "percent agreement" method generally suggests very high reliability of the CR/SP measures and the kappa statistic generally suggests moderate to high reliability, the true reliability of the CR/SP performance measure would appear overall to be high.

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10 Data abstractors reported that data abstraction time was modest for the inpatient (4.9
11 minutes) and outpatient (6.8 minutes) CR/SP PMs, and reported minimal barriers to their
12 abstraction activities. If the CR/SP PMs are included in sets of other PM's, such as the PM set
13 for CABG surgery, for example, it is likely that efficiencies of scale will result in less time being
14 required for the CR/SP PM assessment.
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21 **Limitations**

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23 We selected participating centers to reflect variation in the location, size, and type of centers.
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25 However, our study is based on the experience of a relatively small number of centers from
26 around the United States that volunteered to be in the project and may not be representative other
27 centers from different regions.
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33 **Lessons Learned**

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35 Outpatient abstraction of the CR/SP performance measure data was more time-consuming and
36 somewhat less reliable than the abstraction of inpatient data. This is explained in large part by
37 the fact that the review of inpatient data is limited to the time of the patient index hospitalization
38 (ie, the time of the cardiac event that qualified them for CR/SP). Review of outpatient data is
39 broader, including a review of records for up to 12 months previous to the outpatient visit and
40 also a review of records for up to 12 month after the outpatient visit, due to the fact that patients
41 are eligible for CR/SP for up to 12 months following their qualifying cardiac event.
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51 **Future Directions**

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Healthcare provider education through effective communication channels is critically important to help providers understand and document appropriate exceptions to CR/SP referral, as well as the key components of CR/SP referral documentation: 1) that the patient has been referred to CR/SP, 2) that the patient has been given information and guidance to help them enroll in CR/SP, and 3) that the receiving CR/SP program has been sent patient information to expedite CR/SP enrollment).

Current practices and existing ACCF and AHA registries only require documentation that the patient has been referred to a CR/SP program. Published evidence suggests that the use of additional communication components, as specified in the measures, may increase the predictive validity of the measures.²³ Going forward, with the advent of better data collection systems for CR/SP referral and the ability now to track CR/SP enrollment through the AACVPR Outpatient Cardiac Rehabilitation Registry, we expect to be able to test the hypothesis that this more detailed definition of CR/SP referral will increase enrollment in CR/SP. Furthermore, computerized decision support, made more widely available through efforts to enhance the meaningful use of electronic health records, may also provide value by increasing the ability to track and improve the appropriate utilization of CR/SP.

Reliability of CR/SP performance measure abstraction is high. Data abstractors reported minimal barriers to the abstraction process and required a relatively small amount of time per patient to carry out the abstractions. These results contribute to published evidence regarding the soundness and generalizability of the CR/SP PMs. Further work will need to be carried out to assess the impact of the CR/SP PMs on patient referral rates and patient outcomes.

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Reliability of Abstracting Performance Measures

RESULTS OF THE CARDIAC REHABILITATION REFERRAL AND RELIABILITY (CR3) PROJECT

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■ **BACKGROUND:** Assessment of the reliability of performance measure (PM) abstraction is an important step in PM validation. Reliability has not been previously assessed for abstracting PMs for the referral of patients to cardiac rehabilitation (CR) and secondary prevention (SP) programs. To help validate these PMs, we carried out a multicenter assessment of their reliability.

■ **METHODS:** Hospitals and clinical practices from around the United States were invited to participate in the Cardiac Rehabilitation Referral Reliability (CR3) Project. Twenty-nine hospitals and 23 outpatient centers expressed interest in participating. Seven hospitals and 6 outpatient centers met participation criteria and submitted completed data. Site coordinators identified 35 patients whose charts were reviewed by 2 site abstractors twice, 1 week apart. Percent agreement and the Cohen κ statistic were used to describe intra- and interabstractor reliability for patient eligibility for CR/SP, patient exceptions for CR/SP referral, and documented referral to CR/SP.

■ **RESULTS:** Results were obtained from within-site data, as well as from pooled data of all inpatient and all outpatient sites. We found that intra-abstractor reliability reflected excellent repeatability ($\geq 90\%$ agreement; $\kappa \geq 0.75$) for ratings of CR/SP eligibility, exceptions, and referral, both from pooled and site-specific analyses of inpatient and outpatient data. Similarly, the interabstractor agreement from pooled analysis ranged from good to excellent for the 3 items, although with slightly lower measures of reliability.

