

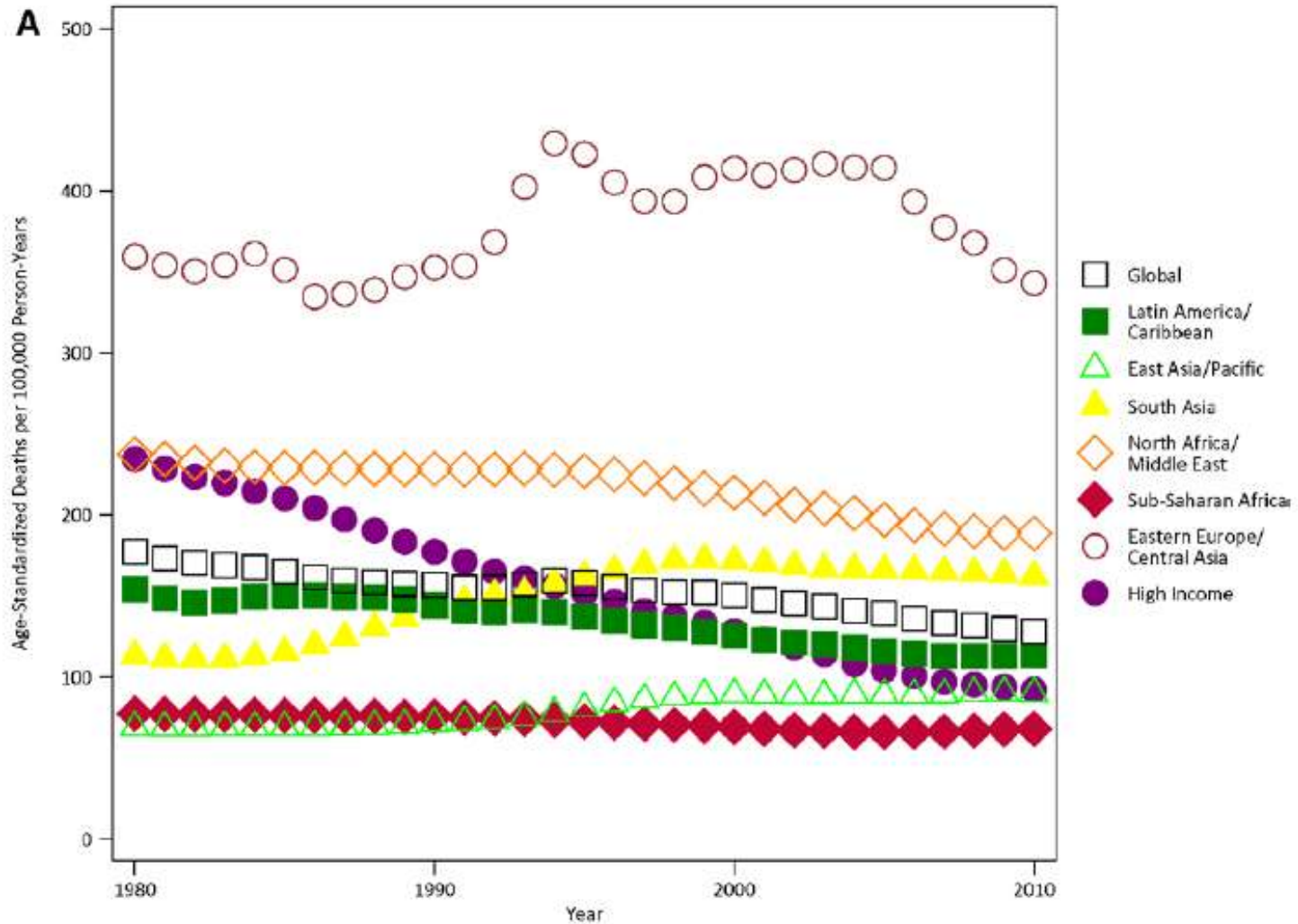
8th Cardiopulmonary Rehabilitation Workshop

Evidences from Asan Medical Center Cardiac Rehabilitation Registry

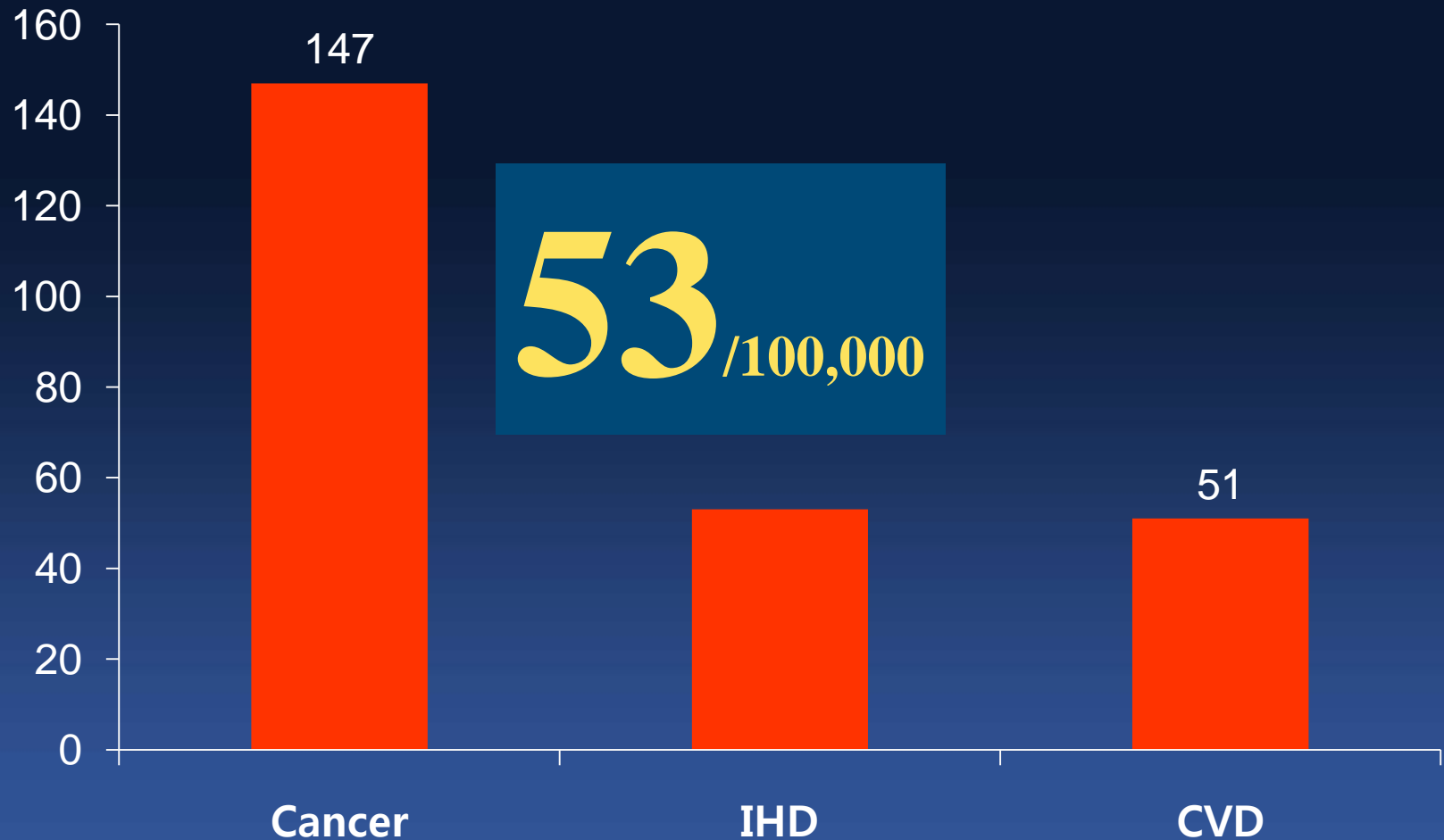
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Heart Institute, Asan medical center

