

**Systemic Risk Stratification in
Revascularization Therapy in Unprotected
Left Main Coronary Stenosis
LM-Risk Score**

Young-Hak Kim, MD, PhD

**Department of Medicine, Asan Medical Center,
University of Ulsan College of Medicine, Seoul, Korea**

Usefulness of Risk Scoring System

- To predict outcomes of patients
- To select a appropriate treatment strategy for each patient
- To predict a need of adjunctive resources
- To compare outcomes of revascularization treatment in different hospitals and populations

Component of Euro SCORE

Risk factors	Score	Risk factors	Score
Cardiac-related factors		Patient-related factors	1
Unstable angina	2	Age	1
Left ventricular dysfunction	1	Sex	1
Left ventricular dysfunction	3	Chronic pulmonary disease	2
Recent myocardial infarction	2	Extracardiac arteriopathy	2
Pulmonary hypertension	2	Neurologic dysfunction	3
Operation-related factors		Previous cardiac surgery	2
Emergent operation	2	Serum creatinine	3
Other than isolated CABG	2	Active endocarditis	3
Surgery on thoracic aorta	3	Critical preoperative state	
Postinfarct septal rupture	4		

LM-Risk Score



Development of LM Risk Score

Investigator Group

- Seung-Jung Park, MD
- Seong-Wook Park, MD
- Myeong-Ki Hong, MD
- Cheol-Whan Lee, MD
- Young-Hak Kim, MD
- Duk-Woo Park, MD

Asan Medical Center,
CardioVascular Research
Foundation, Seoul

- Martin B. Leon, MD
- Roxana Mehran, MD
- Ajay K. Kirtane, MD
- Helen Parise, ScD