■ **CONCLUSIONS:** Abstraction of PMs for CR/SP referral has high reliability, supporting the use of these PMs in quality improvement initiatives aimed at increasing CR/SP delivery to patients with cardiovascular disease.

KEY WORDS

cardiac rehabilitation

quality improvement

referral

reliability testing

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Cardiac rehabilitation (CR) and secondary prevention (SP) services are significantly associated with positive health outcomes in patients with cardiac disorders,¹⁻⁷ yet only a minority of eligible patients ever participate in CR/SP.⁸⁻¹⁰ The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), the American College of Cardiology Foundation (ACCF), and the American Heart Association (AHA)¹¹ have developed, and the National Quality Forum has endorsed, performance measures (PMs) for CR/SP referral to increase the delivery of CR/SP to appropriate patients (see Table 1).¹²⁻¹⁷ In addition, the Centers for Medicare & Medicaid Services has included these measures in the Physician Quality Reporting System and will begin reporting audits of these PMs in the outpatient setting in 2015.

Assessment of the reliability of data collection for performance measurement is an important step included in the ACCF/AHA methodology for the

development and identification of high-value PMs.^{18,19} However, to our knowledge, no studies have been published that have evaluated the reliability of collecting CR/SP PMs. To address this need, and to respond to the National Quality Forum requirements to provide such data as part of their endorsement process, we carried out a multisite study, the Cardiac Rehabilitation Referral Reliability (CR3) Project, aimed at analyzing the reliability of abstracting the CR/SP PMs from inpatient and outpatient records.

METHODS

Hospitals and outpatient cardiology practices in the United States were identified from the ACCF, AHA, and AACVPR databases and were invited to participate. We sought various hospitals and clinics, on the basis of

Table 1 • AACVPR/ACCF/AHA Performance Measures for Referral to a Cardiac Rehabilitation Program From an Inpatient and Outpatient Setting^{12,15}

Component	Details
Inpatient setting	
Performance measure	All patients hospitalized with a primary diagnosis of an acute myocardial infarction or chronic stable angina, or who during hospitalization have undergone coronary artery bypass graft surgery, a percutaneous coronary intervention, cardiac valve surgery, or cardiac transplantation are to be referred to an early outpatient cardiac rehabilitation/secondary prevention program
Numerator	The number of eligible patients with a qualifying event/diagnosis who have been referred to an outpatient cardiac rehabilitation program before hospital discharge or have a documented medical or patient-centered reason why such a referral was not made
Denominator	The number of hospitalized patients in the reporting period hospitalized with a qualifying event/diagnosis who do not meet any of the exception criteria
Exceptions	Patient-oriented factors (eg, patient discharged to a nursing care facility for long-term care) Medical factors (eg, patient deemed to have a medically unstable, life-threatening condition) Health care system factors (eg, lack of cardiac rehabilitation program near a patient home)
Outpatient setting	
Performance measure	All patients evaluated in an outpatient setting who within the past 12 months have experienced an acute myocardial infarction, coronary artery bypass graft surgery, a percutaneous coronary intervention, cardiac valve surgery, or cardiac transplantation, or who have chronic stable angina and have not already participated in an early outpatient cardiac rehabilitation/secondary prevention program for the qualifying event/diagnosis are to be referred to such a program
Numerator	The number of patients in an outpatient clinical practice who have had a qualifying event/diagnosis during the previous 12 months, who have been referred to an outpatient cardiac rehabilitation program
Denominator	The number of patients in an outpatient clinical practice who have had a qualifying event/diagnosis during the previous 12 months and who do not meet any of the exception criteria, and who have not already participated in an outpatient cardiac rehabilitation program since the qualifying event.
Exceptions	Patient oriented factors (eg, patient discharged to a nursing care facility for long-term care) Medical factors (eg, patient deemed to have a medically unstable, life-threatening condition) Health care system factors (eg, lack of cardiac rehabilitation program near a patient home)

Abbreviations: AACVPR, American Association of Cardiovascular and Pulmonary Rehabilitation; ACCF, American College of Cardiology Foundation; AHA, American Heart Association.