Ischemic Heart Disease Mortality in Asia



Ischemic Heart Disease Mortality in Korea



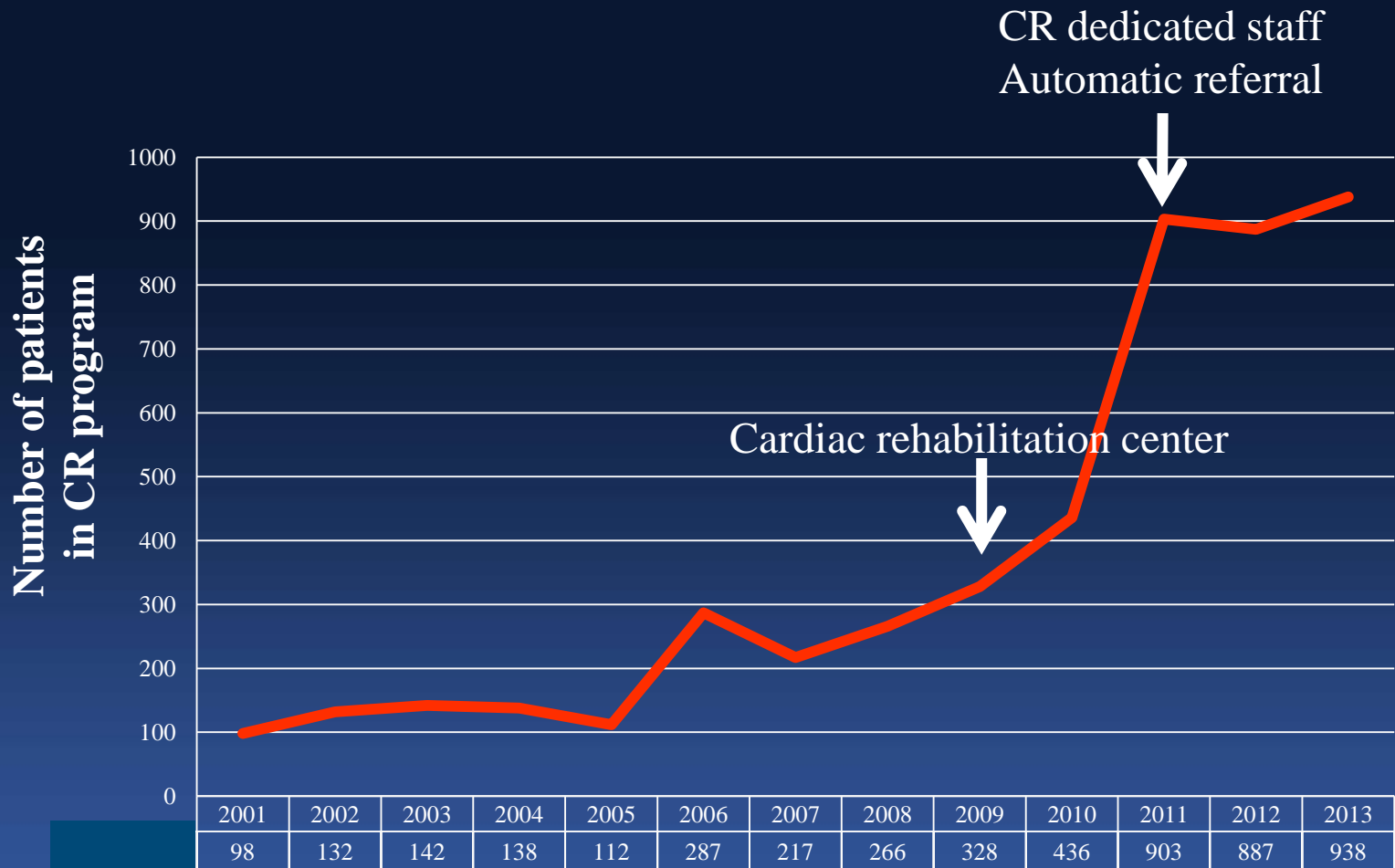
National Statistical Office (2012 data)

Cardiac Rehab in Korea

**Only intervention or surgery is not perfect.
For relieving the ischemic burden,
management with comprehensive approach like cardiac rehab**

- Strongly recommended for cardiac disease as class I-A
- Under-recognized and under-utilized
- Not much interest among majority of cardiologist, especially interventionist or cardiac surgeon
- No sufficient chances to experience cardiac rehab.
- Not reimbursed by insurance policy (government)

Retrace the Course of AMC's Cardiac Rehab



Current Candidate for Cardiac Rehab

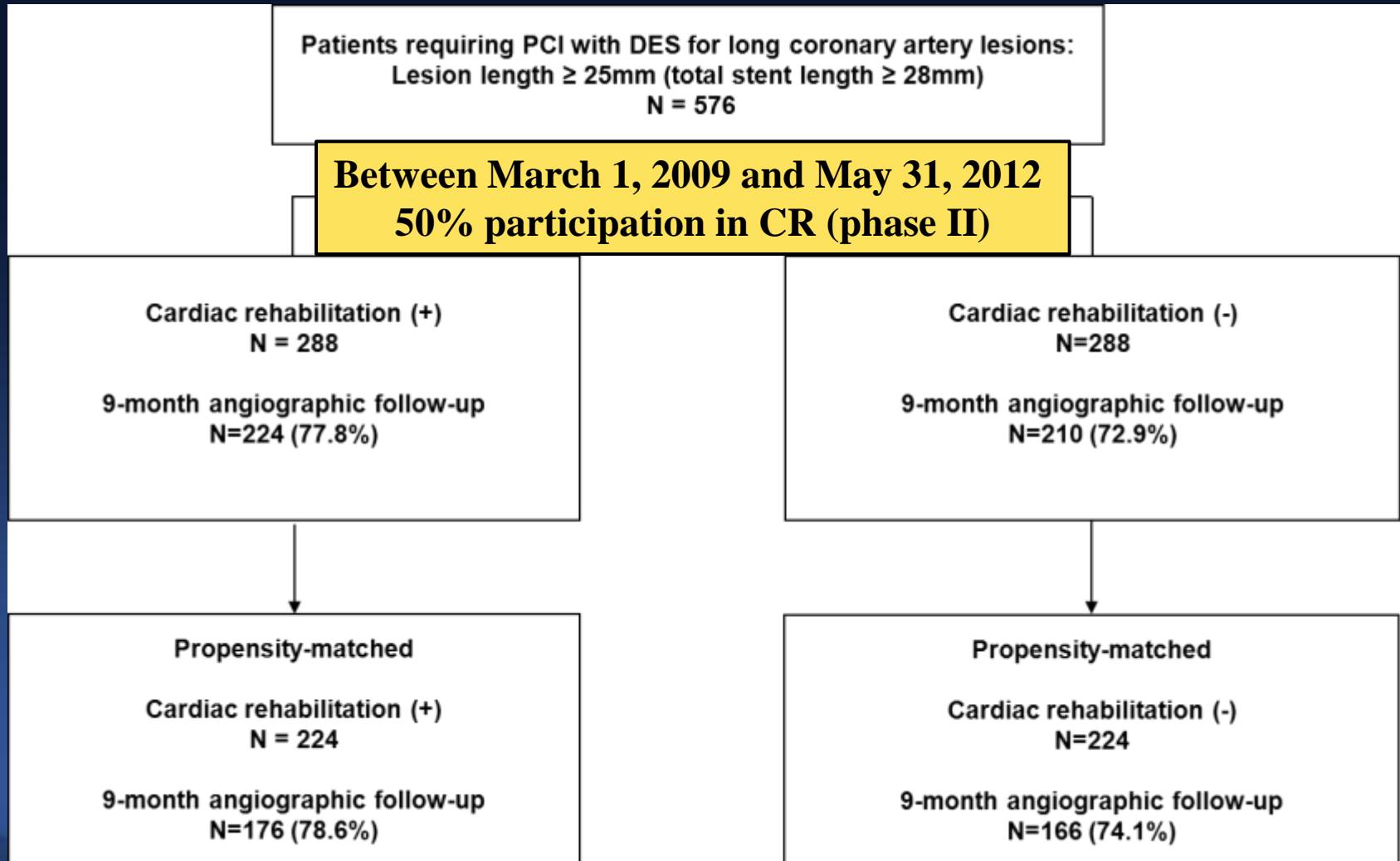
- Ischemic heart disease (medical, PCI, CABG)
- TAVI
- Heart failure
- Pacemaker and ICD
- Primary prevention for high risk profile
- Peripheral artery disease (PTA, bypass surgery)
- Heart transplantation (pending)

