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ORIGINAL ARTICLE

Zwolle Risk Score for Safety Assessment of Same-day Discharge after Primary Percutaneous Coronary Intervention

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Abstract

Objectives: **The Zwolle risk score (ZRS) has been considered to be a useful tool for the systematic evaluation of patients for early discharge after primary percutaneous coronary intervention (PCI). Therefore, aim of this study was to evaluate the clinical utility of ZRS for the same-day discharge strategy after primary PCI at a tertiary care cardiac center of Karachi, Pakistan.**

Methods: **This study was conducted at a tertiary care cardiac center between August 2019 and July 2020. Patients discharged within 24 h (same-day) of the primary PCI procedure were included. Patients were stratified as high- and low-risk based on ZRS score; low-risk (≤3) and high-risk (≥4). All patients were followed during 30-days post-procedure period for major adverse cardiac events (MACE).**

Results: **Out of 487 patients, 83.2% (405) were male and mean age was 54.6 ± 10.87 years. Mean ZRS was 2.34 ± 1.64 with 16.0% (78) patients in high-risk (≥4) group. 30-days MACE rate was observed to be 5.3% (26) with significantly higher rate among high-risk patients as compared to low-risk patients 12.8% (10) vs. 3.9% (16); p = 0.004 respectively with OR of 3.61 [1.57−8.29]. The area under the curve (AUC) of ZRS for prediction of 30-day MACE was 0.67 [95% CI: 0.58−0.77], ZRS ≥4 had sensitivity of 38.5% and specificity of 85.2% with AUC of 0.62 [95% CI: 0.50−0.74] for prediction of 30-day MACE.**

Conclusion: **ZRS showed moderate discriminating potential in identifying patients with high-risk of MACE at 30-day after same-day discharge after primary PCI.**

Keywords: Early discharge, Primary percutaneous coronary intervention, Zwolle risk score, ST-segment elevation myocardial infarction, Major adverse cardiac events

1. Introduction

Inadequate blood supply to the myocardium resulting from severe narrowing of the coronary arteries, known as atherosclerotic cardiovascular disease or coronary artery disease (CAD), remains the major contributor to the increasing morbidity and mortality all across the globe [1]. The acute manifestation of the disease, known as acute coronary syndrome (ACS), comprises of ST-segment elevation myocardial infarction (STEMI), Non-STEMI (NSTEMI), and unstable angina (UA). Imbalance supply and demand of oxygen can cause substantial and sustained ischaemia resulting in

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death of myocardiocytes which generally termed as myocardial infarction (MI) [2]. Transmural ischaemia in cases of STEMI involve full thickness of the myocardium, while NSTEMI does not spread to full thickness, hence early detection and restoration of blood flow is crucial to minimize the infarct size and preservation of myocardium [3,4]. Time is crucial in the management of STEMI and various initiatives have been taken to minimize the ischemic time. In the current clinical practice guidelines, the primary percutaneous coronary intervention (PCI) within the 12 h window period, starting from time of onset of symptoms, remains the recommended reperfusion therapy [3,4].

A significant improvements in the prognosis has been witnessed for the STEMI patients in the recent years, which can be attributed to the adoption of evidence based medicines and therapies and significant advancements it the treatment modalities. However, rate of post- STEMI complications and recurrent ischemia is still substantially high among these patients [5–8]. Occurrence of severe, occasionally life-threatening, complications such as re-infarction, stent thrombosis, malignant arrhythmias, heart failure, and other mechanical complications are associated with STEMI [9]. This necessitates coronary care unit monitoring of these patients for at least 24–48 h. With the increasing number of patients with CAD requiring extended post-procedure hospital care, identification of low-risk patients has become crucial in whom early discharge could be safe. Reduced post-procedure hospital stay can be beneficial for patients as well as it can have substantial financial implications for healthcare systems of low and middle-income countries with funding and resource constraints [10]. Safety and feasibility of early discharge (within 48–72 h of procedure) has been established by various studies [11–14]. Also same-day discharge strategy showed promising results with lower rate of major adverse cardiac events after 30-days of the procedure [10].

A systematic evaluation of candidate patients for decision making regarding early discharge is important to optimize clinical outcomes of primary PCI. Hence, Zwolle Risk Score (ZRS) was developed to guide physicians' decision making regarding early discharge [15]. Its utility has been evaluated by various studies for 72 h discharge [16–18], however; performance of ZRS in same-day discharge strategy for primary PCI has never been evaluated.

2. Objectives

Therefore, aim of this study was to evaluate the clinical utility of ZRS for the same-day discharge strategy in patients with STEMI underwent primary PCI at a tertiary care cardiac center of Karachi, Pakistan.