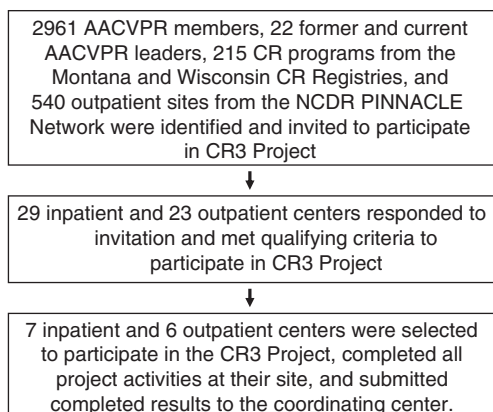


Figure 1. Recruitment of participating centers in the CR3 Project. AACVPR indicates American Association of Cardiovascular and Pulmonary Rehabilitation; CR, cardiac rehabilitation; CR3, Cardiac Rehabilitation Referral Reliability; NCDR, National Cardiovascular Data Registry.

different geographical locations, community sizes, and hospital/practice types/sizes (Figure 1). All 540 outpatient cardiology practices that were members of the ACCF outpatient quality and outcomes data registry (known as the PINNACLE network) as of October 1, 2011, were invited by e-mail to participate in the CR3 Project as outpatient sites. The PINNACLE Network helps cardiovascular teams achieve practice success through quality measurement, performance improvement, and peer-to-peer learning through an interactive community that connects practices across the country. In addition, an invitation to participate in the CR3 Project as an inpatient and/or an outpatient site was sent by e-mail to 2916 members of AACVPR, and targeted invitations were sent to 5 board members, 6 past presidents, and 11 committee chairs of the AACVPR, as well as to the CR/SP programs that were participating in the Wisconsin State Cardiac Rehabilitation Registry (70 centers) and the Montana State Cardiac Rehabilitation Registry (145 programs). Twenty-nine hospitals and 23 outpatient practices responded, expressing interest in participating in the project.

On the basis of available resources to carry out the CR3 Project, we initially planned to include a maximum of 12 sites in the project, with varied geographical locations and center characteristics. An additional site was added, since it was able to participate without the need for CR3 Project resources, resulting in a total of 7 inpatient and 6 outpatient practices that participated in the project. Inclusion criteria included a willingness to participate and ability to (1) provide a study coordinator and 2 separate chart abstractors, (2) complete the project within the specified timeline, and (3) obtain local institutional review board clearance to carry out the project in their setting. Once each hospital and practice completed and submitted their required data, they were sent a small incentive

as a token of appreciation for their participation and submission of complete project data from their site (\$200 gift card). Completed data were received from 7 hospitals and 6 outpatient cardiology practices.

Chart Abstraction

For inpatient facilities, charts of patients who had an index hospitalization (ie, a hospitalization for a cardiac event that is a qualifying diagnosis or procedure for CR/SP) between August 1, 2009, and August 1, 2010, were eligible for review and inclusion. For outpatient centers, charts of patients who had an outpatient visit between August 1, 2009, and August 1, 2010, were eligible for review and inclusion. However, since the PM allows as long as 12 months for a patient to complete CR/SP following a qualifying cardiac event, chart abstraction included a search for a qualifying cardiac event between August 1, 2009, and August 1, 2010, along with a search of records for up to 12 months after the cardiac event, to search for documentation of CR/SP referral during that time period.

Study sites designated 1 study coordinator and 2 chart abstractors. Each study coordinator identified 35 patients from a consecutive sample of patients: 30 patients with an eligible diagnosis for CR/SP referral, and 5 without an eligible diagnosis for CR/SP (see later for additional details). The 2 abstractors at each site reviewed the same 35 patient records that had been selected from their site twice (once at baseline and again 1 week later). Abstractors had a range of experience reviewing charts, from less than 1 month to greater than 5 years.

