Validation of a Clinical Prediction Rule For A Preserved Left Ventricular Systolic Function In Patients After Myocardial Infarction

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Background --- LV systolic function is the single most important predictor of mortality following myocardial infarction. Several indicators of LV dysfunction such as non-invasive estimations of Ejection Fraction (EF) like echocardiography have been examined for prognostic implication. Several studies have yielded clinical predictors of LVEF which were either difficult to use at bedside, have substantial misclassification rates or have never been validated for easy use. This study was conducted to validate the Silver Criteria for a preserved Left Ventricular systolic function in patients after myocardial infarction and adopt a clinical prediction rule that is reliable & applicable to our local setting.

Methods --- This is a validation study involving 108 patients admitted at the Philippine Heart Center from April 2005 to April 2006 due to Acute Myocardial Infarction. Clinical and radiologic evidences of congestive heart failure were noted. Electrocardiographic recordings were reviewed and classified as interpretable or uninterpretable based on the Silver Criteria. Echocardiographic determination of LV EF was done and was compared to the Silver clinical criteria, which consists of 4 clinical parameters. Validity measures, such as sensitivity, specificity, PPV and NPV were then determined

Results --- In the group with predicted EF to be at least 40% (n=34), the most common location of infarction was inferior wall and all patients (100%) had an actual EF of at least 40%. Whereas in the group with unpredictable EF (n=74), 41% had an EF between 40-54%, 34% had EF <40% and 25% above 55%. The Positive Predictive Value (PPV) of this prediction rule was 100% while its Negative Predictive Value (NPV) was 34 %. The sensitivity was 41% while the specificity was 42% .

Conclusion --- This simple yet reliable clinical prediction rule (Silver Criteria) for a preserved LV systolic function for post MI patients is of great value in the management of such patients especially when limited medical resources is a major concern. ***Phil Heart Center J 2007; 13(2):101-104.***

Key Words: Acute Myocardial Infarction ■ ejection fraction ■ systolic function ■ Silver criteria ■ clinical prediction rule ■ validation study

Left ventricular (LV) systolic dysfunction has a major prognostic significance in determining the hospital course of patients after a myocardial infarction.1 It is the single most important predictor of mortality following myocardial infarction. Among patients with an LVEF of <40%, the rate of mortality is markedly increased at 6 months.[2] Several indicators of LV dysfunction have been examined for prognostic implication such as clinical parameters, hemodynamic findings and non-invasive estimations of Ejection Fraction (EF) like echocardiography. In a study by Nijland et al, myocardial viability was compared with clinical indicators of LV systolic dysfunction in terms of prognostic significance. Myocardial viability is the single best predictor of recurrent in-hospital ischemic events and unstable angina after discharge while clinical parameters (age, hypertension & EF) have a higher prognostic value for hard cardiac events (Death & VT) and occurrence of heart failure.[3]

In a study by Thomas et al, clinical parameters (age, obesity, tachycardia, HPN, LVH, LA abnormality and congestion on CXR) had a low sensitivity, specificity and predictive values for differentiating normal versus decreased systolic LV function.[4]

Several studies have yielded clinical predictors of LVEF, which were either difficult to use at bedside, have substantial misclassification rates, or have never been validated for easy use.

The Silver Criteria, consisting of 4 clinical parameters, allows one to predict who among post MI patients would have a LVEF of >40% with a 98% predictive value.[5] (Figure 1). Such correlation is expected if all of the following are met:

1. Absence of a history of Congestive Heart Failure
2. No previous Q-wave M.I.
3. An index M.I. that is not a Q-wave anterior infarction
4. An interpretable ECG (No LBBB, no LVH or ventricular pacing)

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Determination of post M.I. patient's LV function whether preserved or impaired, rather than knowing the exact LVEF is more essential in deciding which group of patients require further evaluation like revascularization or subsequent medical management.

Accordingly, as much as 40% of patients may be subjected to unnecessary invasive or non-invasive testing after myocardial infarction if LVEF is the major indication for such study.

Hence, predicting the presence of a preserved LV systolic function (EF>40%) with a high probability would be a challenging and cost-effective task. It distinguishes those patients who need further reasonable testing (invasive or non-invasive) that may influence decision-making. The cost of such procedures for a financially drained patient cannot be overlooked. Therefore, if this prediction rule is validated in our institution, results of which will determine its applicability in the local setting and would benefit most patients with limited resources. Thus, this paper was conducted to validate the clinical prediction rule (i.e. the Silver Criteria) for a preserved

Methods

This is a validation study involving patients diagnosed with acute myocardial infarction and admitted at the Emergency Room Chest pain Unit & Coronary Care Unit. The Emergency Room Chest pain Unit & Coronary Care Unit of the Philippine Heart Center from April 2005 to April 2006. Prospective patients presenting with chest pain that had either elevated Troponin/CK-MB or had electrocardiographic evidence of MI were included in the study. Excluded were those with other causes of systolic heart failure such as Cardiomyopathy, Valvular Heart Diseases, Congenital Heart Diseases, Pericardial Diseases and Drugs & Toxins (Alcohol, Anthracyclines). All patients were listed in Acute Coronary Syndrome Registry.