Looking for Corroborative Evidences

Analysis of Asan Medical Center CR registry

- Impact of cardiac rehab, for
 - Drug-eluting stenting in long coronary lesions
 - Left main coronary artery stenosis
 - Coronary artery bypass graft surgery
- Identifying influencing factors in participation in cardiac rehab

Impact of Cardiac Rehabilitation on Angiographic Outcomes after Drug-eluting Stents in Patients with *De Novo* Long Coronary Artery Lesions



Baseline characteristics

Characteristics	Crude		Propensity-matched	
	Cardiac rehabilitation (288 Patients)	Non-cardiac rehabilitation (288 Patients)	Cardiac rehabilitation (224 Patients)	Non-cardiac rehabilitation (224 Patients)
Age (years)	60.0±9.1	61.2±9.5	60.8±8.5	60.9±9.5
Height (cm)	164.3±9.3	163.4±12.6	164.6±8.5	163.6±8.2
Weight (kilograms)	68.0±9.9	68.7±10.4	68.93±9.8	67.7±10.1
Body mass index (kilogram/m ²)	25.0±2.8	25.5±2.8	25.4±2.8	25.2±2.8
Obesity	136 (47.2%)	152 (52.8%)	112 (50.0%)	113 (50.4%)
Male gender	217 (75.3%)	229 (79.5%)	175 (78.1%)	171 (76.3%)
Diabetes mellitus	72 (25.0%)	79 (27.4%)	60 (26.8%)	58 (25.9%)
Hypertension	129 (44.8%)	117 (40.6%)	129 (57.6%)	127 (56.7%)
Hyperlipidemia	200 (69.4%)	194 (67.4%)	130 (58.0%)	114 (50.9%)
Current smoker	74 (25.7%)	87 (30.2%)	89 (39.7%)	93 (41.7%)
Family history of coronary artery disease	35 (12.2%)	30 (10.5%)	25 (11.2%)	22 (9.8%)
Previous coronary angioplasty	14 (4.9%)	34 (11.8%)	12 (5.4%)	16 (7.1%)
Previous stroke	8 (2.8%)	13 (4.6%)	8 (3.6%)	6 (2.7%)
Previous myocardial infarction	1 (0.3%)	10 (3.5%)	1 (0.4%)	1 (0.4%)
Left ventricular ejection fraction (%)	59.9±5.4	59.8±6.9	59.88±5.5	59.6±6.5
Multi-vessel disease	126 (43.8%)	145 (50.3%)	109 (48.7%)	105 (46.9%)
Clinical indication				
Stable angina or silent ischemia	195 (67.7%)	209 (72.6%)	156 (69.6%)	153 (68.3%)
Unstable angina	69 (24.0%)	57 (19.8%)	50 (22.3%)	54 (24.1%)
Non-ST segment elevation myocardial infarction	24 (8.3%)	22 (7.6%)	18 (8.0%)	17 (7.6%)

Procedural Characteristics

Characteristics	Crude		Propensity-matched	
	Cardiac rehabilitation (288 Patients)	Non-cardiac rehabilitation (288 Patients)	Cardiac rehabilitation (224 Patients)	Non-cardiac rehabilitation (224 Patients)
Lesion characteristics				
Target vessel				
Left anterior descending	194 (67.4%)	191 (66.3%)	118 (52.7%)	121 (54.0%)
Left circumflex	26 (9.0%)	31 (10.8%)	56 (25.0%)	56 (25.0%)
Right coronary	68 (23.6%)	66 (22.9%)	50 (22.3%)	47 (21.0%)
Procedural characteristics				
Used drug-eluting stent				
Sirolimus-eluting stent (Cypher)	80 (27.8%)	79 (27.4%)	65 (29.0%)	61 (27.2%)
Zotarolimus-eluting stent (Endeavor Resolute)	80 (27.9%)	78 (27.1%)	61 (27.2%)	69 (30.8%)
Biolimus A9-eluting stent (Nobori)	65 (22.6%)	63 (21.9%)	49 (21.9%)	47 (21.0%)
Everolimus-eluting stent (Promus Element)	63 (21.9%)	68 (23.6%)	49 (21.9%)	47 (21.0%)
Number of stents used at the target lesion				
One stent	123 (42.7%)	124 (43.1%)	100 (44.6%)	102 (45.5%)
Two stents	137 (47.6%)	129 (44.8%)	101 (45.1%)	99 (44.2%)
Three stents	27 (9.4%)	32 (11.1%)	23 (10.3%)	20 (8.9%)
Four stents	1 (0.3%)	3 (1.0%)	0	3 (1.3%)
Mean	1.7±0.7	1.7±0.7	1.7±0.7	1.7±0.7
Length of stents used at the target lesion (mm)	44.7±16.0	46.1±17.0	44.2±16.1	44.3±16.1