Abstractors were blinded as to which patients in their sample had a qualifying diagnosis and which patients had exceptions for CR/SP. Only the site coordinator, who did not participate in the abstraction process, had access to this information. Patients considered to have qualifying events for CR/SP, as defined by the Centers for Medicare & Medicaid Services and therefore as specified in the PM, had 1 or more of the following: myocardial infarction, percutaneous coronary intervention, coronary artery bypass graft surgery, heart valve surgery, heart transplantation surgery, and chronic stable angina. Patients without a qualifying event, for the purpose of this abstraction project, were to have had documented 1 or more of the following diagnoses that are not currently considered by the Centers for Medicare & Medicaid Services to be a covered indication for CR/SP:

- *For inpatient centers:* atrial fibrillation, heart failure, or syncope during the index hospitalization period under review (with no documented qualifying events for CR during that same hospitalization).
- *For outpatient centers:* atypical chest pain, palpitations, or dyspnea during the 12 months before the

index outpatient visit (with no documented qualifying events for CR referral during that same time period).

The CR3 Project workgroup created chart abstraction forms, site coordinator instructions, abstractor instructions, a frequently asked questions document, and site tracking forms to allow the study coordinator to track and report site-specific results for intra-abstractor (1 abstractor reviewing the chart 2 times) and interabstractor (2 abstractors reviewing 1 chart) reliability. The workgroup held a kickoff call with each center's study coordinator to train them before the start of the CR3 Project. Thereafter, the workgroup communicated weekly with site coordinators to address any questions or operational concerns that arose. The training of site coordinators was carried out during one or two 1-hour conference calls before starting the project. When coordinators had questions, they contacted the staff liaison to the CR3 working group directly by e-mail or telephone. New questions and their corresponding answers were communicated weekly to all site coordinators. The entire project took approximately 20 weeks to complete (October 2011 through February 2012).

Definitions

The following definitions were developed for use in the study.

Eligible patients for CR/SP referral:

- Inpatient: a patient who survived the index hospitalization and who had a qualifying event/diagnosis for referral to CR/SP during the index hospitalization period under review.
- Outpatient: a patient who had a qualifying event/diagnosis for referral to CR/SP within the previous 12 months before the index outpatient visit.

Patients not eligible for CR/SP referral:

- Inpatient: a patient who had a cardiac event/diagnosis (atrial fibrillation, heart failure, or syncope for purposes of this study) during the index hospitalization period under review and no indication for CR/SP referral as specified in the PM.
- Outpatient: a patient who had a cardiac event/diagnosis (atypical chest pain, palpitations, or dyspnea for purposes of this study) during the 12 months before the index outpatient visit and no indication for CR/SP referral as specified in the PM.

CR/SP referral:

- Inpatient: documentation in patient hospital medical records that the patient was referred to an outpatient CR/SP program.

- Outpatient: documentation in patient outpatient clinical medical records that the patient has been referred to an outpatient CR/SP program within 12 months after a qualifying event/diagnosis.

For purposes of this project, documentation in the medical record could include any of the following sources: hospital discharge summaries, office notes, clinical notes and medical records, orders (written/electronic), prescriptions (eg, contact information for CR/SP specialist), or other parts of the clinical record that documents patient information.

Exceptions

Because there are valid reasons why certain patients should not be referred to a CR/SP program, exceptions to the CR/SP measures are allowed. When a clinician is allowed to document exceptions, he or she is given the flexibility to decide whether or not to institute a given intervention/process depending upon the overall benefits and risks to the patient. Exceptions allow clinicians this flexibility without the threat of being "penalized" for not referring a patient to CR/SP. Without the presence of exceptions, potential negative unintended consequences could arise, such as forcing CR/SP on patients who are unstable. Furthermore, analysis of exception rates for quality improvement purposes allows providers and health systems to test the effects of process changes within their practices and communities that may facilitate CR/SP referral. Relatively few patients would be expected to qualify for an exception to CR/SP referral. Such exceptions would generally be limited to factors that may make CR/SP unsafe or ineffective, or lack of accessibility to a CR/SP program within a reasonable commuting distance.

Such exceptions would generally be limited to factors that may make CR/SP unsafe or ineffective, or that otherwise prohibit access to a CR/SP program. Examples of exceptions from referral to CR/SP include:

- Patient exceptions (eg, patient resides in a long-term nursing care facility)
- Medical exceptions (eg, presence of an acute medical condition that makes the patient unstable and unsafe for exercise training)
- System exceptions (eg, lack of an available CR/SP program within 60 minutes of travel time from the patient home)

Since the measures look only at whether patients were referred, not whether they enrolled, patient refusal was not considered to be an exception. If a health care provider recommended CR/SP referral to a patient, the patient refused the referral, and the provider documented the patient refusal, then that encounter was judged to have met the PM since the

provider complied with the expectation to recommend referral to CR/SP.