Columbia University,
Cardiovascular
Research Foundation,
NY

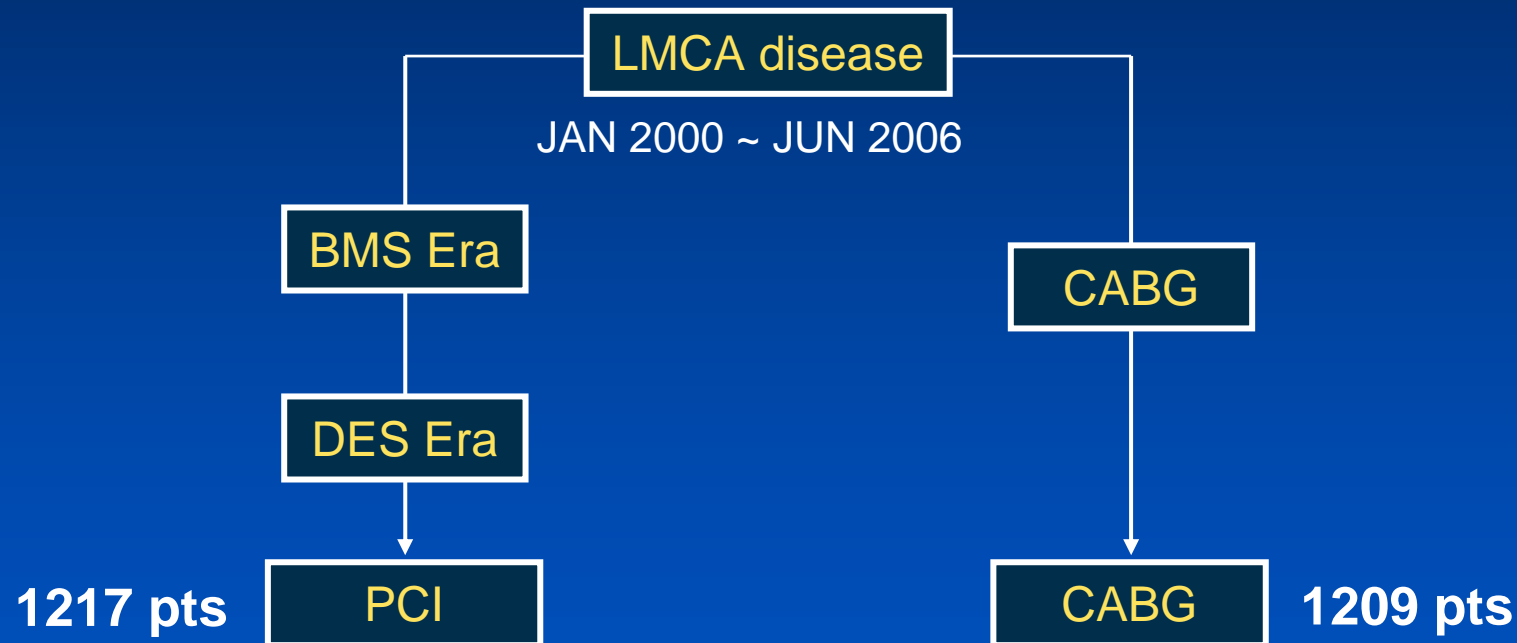
- Stuart J. Pocock, PhD

London School of Hygiene
and Tropical Medicine,
London

Discrimination of Risk Factors Population at Risk

2426 Patients in MAIN-COMPARE Registry

Revascularization for Unprotected Left **MAIN** Coronary Artery Stenosis: **COM**parison of **P**ercutaneous Coronary **A**ngioplasty versus Surgical **RE**vascularization from Multi-Center Registry



12 major academic institutions in Korea

Statistical Analysis

- A multivariable Cox model was used to assess the statistical significance of each candidate prognostic variable.
- After each factor was tested independently in a univariate Cox model, those that achieved a significance level with $p < 0.05$ were selected for testing in a multivariate stepwise selection.
- Variables associated with $p < 0.05$ were retained in the final model and were used in developing risk score.
- Interaction test was performed according to the procedure types.
- The ROC curves were used to test the accuracy of the risk score.

Outcomes of Interest

Death or Q-MI at 2 Years

	PCI (N=1217)	CABG (N=1209)	Total (N=2426)
F/U duration (days) Median [IQR]	707.00 [399.00, 1121.00]	909.00 [478.50, 1501.50]	797.50 [438.00, 1313.00]
Binary Outcomes			
Death	6.7%	7.4%	7.0%
Q-wave MI	0.6%	0.8%	0.7%
Death/Q-MI	6.9%	7.8%	7.3%
K-M Estimates			
Death	7.9%	8.1%	8.0%
Q-wave MI	0.6%	0.9%	0.7%
Death/Q-MI	8.0%	8.5%	8.2%

Candidate Predictors of Death/MI

37 Variables

DES (vs. BMS)

Age

Obesity (BMI > 30)

Female

Previous PCI

Previous MI

Previous CHF

Diabetes mellitus

Hypertension

Hyperlipidemia

Previous CVA

Chronic renal failure

Peripheral vascular disease

Smoking

Chronic lung disease

Significant valve disease

Acute coronary syndrome

Myocardial infarction

Atrial fibrillation

TIMI flow

LV EF (%)

Cardiogenic shock

Indication of procedure

Multivessel disease

Extra-LM vascular involvement

RCA disease

Lesion location

Bifurcation type

ACC/AHA type

In-stent restenosis

Infarct-related artery

Restenotic lesions

Lesion length

Total occlusion

calcification

Thrombus

Ulceration

Multivariate Cox Analysis

PCI Groups

Multivariate Predictors	Coeff	SE	p value	Hazard Ratio [95% C.I.]	Risk Score
DES					
Age \geq 75	1.060	0.245	0.000	2.89 [1.79, 4.66]	4
Previous MI					
Hyperlipidemia					
Chronic renal failure	2.015	0.291	0.000	7.50 [4.24, 13.28]	7
Significant valve disease					
STEMI					
Atrial fibrillation	1.354	0.356	0.000	3.87 [1.93, 7.78]	4
Infarction Related	0.844	0.240	0.000	2.33 [1.45, 3.72]	4
EF, 30%-40%	0.915	0.336	0.007	2.50 [1.29, 4.83]	3
EF, <30%	1.824	0.416	0.000	6.20 [2.74, 14.03]	4
Emergent procedure					
RCA disease					
MEDINA 1.1.1 or 1.1.0					
Thrombus					