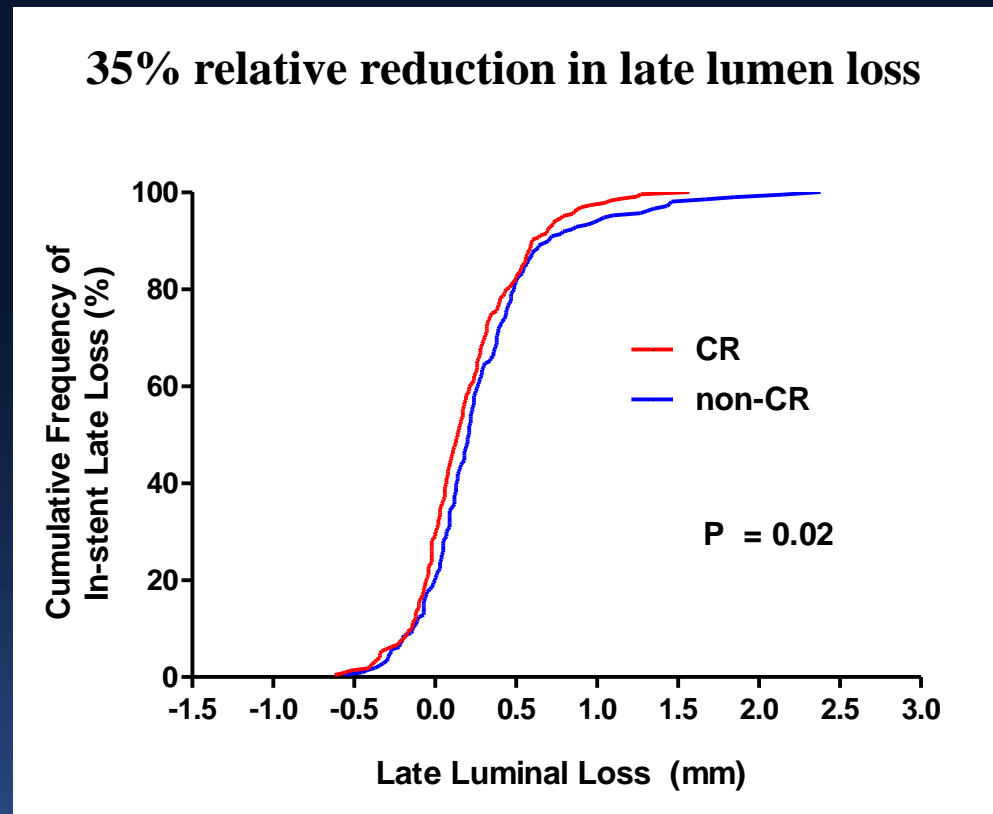
Results in physical & biochemical variables

Clinical Outcomes	Change¶	P
	Difference (95% CI)*	
Current smoking	-7.59 (-12.62, -2.56)	0.046
Total cholesterol (mg/dL)	-6.58 (-13.77, 0.60)	0.072
Triglyceride (mg/dL)	-11.71 (-24.05, 0.64)	0.063
HDL-cholesterol (mg/dL)	2.10 (0.48, 3.71)	0.011
LDL-cholesterol (mg/dL)	-1.47 (-7.42, 4.49,)	0.629
hsCRP (mg/dL)	-0.08 (-0.16, 0.00)	0.042
HbA1C (%)	-0.93 (-1.47, -0.38)	0.001
Depression, moderate to severe	-11.16 (-17.41, -4.91)	<0.001
Body weight (kilograms)	-0.10 (-1.02, 0.82)	0.831
Obesity (body mass index >25)	-10.27 (-15.29, -5.24)	<0.001
VO ₂ max (ml/kg/min)	1.47±4.96	<0.001

Results on angiographic outcomes

Characteristics	Crude			Propensity-matched		
	Cardiac rehabilitation (288 Patients)	Non-cardiac rehabilitation (288 Patients)	P	Cardiac rehabilitation (224 Patients)	Non-cardiac rehabilitation (224 Patients)	P
Follow-up at 9 months, no. eligible patients (%)	224 (77.8%)	210 (72.9%)	0.21	176 (78.6)	166 (74.1)	0.26
Late luminal loss (mm)						
In-segment	0.11±0.33	0.17±0.43	0.08	0.10±0.33	0.17±0.46	0.09
In-stent (primary endpoint)	0.19±0.33	0.29±0.45	0.02	0.18±0.31	0.28±0.47	0.02
Proximal margin	0.18±0.46	0.22±0.42	0.45	0.19±0.48	0.21±0.41	0.69
Distal margin	0.06±0.27	0.08±0.33	0.61	0.06±0.28	0.07±0.35	0.70
Angiographic restenosis						
In-segment	12 (5.3%)	14 (6.6%)	0.48	8 (4.5%)	11 (6.6%)	0.47
In-stent	8 (3.5%)	12 (5.7%)	0.24	5 (2.8%)	11 (6.6%)	0.12
Proximal margin	4 (1.8%)	3 (1.4%)	0.82	4 (2.3%)	1 (0.6%)	0.37
Distal margin	1 (0.5%)	2 (0.9%)	0.60	1 (0.6%)	1 (0.6%)	0.99