Data Analyses

Both the Cohen κ statistic and percent agreement were used to measure the intra- and interabstractor reliability for the following qualitative ratings: (1) documented eligibility for CR/SP referral, (2) exception documented for CR/SP referral, and (3) documentation of CR/SP referral. The κ statistic is a chance-corrected index of agreement ranging from -1 to 1 , with $\kappa < 0$ representing observed agreement worse than that due to chance alone. We interpreted a κ greater than 0.75 as excellent, 0.40 to 0.75 as fair to good, and less than 0.40 as poor, following the guidelines of Fleiss et al.²⁰ Unlike the κ statistic, percent agreement does not take into account the agreement occurring by chance but can be informative in situations for which the prevalence of a given response is very high or low and the interpretation based solely on the value of κ may be misleading. This phenomenon, known as the κ paradox,^{21,22} occurs when the observed proportion of agreement is high but the value of the κ statistic is low.

For brevity, intra-abstractor reliability is reported for only 1 of the 2 abstractors (arbitrarily designated “abstractor 1” at each site), and interabstractor reliability only for the initial set of ratings (ie, “time 1”). Stratifying on inpatient versus outpatient setting, reliability was analyzed (1) on the overall group with sites pooled together and (2) within sites and summarizing the site-specific results across the overall group. All analyses were performed using the SAS statistical software package (version 9.2, SAS Institute Inc, Cary, NC).

RESULTS

Characteristics of the 234 inpatients and 211 outpatients (total 445) included in the CR3 Project are shown in Table 2. Most patients from both inpatient and outpatient sites were male, white, and younger than 65 years. A total of 1746 chart reviews were performed for the CR3 Project (415 of the total 445 patient charts [93%] were reviewed as specified in the CR3 Project protocol, each 1 being reviewed 4 times [twice by each abstractor], while incomplete reporting of data resulted in 26 that were reviewed only 3 times each and 4 that were each reviewed only twice).

Participating centers represented various practice types and settings, including the following: rural, suburban, or urban area locations; teaching and non-teaching centers; and single specialty and multispecialty centers. One hospital was from the Pacific Northwest, 4 from the Midwest, 1 from the Northeast,

Table 2 • Sociodemographic Characteristics of Patients in the Cardiac Rehabilitation Referral Reliability Project

Characteristics	Patients From Inpatient Sites (n = 234), %	Patients From Outpatient Sites (n = 211), %
Age, y		
18-39	3	5
40-64	40	50
65-79	45	33
≥ 80	12	12
Sex		
Female	35	36
Race and ethnicity		
White	84	84
Black	8	8
Asian	0.5	0.5
American Indian	1	0.5
Native Hawaiian/ Pacific Islander	0.5	0.5
Other	5.5	5.5
Hispanic ethnicity	0.5	1

and 1 from the Southeast. Three inpatient centers used paper medical records, 5 used electronic medical records, and 2 used both. Outpatient clinics in the CR3 Project were located throughout the Midwest and in the Southeastern part of the United States. Two outpatient clinics used paper medical records and 4 used electronic medical records, while none used both.

Site abstractors involved in the CR3 Project had varying degrees of experience with chart abstraction before participating in the project, with 54% of abstractors having 2 years of experience or less and 23% having less than 1 month of experience. Among the 13 inpatient and outpatient sites, the pair of abstractors had similar levels of experience at 11 sites. Excluding the 2 sites in which the pairs of abstractors had discordant levels of experience, we found that ratings of CR/SP eligibility, exceptions, and referral were not more reliable from abstractors having more than 2 years of experience. Interestingly, some of these ratings reflected more favorable reliability in abstractors having less than 2 years of experience (data not shown). In addition, we did not find a difference between the reliability of the first abstractions and the second abstractions, suggesting that there was no “learning effect” among abstractors. The mean \pm SD

time per chart abstraction, reported by abstractors, was 4.9 ± 3.2 minutes for inpatient abstractions and 6.8 ± 4.7 minutes for outpatient abstractions.