Initially, patients were noted whether clinical features of congestive heart failure were present prior to or during admission. Then, chest radiographic evidences of pulmonary congestion/edema were verified. Congestive Heart Failure (CHF) was defined as presence of 2 major criteria or 1 major plus 2 minor criteria based on Framingham's study, a previous record of CHF in the past, or the presence of radiologic evidence of pulmonary congestion and / edema.

After which, the patient's ECG were taken. Patients' ECG were also classified as interpretable or uninterruptable based on the inclusion criteria as proposed by Dr. Silver et al. Patients were subsequently classified as having STEMI or NSTEMI. Electrocardiographic criteria used in the study were as follows: 1) ST segment elevation/depression was defined as a deflection of at least 1 mm from the baseline PR segment. STEMI (ST Elevation MI) was designated to patients with ST elevation in at least 2 limb leads or 2 contiguous precordial leads.

NSTEMI (Non ST Elevation MI) was labeled in its absence or presence of ST depression / T-wave inversion and elevated cardiac enzymes. 2) Q-waves were defined as a negative initial deflection in the QRS complex of at least 1 mv in amplitude or 40 ms in duration. 3) Old MI was defined as presence of Q waves outside the area of the index MI. 4) LBBB was defined as a widened QRS with a duration of at least 110 ms with a typical QRS morphologic pattern in leads V1 & V6. 5) LVH with strain pattern is a widened QRS of at least 110 ms and standard voltage criteria for LVH (by Sokolow) in the presence of repolarization changes (T-wave inversion). ECG changes were classified as anterior in location if changes appeared in V1-V4; inferior if located in II, III & aVF; lateral for leads V5-V6; inferolateral if on II, III, aVF, V5 and V6; inferior with RV extension if changes occurred in leads V3R and V4R. Finally, using the Silver Criteria (see Fig. 1), the 4 clinical parameters for a preserved LVEF (EF =>40%) were noted. Each patient's EF was then classified as predictable (EF=>40%) if all of the 4 parameters were met and unpredictable if at least 1 of the 4 was not met.

Lastly, the LVEF of all patients were determined from transthoracic echocardiographic study. Transthoracic echocardiographic determination of LVEF by Simpson was obtained in all patients within 48 hours of admission. The LVEF's were dichotomized as either 40% or more or <40%. This cut-off point was preselected because of its well-recognized clinical significance.[6]

Results

The baseline demographic data of the validation set consisting of 108 patients were noted. Majority of the patients were between 40-60 years of age (Table 1). In the group with predictable EF (n=34), the most common location of infarction was inferior (55%), followed by inferolateral wall (18%) & NSTEMI (18%). Only 9% constitute inferior wall with RV extension. In the group with unpredictable EF (n=74), the most common location of infarction was anterior wall which was actually one of the criteria for an unpredictable EF. NSTEMI and inferior wall involvement were 17% and 14% respectively (Table 2).

The Clinical Prediction Rule (Silver Criteria) was then applied to all patients (Figure 1). All patients belonging to the predictable group actually had an LVEF of 40% or more. Majority (74%) had an EF > 55%, and the rest (26%) had an EF between 40-54%. In the group with unpredictable EF (n=74), majority (41%) had an EF between 40-54% and 34% had an EF <40%. 25% of the group even had an EF >55% (Table 3). Most of the patients (44 out of 74) under this group did not satisfy 1 criterion. Only 9% of them had not satisfied 3 criteria. (Figure 2). Thus, the Positive Predictive Value (PPV)

of this prediction rule was 100% while its Negative Predictive Value (NPV) was 34%. Sensitivity (41%) and Specificity (42%) of this rule were however low, but were not of major concern in this study (Table 4).

Discussion

Results of this study has validated with high predictive value the earlier assumption that the likelihood of having a LVEF >40% after MI can be best predicted based on simple clinico-electrocardiographic data. It yielded even a higher PPV (100%) than those of Dr. Silver et al (PPV: 98%). As was previously observed in its derivation, this clinical prediction rule has a low Negative Predictive Value (34% vs. 43%). However, since the aim of this study was to predict the EF of patients with a high likelihood of a preserved EF (>40%) but not to predict the EF of patients under the unpredictable group, the value of a low NPV is therefore less meaningful.