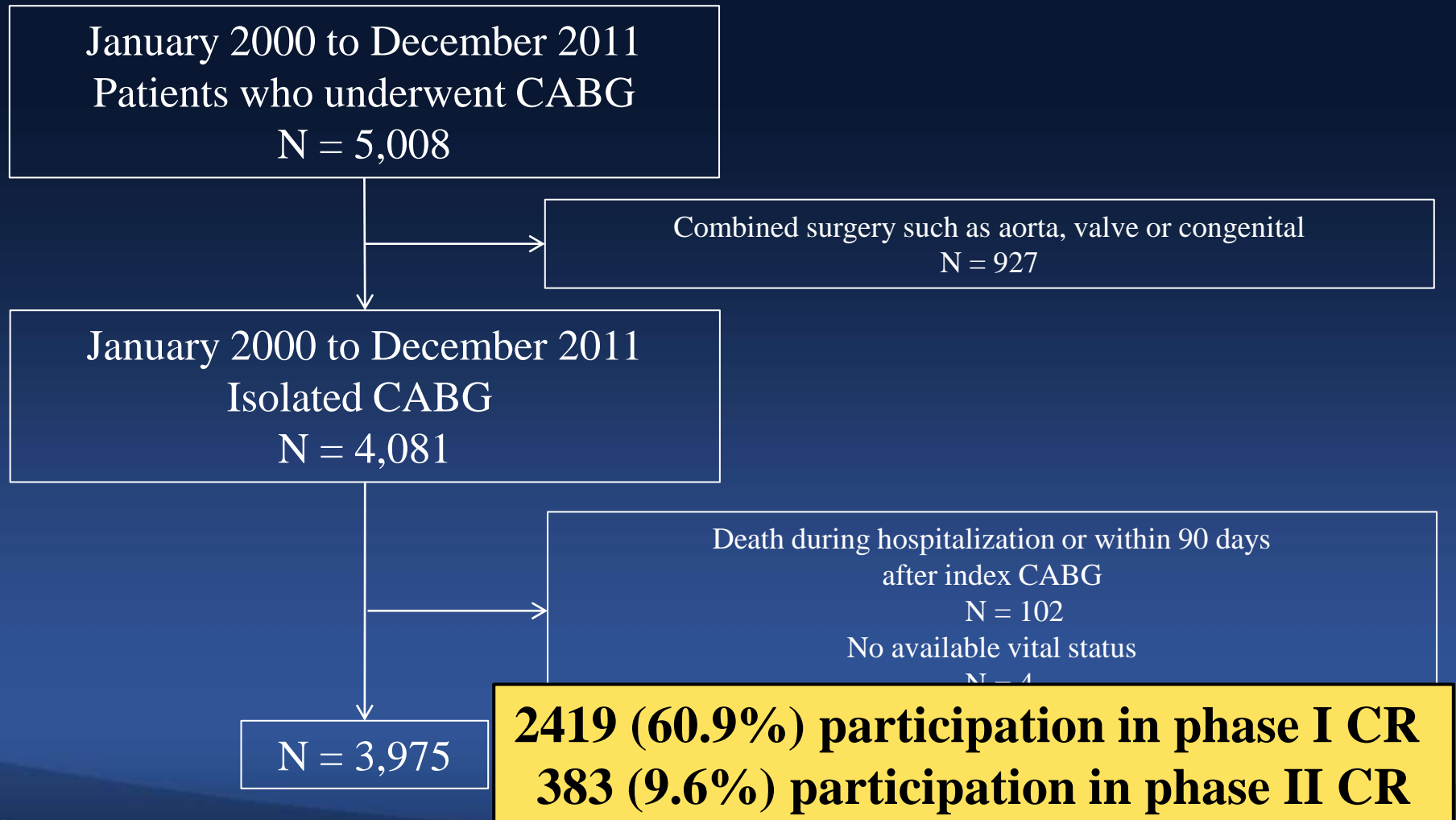
Cardiac Rehab. impact in long lesion



Difference, 0.10 mm; 95% confidence interval, 0.02 to 0.18; P=0.02

Outpatient cardiac rehab after PCI with DES for long lesions reduces in-stent late lumen loss while improving patient risk profile.

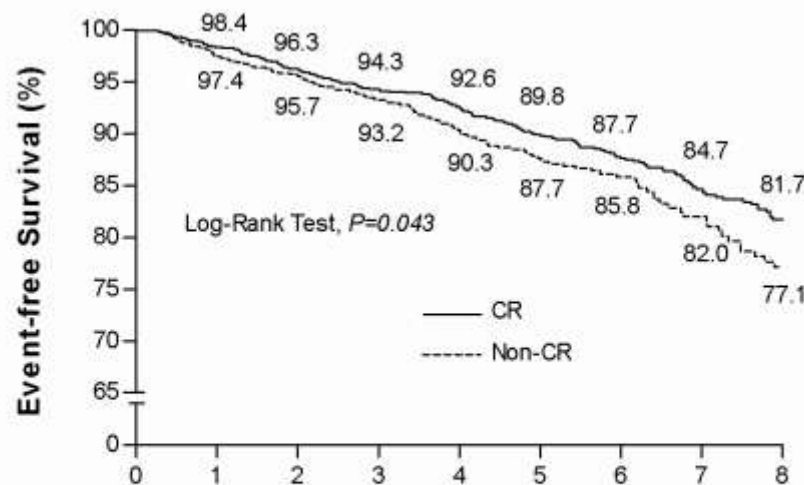
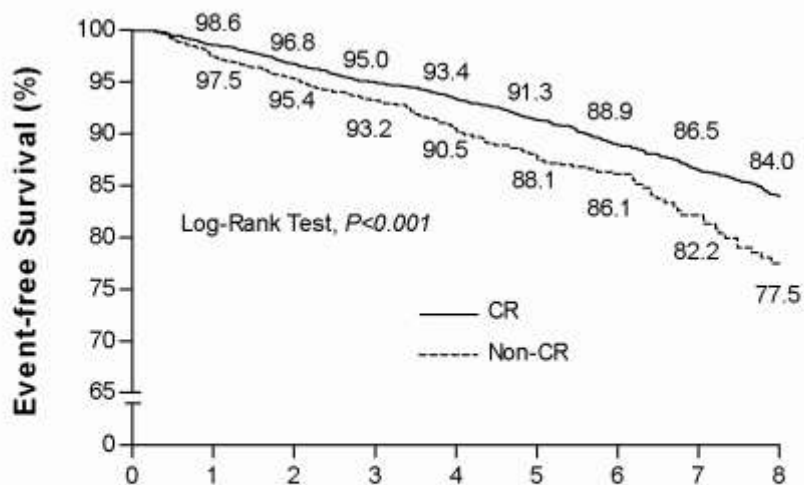
Impact of Participation in Cardiac Rehabilitation on Long-term Survival after Coronary Artery Bypass Graft Surgery



Impact of Participation in phase I CR for all-cause mortality

Crude cohort

Propensity-matched cohort



No. at risk	Years after Initial Surgery								
	0	1	2	3	4	5	6	7	8
CR	2419	2381	2330	2254	2159	2027	1707	1452	1243
Non-CR	1556	1508	1402	1155	915	790	590	430	310

No. at risk	Years after Initial Surgery								
	0	1	2	3	4	5	6	7	8
CR	1097	1078	1049	989	865	768	697	512	426
Non-CR	1097	1065	1003	835	746	697	584	411	300

Multivariate adjusted HR 0.77 (0.64 to 0.93)

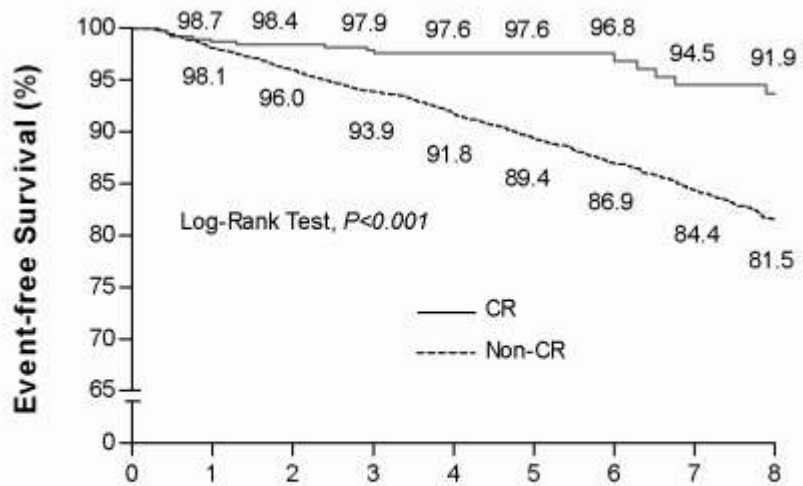
HR 0.80 (0.64 to 0.98)

20% of mortality reduction in phase I cardiac rehab

Impact of Participation in phase II CR for all-cause mortality

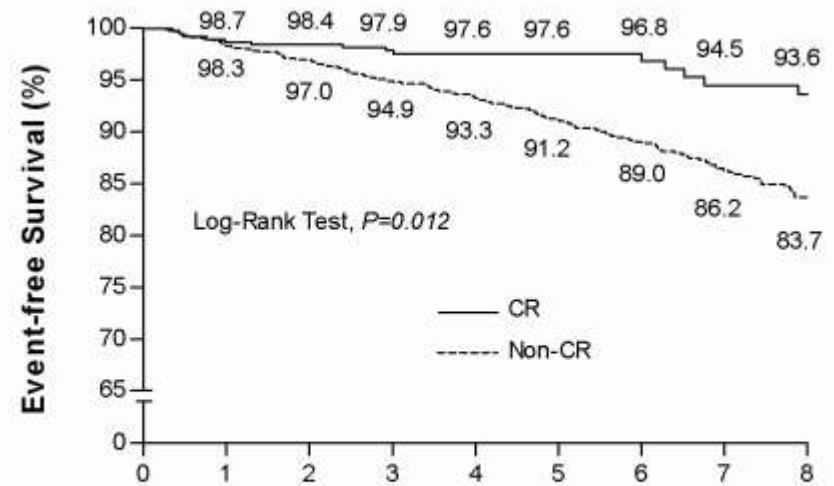
Crude cohort

Propensity-matched cohort



No. at risk	Years after Initial Surgery								
	0	1	2	3	4	5	6	7	8
CR	383	378	373	340	289	241	210	182	163
Non-CR	3592	3511	3359	3069	2785	2376	1888	1531	1390