Reliability Outcomes

Inpatient sites (Table 3)

Intra-abtractor reliability analysis of pooled inpatient data demonstrated excellent repeatability for ratings of CR/SP eligibility (100% agreement; $\kappa = 1.00$), CR/SP exceptions (96% agreement; $\kappa = 0.76$), and CR/SP referral (98% agreement; $\kappa = 0.95$). On the basis of site-specific inpatient data, each of the three CR/SP items showed high percent agreement ($\geq 90\%$) at all sites and excellent repeatability ($\kappa \geq 0.75$) in most sites (100% of sites for patient eligibility, 67% for patient exceptions, and 80% for patient referral).

Pooled analysis of inpatient sites demonstrated excellent interabtractor reliability analysis for ratings of CR/SP eligibility (94% agreement; $\kappa = 0.77$) and CR/SP exceptions (97% agreement; $\kappa = 0.79$), and modest agreement between abstractors for rating CR/SP referral (86% agreement; $\kappa = 0.70$). Consistent with the pooled results, site-specific analyses demonstrated excellent interabtractor reliability (as measured by $\kappa \geq 0.75$) in most inpatient sites for ratings of eligibility (71% of sites) and exceptions (67% of sites) but in less than half (40%) of sites for the rating of CR/SP referral.

Outpatient sites (Table 3)

Pooled analyses of the 6 outpatient sites demonstrated excellent intra-abtractor reliability for the 3 ratings of CR/SP eligibility, exceptions, and referral (agreement $\geq 95\%$; $\kappa \geq 0.88$). From site-specific analysis of intra-abtractor reliability, percent agreement $\geq 90\%$ was observed in all 6 sites for ratings of CR/SP eligibility and exceptions, and in all but 1 site for rating of CR/SP referral. Likewise, excellent repeatability ($\kappa \geq 0.75$) was demonstrated in most outpatient sites (100% of sites for rating of eligibility, 67% for exceptions, and 67% for referral).

Regarding interabtractor reliability for outpatient sites, pooled analyses reflected excellent agreement between abstractors for ratings of both CR/SP eligibility ($\kappa = 0.78$) and CR/SP referral ($\kappa = 0.80$), and poor to fair agreement in rating patient exceptions for CR/SP referral ($\kappa = 0.43$). Similarly, according to site-specific results, excellent interabtractor reliability was observed in most (two-thirds) of the outpatient sites for rating CR/SP eligibility and in none of the sites for rating CR/SP exceptions. Interestingly, despite excellent interabtractor agreement for rating CR/SP referral obtained from pooled analysis, site-specific results varied considerably (range of κ across 6 sites, -0.07 to 1.00), with excellent reliability seen in only one-third of outpatient sites (and percent agreement less than 90% in half the sites).

Table 3 • Reliability Testing Results From Pooled and Site-Specific Data Analyses From the Cardiac Rehabilitation Referral Reliability Project for Inpatient and Outpatient Sites

Setting	Reliability	Item	Percent Agreement			
			Pooled Data (No. of Abstractions in Agreement/Total No. of Abstractions)		κ	
			Range Across Study Sites		Pooled Data (95% CI)	Range Across Study Sites
Inpatient	Intrarater	Eligibility	100 (232/232)		1.00	1.00 to 1.00
		Exception	96 (189/196)		0.76 (0.60-0.93)	0.67 to 1.00
		Referral	98 (172/176)		0.95 (0.90-0.99)	0.62 to 1.00
	Interrater	Eligibility	94 (218/231)		0.77 (0.65-0.89)	0.31 to 1.00
		Exception	97 (185/191)		0.79 (0.63-0.95)	0.66 to 0.91
		Referral	86 (148/172)		0.70 (0.59-0.81)	0.23 to 1.00
Outpatient	Intrarater	Eligibility	98 (191/194)		0.94 (0.87-1.00)	0.88 to 1.00
		Exception	99 (146/148)		0.89 (0.74-1.00)	0.70 to 1.00
		Referral	95 (130/137)		0.88 (0.79-0.96)	0.39 to 1.00
	Interrater	Eligibility	94 (190/203)		0.78 (0.66-0.89)	0.46 to 1.00
		Exception	95 (139/146)		0.43 (0.09-0.78)	0.40 to 0.46
		Referral	91 (124/136)		0.80 (0.70-0.91)	-0.07 to 1.00

Abbreviation: CI, confidence interval.