Multivariate Cox Analysis

CABG Groups

Multivariate Predictors	Coeff	SE	p value	Hazard Ratio [95% C.I.]	Risk Score
Old age (Age >= 75)	0.861	0.254	0.001	2.36 [1.44, 3.89]	3
Previous MI					
Hyperlipidemia	-0.644	0.264	0.015	0.53 [0.31, 0.88]	-2
Chronic renal failure					
Significant valve disease					
STEMI	0.857	0.359	0.017	2.36 [1.17, 4.76]	2
Atrial fibrillation	1.262	0.384	0.001	3.53 [1.66, 7.50]	3
Infarction Related					
EF, 30%-40%					
EF, <30%	1.519	0.360	0.000	4.57 [2.25, 9.28]	4
Emergent procedure					
RCA disease	0.680	0.281	0.015	1.97 [1.14, 3.42]	2
MEDINA 1.1.1 or 1.1.0 (ostial LAD involvement)	0.625	0.222	0.005	1.87 [1.21, 2.89]	3
Thrombus					

Multivariate Cox Analysis

Combined Groups

Multivariate Predictors	Coeff	SE	p value	Hazard Ratio [95% C.I.]	Risk Score
DES					
Old age (Age >= 75)	0.966	0.169	0.000	2.63 [1.89, 3.66]	6
Previous MI					
Hyperlipidemia					
Chronic renal failure	1.310	0.231	0.000	3.71 [2.36, 5.83]	6
Significant valve disease					
STEMI	0.645	0.255	0.011	1.91 [1.16, 3.14]	3
Atrial fibrillation	1.130	0.262	0.000	3.10 [1.85, 5.17]	4
Infarction Related	0.458	0.189	0.016	1.58 [1.09, 2.29]	2
EF, 30%-40%	0.630	0.237	0.008	1.88 [1.18, 2.99]	3
EF, <30%	1.667	0.261	0.000	5.30 [3.17, 8.84]	6
Emergent procedure					
RCA disease	0.442	0.164	0.007	1.56 [1.13, 2.14]	3
MEDINA 1.1.1 or 1.1.0					
Thrombus	0.756	0.294	0.010	2.13 [1.20, 3.79]	3

Multivariate Interaction Model

Combined Group

Multivariate Predictors	Coefficient	SE	p value	Hazard Ratio [95% C.I.]	Risk Score
DES	-0.4410	0.2857	0.1227	0.64 [0.37, 1.13]	0
PCI	0.0674	0.3138	0.8299	1.07 [0.58, 1.98]	0
65 <= Age < 75	0.3190	0.1839	0.0828	1.38 [0.96, 1.97]	2
Age >= 75	1.0866	0.1971	0.0000	2.96 [2.01, 4.36]	6
EF <30%	1.7152	0.2656	0.0000	5.56 [3.30, 9.36]	7
STEMI	0.7855	0.2235	0.0004	2.19 [1.42, 3.40]	4

Multivariate Interaction Model

Interaction Terms

Multivariate Predictors	Coeffi.	SE	p value	Hazard Ratio [95% C.I.]	Risk Score
Only add if CABG					
MEDINA 1.1.1 or 1.1.0 (ostial LAD involvement)	0.6383	0.2202	0.0038	1.89 [1.23, 2.92]	3
Only add if any PCI					
Chronic renal failure	1.7885	0.2831	0.0000	5.98 [3.43, 10.42]	6
Infarction Related	0.6735	0.2365	0.0044	1.96 [1.23, 3.12]	3
Only add if PCI with DES					
Significant valve disease	1.1136	0.5492	0.0427	3.05 [1.04, 8.94]	2
Low EF (30%-40%)	1.2647	0.3833	0.0010	3.54 [1.67, 7.51]	3
Total Occlusion	1.2899	0.4208	0.0022	3.63 [1.59, 8.29]	3
Only add if PCI with BMS					
Hyperlipidemia	-0.6378	0.2420	0.0084	0.53 [0.33, 0.85]	-3
Atrial fibrillation	1.4030	0.2910	0.0000	4.07 [2.30, 7.19]	5
RCA disease	0.5285	0.2344	0.0241	1.70 [1.07, 2.69]	2

Range of Scores

CABG 0 ~ 22

PCI with DES 0 ~ 36

PCI with BMS 0 ~ 35

Incidence of Observed Events (Death/Q-MI) According to the Risk Score

Risk Group	Total N	Non-events		Events (Death/Q-MI)	
		N	%	N	%
Complete group (N=1604)					
0 (Very Low)	613	601	98.04	12	1.96
1-5 (Low)	792	744	93.94	48	6.06
6-9 (Moderate)	255	220	86.27	35	13.73
≥ 10 (High)	69	39	56.52	30	43.48
Partial group (N=2248)					
0 (Very Low)	910	887	97.47	23	2.53
1-5 (Low)	1064	1003	94.27	61	5.73
6-9 (Moderate)	361	309	85.60	52	14.40
≥ 10 (High)	91	49	53.85	42	46.15

“Complete” refers to only patients who have non-missing data for ALL covariates.