Multivariate adjusted HR 0.57 (0.39 to 0.84)



No. at risk	Years after Initial Surgery								
	0	1	2	3	4	5	6	7	8
CR	379	374	369	340	289	241	210	181	161
Non-CR	1429	1398	1326	1161	1027	830	710	619	522

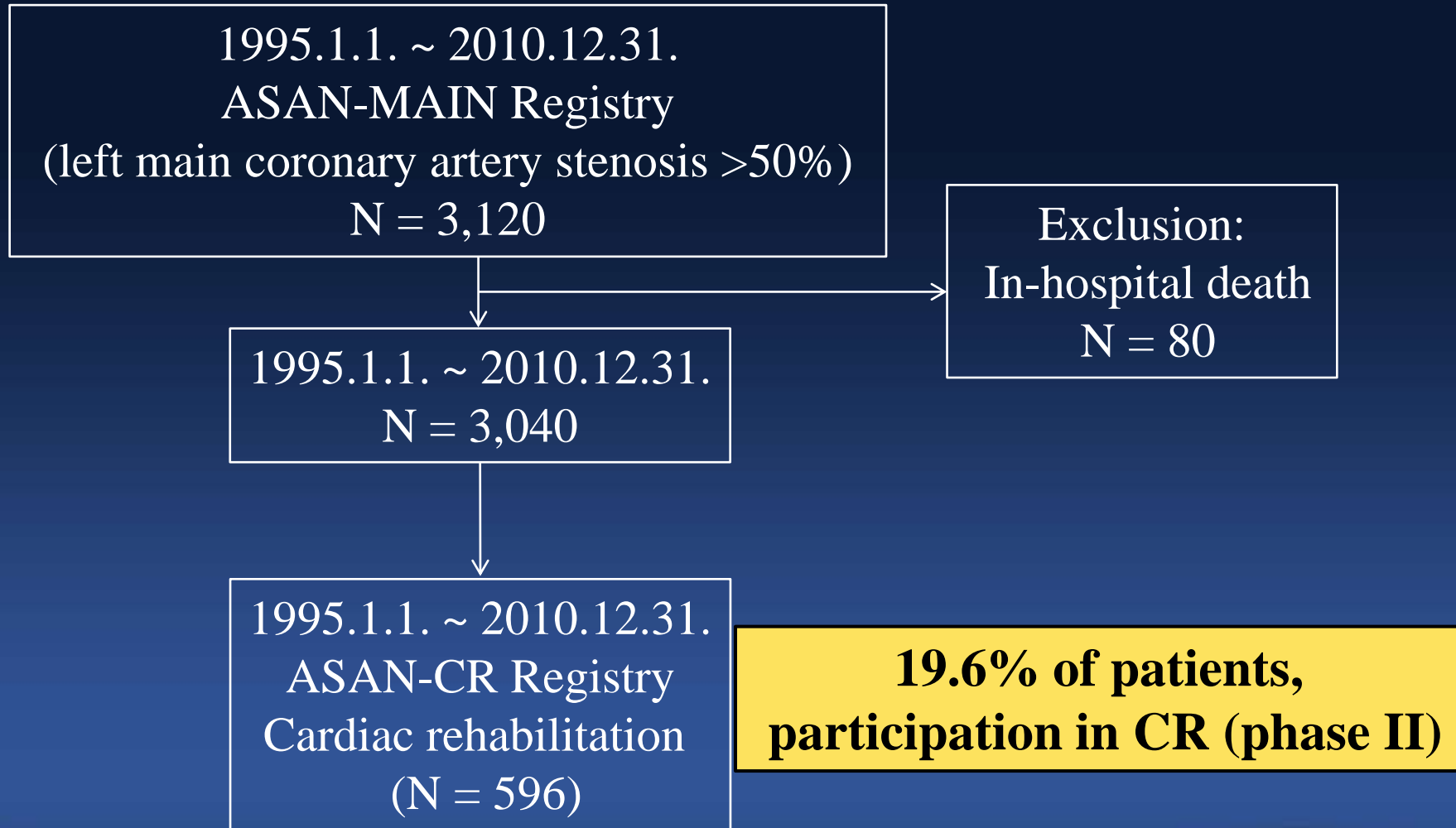
HR 0.60 (0.40 to 0.90)

40% of mortality reduction in phase II cardiac rehab

Impact of Participation in Cardiac Rehab after Coronary Artery Bypass Graft Surgery

- CR participation was significantly associated with **20% reduction in all-cause mortality after phase I CR during hospitalization and 40% reduction after phase II CR.**
- Of these, 2419 (60.9%) participated in Phase I of CR while hospitalized, and 383 (9.6%) participated in Phase II of CR at an outpatient clinic.
- As well as phase II, earlier intervention in phase I CR could lead to better outcomes.

Cardiac Rehab in Left Main Coronary Artery Stenosis



Baseline Characteristics

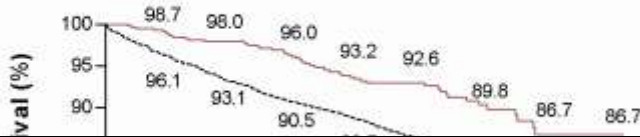
Characteristics	Overall cohort			Propensity-matched cohort	
	CR (596 Patients)	Non CR (2444 Patients)	P	CR (507 Patients)	Non CR (507 Patients)
Age, years	62.8±10.3	62.4±10.5	0.47	63.0±10.2	63.3±10.4
Body mass index, kg/m ²	24.5±2.7	24.5±2.9	0.73	24.5±2.8	24.5±2.7
Obesity	241 (39.2)	994 (41.4)	0.32	196 (38.7)	204 (40.6)
Male gender, number (%)	454 (76.2)	1780 (72.9)	0.11	383 (75.5)	385 (75.9)
Diabetes mellitus, number (%)	221 (37.1)	851 (34.9)	0.34	185 (36.5)	186 (36.8)
Hypertension, number (%)	368 (61.7)	1372 (56.3)	0.02	316 (62.3)	303 (60.0)
Hyperlipidemia, number (%)	307 (51.5)	1034 (42.4)	<0.001	256 (50.5)	256 (50.7)
Current smoker, number (%)	152 (25.5)	694 (28.5)	0.15	133 (26.2)	126 (25.0)
Family history of CAD, number (%)	55 (9.2)	243 (10.0)	0.65	47 (9.3)	53 (10.5)
Previous coronary angioplasty, number (%)	119 (20.0)	358 (14.7)	0.002	100 (19.7)	101 (20.0)
Previous stroke, number (%)	46 (7.7)	207 (8.5)	0.62	43 (8.5)	44 (8.7)
Previous MI, number (%)	60 (10.1)	101 (10.5)	0.86	50 (9.9)	52 (10.3)
Previous heart failure, number (%)	9 (1.5)	107 (4.4)	<0.001	7 (1.4)	7 (1.4)
Peripheral vascular disease	26 (4.4)	240 (9.9)	<0.001	26 (5.1)	28 (5.5)
Chronic lung disease	10 (1.7)	85 (3.5)	0.03	9 (1.8)	11 (2.2)
Chronic renal failure	15 (2.5)	78 (3.2)	0.43	14 (2.8)	13 (2.6)
Atrial fibrillation	41 (6.9)	170 (7.0)	0.99	36 (7.1)	27 (5.3)
Left ventricular ejection fraction, %	59.8±8.7	59.1±10.7	0.51	59.8±8.8	59.8±9.4
Extent of disease			<0.001		
LM only	55 (9.2)	266 (10.9)		44 (8.7)	48 (9.5)
LM with 1-vessel	105 (17.6)	339 (13.9)		88 (17.4)	93 (18.3)
LM with 2-vessel	204 (34.2)	546 (22.3)		165 (32.5)	156 (30.8)
LM with 3-vessel	232 (38.9)	1293 (52.9)		210 (41.4)	210 (41.4)