This study demonstrates high reliability for assessing CR/SP eligibility, referral, and exceptions by using the CR/SP outpatient and inpatient PMs. Data abstraction of patient records was performed by abstractors with varying amounts of abstraction experience at various inpatient and outpatient centers, suggesting generalizability of our findings.

Reliability testing is 1 of 3 important steps in developing high value PMs, as outlined by the ACCF/AHA Task Force on PMs.¹⁹ The 3 steps include (1) construction of the measurement set, (2) assessment of feasibility and reliability of data collection, and (3) measurement of clinician performance. Construction of the CR/SP PM set has previously been reported.¹²⁻¹⁷

Our testing generally found high reliability for comparisons between abstractors for the 3 key components of the CR/SP PMs: patient eligibility for CR/SP, patient exceptions to CR/SP referral, and patient referral to CR/SP. We included 2 measures of reliability, each shedding important light on the reliability of PM abstraction: percent agreement and the κ statistic. "Percent agreement" is a helpful assessment of reliability, but given that more than 80% of patients in the study sample were eligible for CR/SP and more than 90% of patients were absent exceptions to CR/SP participation, the percent agreement may have been somewhat inflated, since by chance alone abstractors may have chosen the correct eligibility or exception status.

Conversely, the κ statistic performs best when there is nearly equal chance of study outcomes. When there is a high likelihood of 1 of the 2 outcomes, as in our study (high likelihood of CR/SP eligibility), the results of the κ analyses can underestimate true reliability because of a phenomenon known as the "kappa score paradox" in which there is high percent agreement, yet a low κ score.^{21,22} Indeed, we observed this paradox in some centers. The true reliability of abstracting our PMs most likely lies between the results from the 2 methods of assessment we used. Since the "percent agreement" method generally suggests very high reliability of the CR/SP measures and the κ statistic generally suggests moderate to high reliability, the true reliability of the CR/SP PM would appear overall to be high.

Data abstractors reported that data abstraction time was modest for the inpatient (4.9 minutes) and outpatient (6.8 minutes) CR/SP PMs, and minimal barriers to their abstraction activities. If the CR/SP PMs are included in sets of other PMs, such as the PM set for coronary artery bypass graft surgery, for example, it is likely that efficiencies of scale will result in less time being required for the CR/SP PM assessment.

Limitations

We selected participating centers to reflect variation in the location, size, and type of centers. However, our study is based on the experience of a relatively small number of centers from around the United States that volunteered to be in the project and may not be representative of other centers from different regions.

Lessons Learned

Outpatient abstraction of the CR/SP PM data was more time-consuming and somewhat less reliable than the abstraction of inpatient data. This is explained in large part by the fact that the review of inpatient data is limited to the time of the patient index hospitalization (ie, the time of the cardiac event that qualified them for CR/SP). Review of outpatient data is broader, including a review of records for up to 12 months previous to the outpatient visit and also a review of records for up to 12 month after the outpatient visit, because of the fact that patients are eligible for CR/SP for up to 12 months following their qualifying cardiac event.

Future Directions

Health care provider education through effective communication channels is critically important to help providers understand and document appropriate exceptions to CR/SP referral, as well as the key components of CR/SP referral documentation: (1) that the patient has been referred to CR/SP, (2) that the patient has been given information and guidance to help them enroll in CR/SP, and (3) that the receiving CR/SP program has been sent patient information to expedite CR/SP enrollment).

Current practices and existing ACCF and AHA registries only require documentation that the patient has been referred to a CR/SP program. Published evidence suggests that the use of additional communication components, as specified in the measures, may increase the predictive validity of the measures.²³ Going forward, with the advent of better data collection systems for CR/SP referral and the ability now to track CR/SP enrollment through the AACVPR Outpatient Cardiac Rehabilitation Registry, we expect to be able to test the hypothesis that this more detailed definition of CR/SP referral will increase enrollment in CR/SP. Furthermore, computerized decision support, made more widely available through efforts to enhance the meaningful use of electronic health records, may also provide value by increasing the ability to track and improve the appropriate utilization of CR/SP.

Reliability of CR/SP PM abstraction is high. Data abstractors reported minimal barriers to the abstraction

process and required a relatively small amount of time per patient to carry out the abstractions. These results contribute to published evidence regarding the soundness and generalizability of the CR/SP PMs. Further work will need to be carried out to assess the impact of the CR/SP PMs on patient referral rates and patient outcomes.

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