The validation set (n=108) with a desired Confidence interval of +/-10% is more than the required sample size of 95. Hence, insufficient number of patients is therefore not a limitation of this study.

The format of classifying patients' EF as to predictable or not has shown that probably because of smaller area of jeopardized myocardium in the absence of other confounding factors, patients with inferoposterior infarctions have a more preserved LV systolic function than those with anterior infarctions.

Due to its promising value in cost-cutting of medical expenses, clinicians especially in areas with limited diagnostic technology might find great application of this simple and reliable clinical prediction rule in the management of patients with acute myocardial infarction. Likewise, for patients with a predictable EF in whom the only indication for a diagnostic procedure is LVEF determination, a second thought against ordering such tests might be considered.

Table 1. Baseline Characteristics of Included Patients with Acute Myocardial Infarction

		Frequency N=108	Percentage %
Sex	Males	75	69
	Females	33	31
Age Group			
	<40 years	9	8
	40-60	62	58
	>60	37	34
Risk Factors			
	HPN	62	57
	DM	48	44

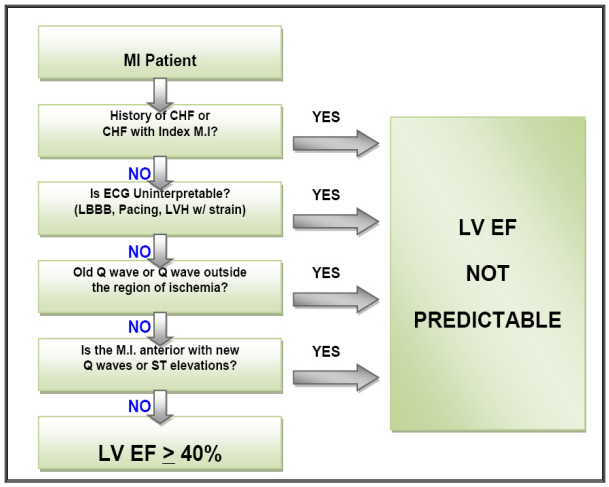

Figure 1. Clinical Prediction Rule

Table 2. Distribution of Location of Myocardial Infarction According to the Ejection Fraction (EF) by Clinical Prediction Rule

LOCATION OF MI	EJECTION FRACTION (EF) BY CLINICAL PREDICTION RULE			
	PREDICTABLE EF N=34		*UNPREDICTABLE EF* N=74	
	N	%	N	%
Inferior	19	55	10	14
Inferior with RV extension	3	9	4	5
Inferolateral	6	18	0	0
Anterior	0	0	47	64
NSTEMI	0	0	13	17

Table 3. Distribution of Patients according to their Ejection Fractions (2 D Echo and Clinical Prediction Rule)

EJECTION FRACTION By 2 D Echo	EJECTION FRACTION (EF) BY CLINICAL PREDICTION RULE			
	PREDICTABLE EF N=34		*UNPREDICTABLE EF* N=74	
	N	%	N	%
<40%	0	0	25	34
40-54%	9	26	30	41
≥55 %	25	74	19	25

Table 4. Measures of Validity of the Clinical Prediction Rule as Compared to EF Obtained by 2D Echo

Ejection Fraction by Clinical Prediction Rule	Ejection Fraction (EF) by 2 D Echo		
	EF ≥ 40%	EF <40%	TOTAL
Predictable	34	0	34
Unpredictable	49	25	74
TOTAL	83	25	108

Positive Predictive Value (PPV): 100% **Sensitivity: 41%**
Negative Predictive Value (NPV): 34% **Specificity: 42%**

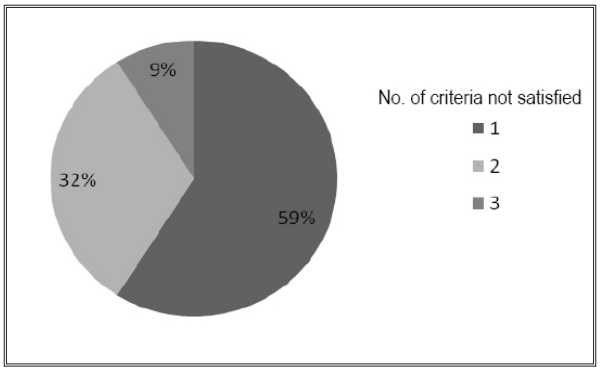

Figure 2. Distribution of Unpredictable EF subgroup according to number of criteria not satisfied (n=74)

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