Baseline Characteristics

Characteristics	Overall cohort			Propensity-matched cohort	
	CR (596 Patients)	Non CR (2444 Patients)	P	CR (507 Patients)	Non CR (507 Patients)
Total number of diseased lesion	2.6±1.5	3.3±1.8	<0.001	2.7±1.5	2.7±1.4
Involvement of LM bifurcation	365 (61.2)	1510 (61.8)	0.81	306 (60.4)	311 (61.3)
Clinical indication, number (%)			<0.001		
Silent ischemia	63 (10.6)	182 (7.4)		51 (10.1)	45 (8.9)
Stable angina	240 (40.3)	604 (24.7)		197 (38.9)	200 (39.4)
Unstable angina	235 (39.4)	1424 (58.3)		204 (40.2)	208 (41.0)
NSTEMI	35 (5.9)	150 (6.1)		35 (6.9)	36 (7.1)
STEMI	23 (3.9)	84 (3.4)		20 (3.9)	18 (3.6)
Treatment strategy			<0.001		
Medical therapy	52 (8.7)	349 (14.3)		52 (10.3)	55 (10.9)
PCI	416 (69.8)	730 (30.0)		333 (64.5)	327 (65.7)
drug-eluting stents	404	458		321	319
bare-metal stents	12	273		12	9
CABG	128 (21.5)	1365 (55.9)		128 (25.2)	119 (23.5)
Severe calcification at LM	47 (7.9)	167 (6.8)	0.37	36 (7.1)	37 (7.3)
Thrombus at LM	25 (4.2)	28 (1.1)	<0.001	12 (2.4)	12 (2.4)
Ulceration at LM	18 (3.0)	51 (2.1)	0.17	14 (2.8)	14 (2.8)
Chronic total occlusion at LM	3 (0.5)	44 (1.8)	0.02	3 (0.6)	4 (0.8)

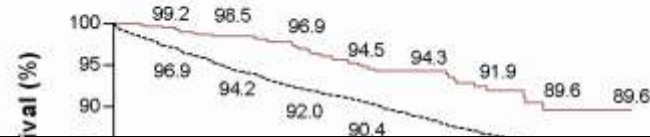
Results in total cohort

All-cause mortality

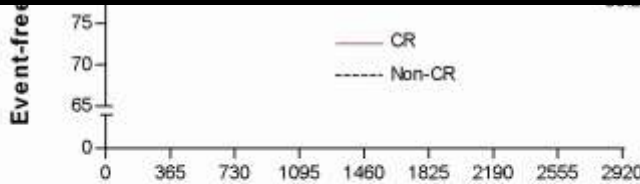


Multivariate adjusted HR 0.70 (0.49 to 1.00)

Cardiovascular mortality

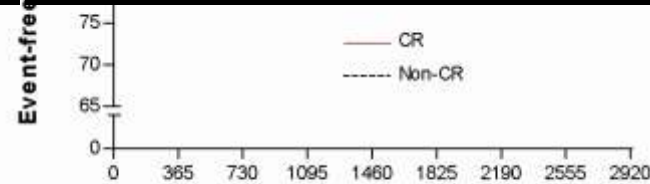


Multivariate adjusted HR 0.69 (0.48 to 0.97)



No. at risk

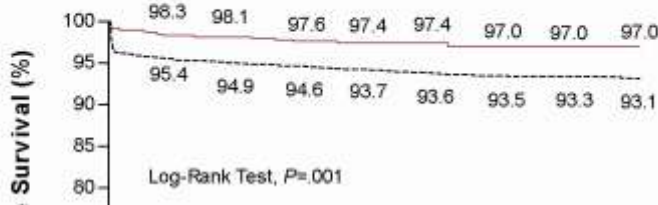
Days after Initial Procedure	0	365	730	1095	1460	1825	2190	2555	2920
CR	596	588	584	555	456	390	276	218	166
Non-CR	2444	2349	2273	2190	2056	1806	1630	1493	1344



No. at risk

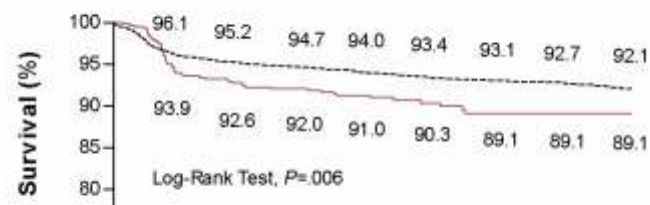
Days after Initial Procedure	0	365	730	1095	1460	1825	2190	2555	2920
CR	596	588	584	555	456	391	271	218	166
Non-CR	2444	2349	2273	2190	2056	1806	1630	1493	1344

Myocardial infarction

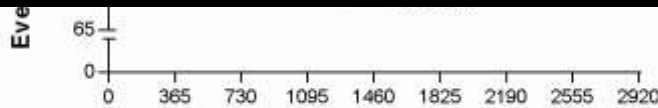


Multivariate adjusted HR 0.81 (0.46 to 1.41)

Target Vessel Revascularization

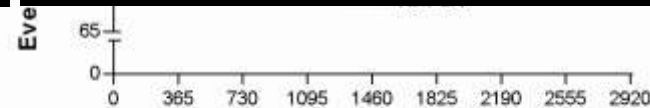


Multivariate adjusted HR 1.24 (0.91 to 1.69)