“Partial” refers to all patients where all available data is used for the risk score. If a patient is missing data for a binary variable it is assumed that the patient does not have that risk factor (i.e. it is not added).

Incidence of Observed Events (Death/Q-MI) According to the Risk Score

	PCI		CABG	
	N	%	N	%
Complete group (N=1604)				
0 (Very Low)	23	2.09	4	1.74
1-5 (Low)	13	4.00	35	7.49
6-9 (Moderate)	10	7.14	25	21.74
≥ 10 (High)	25	43.86	5	41.67
Partial group (N=2248)				
0 (Very Low)	9	1.75	14	3.53
1-5 (Low)	19	4.42	42	6.62
6-9 (Moderate)	19	9.74	33	19.88
≥ 10 (High)	37	46.84	5	41.67

Under the ROC Curve for 100 randomly selected samples

	Mean	SD	Median	IQR
Complete	0.6173	0.0263	0.6173	0.6003 – 0.6323
Partial	0.7262	0.0213	0.7259	0.7132 – 0.7403

Example

69 Y Male, EF 42%, CRF, SA, LM extended to LAD, PCI with DES

	Patients	Risk Score	Patient risk
Overall			
DES	Yes	0	0
PCI	Yes	0	0
65 <= Age < 75	Yes	2	2
Age >= 75	No	6	0
EF < 30%	No	7	0
STEMI	No	4	0
Any PCI			
CRF	Yes	6	6
Infarct related	No	3	0
DES only			
Significant valve disease	No	2	0
EF 30-40%	No	3	0
Total occlusion	No	3	0
Total score			8

Incidence of Expected Events (Death/Q-MI)

	PCI		CABG	
	N	%	N	%
Complete group (N=1604)				
0 (Very Low)	23	2.09	4	1.74
1-5 (Low)	13	4.00	35	7.49
6-9 (Moderate)	10	7.14	25	21.74
≥ 10 (High)	25	43.86	5	41.67
Partial group (N=2248)				
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≥ 10 (High)	37	46.84	5	41.67

Example

69 Y Male, EF 42%, CRF, SA, LM extended to LAD, CABG

	Patients	Risk Score	Patient risk
Overall			
DES	Yes	0	0
PCI	Yes	0	0
65 <= Age < 75	Yes	2	2
Age >= 75	No	6	0
EF < 30%	No	7	0
STEMI	No	4	0
CABG			
MEDINA 1.1.1 or 1.0.1 (ostial LAD involvement)	Yes	6	6
Total score			8

Incidence of Expected Events (Death/Q-MI)

	PCI		CABG	
	N	%	N	%
Complete group (N=1604)				
0 (Very Low)	23	2.09	4	1.74
1-5 (Low)	13	4.00	35	7.49
6-9 (Moderate)	10	7.14	25	21.74
≥ 10 (High)	25	43.86	5	41.67
Partial group (N=2248)				
0 (Very Low)	9	1.75	14	3.53
1-5 (Low)	19	4.42	42	6.62
6-9 (Moderate)	19	9.74	33	19.88
≥ 10 (High)	37	46.84	5	41.67

**69 Y Male,
EF 42%,
CRF,
Stable Angina,
LM extended to LAD**

We may recommend PCI with DES

- Expected risk of Death/QMI in PCI with DES 7-10%
- Expected risk of Death/QMI in CABG 20-22%

Final Step

External Validation

We need your help to get a large
database...

Summary

- With the MAIN-COMPARE registry, the risk stratification system, so called “LM-Score”, is being developed to provide a more accurate and reliable prediction of outcomes for patients with unprotected LMCA stenosis receiving revascularization therapy.
- In the preliminary analysis, the risk score appears to be effective to predict the outcomes of patients treated with either PCI or CABG.
- The predictability of final statistical model will be additionally ascertained by the process of external validation using a separated large database.