No. at risk

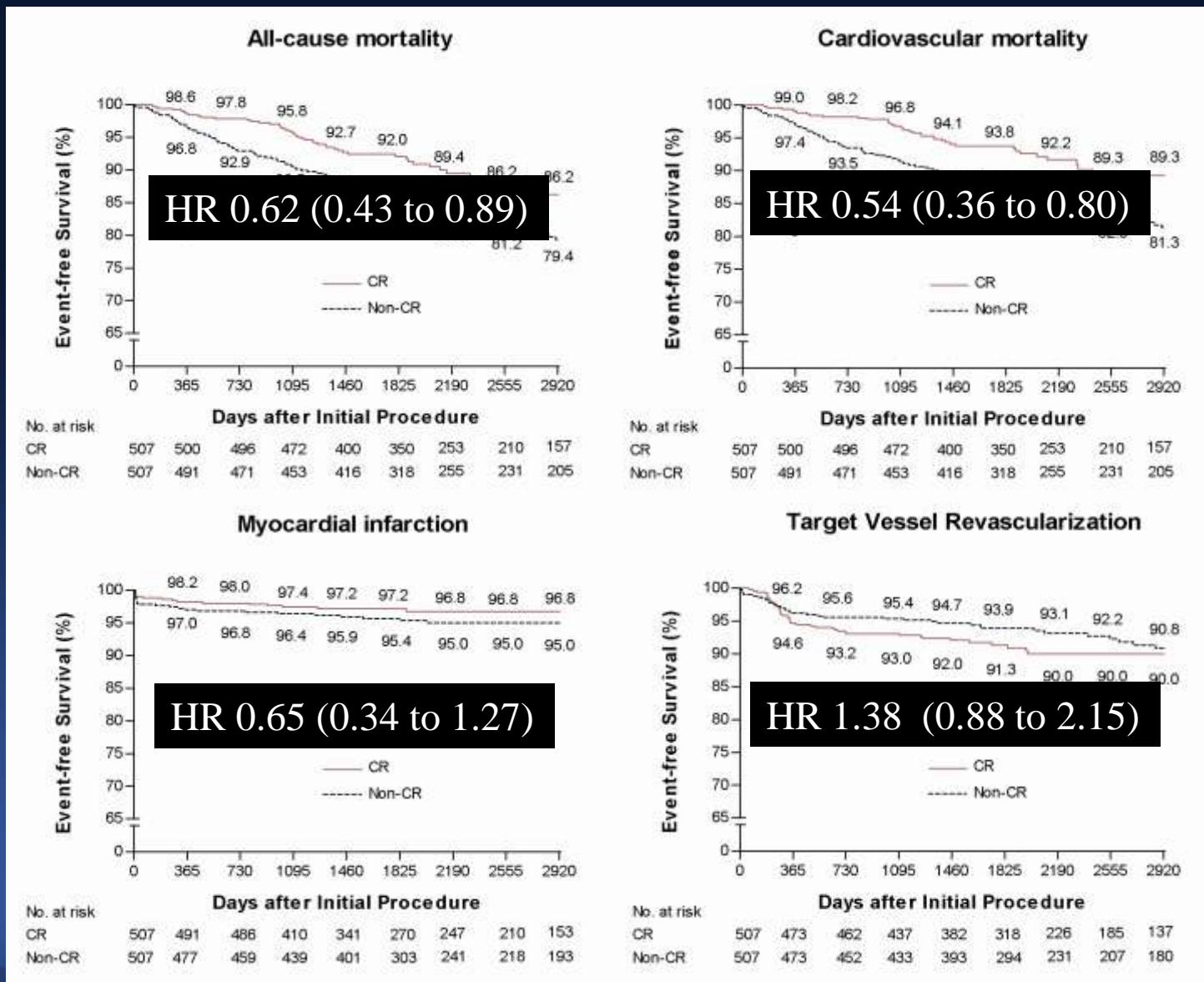
Days after Initial Procedure	0	365	730	1095	1460	1825	2190	2555	2920
CR	596	578	573	543	425	381	270	220	164
Non-CR	2444	2244	2166	2080	1942	1690	1517	1386	1240



No. at risk

Days after Initial Procedure	0	365	730	1095	1460	1825	2190	2555	2920
CR	596	552	540	508	453	353	245	196	146
Non-CR	2444	2256	2168	2076	1930	1672	1494	1360	1207

Results in propensity-matched cohort

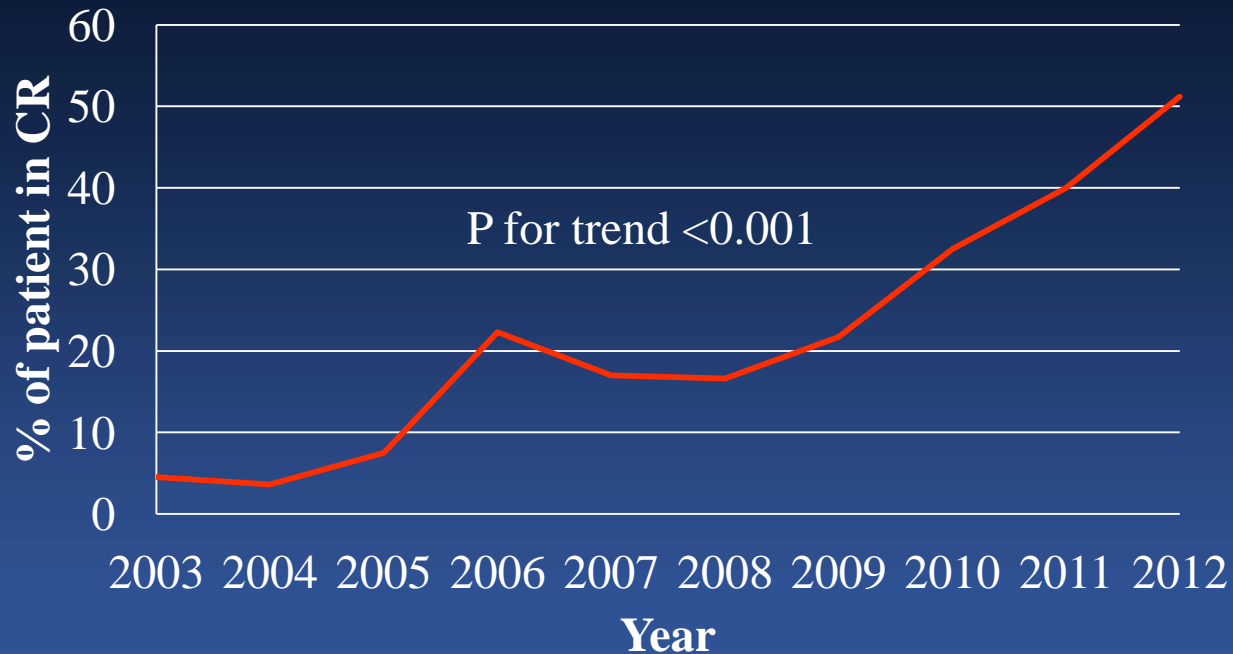


Cardiac Rehab in Left Main Coronary Artery Stenosis

- The overall use rate of CR was just **19.6%**.
- Participation of phase II CR in left main stenosis, regardless of treatment strategy, showed **30 to 38% lower in 7-year all-cause mortality and 31 to 46% lower in 7-year cardiovascular mortality.**

Temporal trends and influencing factors in CR after PCI

Total – 10,059 patients
CR in 1869 (18.6%)



Temporal trends and influencing factors in CR after PCI

Total – 10,059 patients
CR in 1869 (18.6%)

Variables	Odds Ratio (95% CI)	P-value
Age	0.89 (0.82 to 0.96)	0.004
LVEF, %	0.90 (0.84 to 0.98)	0.007
Diabetes mellitus	0.85 (0.75 to 0.93)	0.015
Acute coronary syndrome	1.54 (1.03 to 1.85)	0.023
Previous stroke	1.65 (1.15 to 2.02)	0.026
Chronic renal failure	0.82 (0.65 to 0.97)	0.021
Automatic referral	2.34 (1.85 to 2.97)	<0.001

Conclusions

- The rate of participation in cardiac rehab was very low.
- Cardiac rehab is an under-utilized medicine in Korea.
- Cardiac rehab can reduce mortality tremendously, among patients with left main stenosis and CABG.
- Cardiac rehab can reduce in-stent late luminal loss after long coronary artery stenting.
- Settlement of efficacious system is very important.