Abbreviations

CVD	cardiovascular diseases
NSTEMI	non-ST elevation myocardial infarction
STEMI	ST elevation myocardial infarction
PCI	percutaneous coronary intervention
ZRS	Zwolle risk score
MACE	major adverse cardiac events
TIMI	Thrombolysis in Myocardial Infarction
ROC	receiver operating characteristic
AUC	area under the curve
CI	confidence interval
SD	standard deviation
OR	odds ratio

3. Methods

This prospective observational cohort study is a sub-group analysis of a previously reported study by Shah JA et al. [10]. This study was conducted at a tertiary care cardiac hospital of Karachi, Pakistan between August 2019 and July 2020. Study included consecutive patients with STEMI that were discharged to home by treating physician within in 24 h (same-day) of primary PCI procedure. This study was approved by the ethical review board of the institution and consent for participation, and follow-up was taken from all the patients. A detailed descriptions of patient recruitment, management, and evaluation criteria are presented elsewhere [10]. Patients with myocardial infarction complicated by cardiogenic shock, atrioventricular (AV) block, or history of prior cardiac surgery or intervention or patients lost to follow-up at 30-day (3.4% (17)) [10] were excluded from the study.

Along with demographic and clinical characteristics, described elsewhere [10], the Zwolle risk score (ZRS) was calculated as per the scoring criteria defined by De Luca G et al. [15] based on age, Killip class at presentation, total ischemic time (defined as symptom onset to device activation time), anterior wall myocardial infarction (AWMI), pre-procedure TIMI (Thrombolysis in Myocardial Infarction) flow grade, and number of diseased vessels. Patients were categorized into high- and low-risk group based on additive score; low-risk ($\leq$3) and high-risk ($\geq$4). All patients were followed during 30-days post-procedure period, telephonic or physical, and major adverse cardiac events (MACE) were noted which included mortality, re-infarction, repeat revascularization, cerebrovascular events, any bleeding event, or unplanned hospitalization due to heart failure.

IBM SPSS software version 21 was used for the analysis of data. Appropriate frequency percentage or mean ± standard deviation (SD)/median [interquartile range (IQR)] were calculated. Patients in low- and high-risk group were compared for demographic and clinical characteristics and 30-day outcomes with the help of appropriate independent sample t-test/Mann–Whitney U test and Chi-square test/Fisher's exact test. The area under the curve (AUC) along with its 95% confidence interval (95%) were obtained for ZRS to predict 30-day MACE using the receiver operating characteristic (ROC) curve analysis. Crude odds ratio (95% CI) for 30-day MACE and outcomes were computed for high-risk group. P-value ≤0.05 was considered statistically significant.

4. Results

A total of 487 same-day discharged patients were included, out of which 83.2% (405) were male patients and mean age was 54.6 ± 10.87 years with 14.8% (72) elderly (>65 years) patients. More than 90% (444) of the patients were in Killip class I at presentation. Mean ZRS was 2.34 ± 1.64 with 16.0% (78) patients in high-risk group. Baseline characteristics, angiographic findings, procedural characteristics and post-procedure complications by high- and low-risk groups are presented in Table 1.

Thirty-day MACE rate was observed to be 5.3% (26), with a significantly higher rate among high-risk group as compared to low-risk group 12.8% (10) vs. 3.9% (16); p = 0.004 respectively. High-risk group had significantly higher risk of 30-day MACE with OR of 3.61 [1.57–8.29]. Similarly, risk of 30-day all-cause mortality was higher among patients in high-risk group with OR of 5.6 [1.76–17.84] with 30-day all-cause mortality rate of 7.7% (6) vs. 1.5% (6); p = 0.006 respectively. The 30-day major adverse cardiac events rate stratified by low- and high-risk groups are presented in Table 2.

The ROC of ZRS for prediction of 30-day MACE is presented in Fig. 1. The AUC of ZRS for prediction of 30-day MACE was found to be 0.67 [95% CI: 0.58–0.77], cut-off criteria of ZRS ≥4 for a high-risk group had a sensitivity of 38.5% and specificity of 85.2% with AUC of 0.62 [95% CI: 0.5–0.74] for prediction of 30-day MACE.

5. Discussion

The aim of this study was to assess the utility of the ZRS for the same-day discharge strategy after primary PCI. ZRS showed moderate discriminating power in identifying patients at higher risk of 30-day MACE with AUC of 0.67 [0.58–0.77] and MACE rate of 12.8% for the patients with ZRS of ≥4 (high-risk) as against the 3.9% among patients with ZRS of ≤3 (low-risk).Safety of early discharge strategy (48–72 h) after primary PCI with appropriately planned follow-up has been well established for low-risk patients in various studies. Zwolle risk score is among the most commonly used systematic assessment criteria for the identification of low-risk patients [19]. Some studies have also used NT-proBNP (<200 pg/mL) [9] and CADILLAC risk score ≤2,28 for the identification of candidate patients for early discharge [20]. Although data are scarce regarding same-day discharge strategy after primary PCI, only few studies so far have reported favorable outcomes of same-day discharge strategy in elective procedures [21–23] and only single observational study so far has been reported for primary PCI patients [11].

In a study conducted by Lim TW et al. [16] ZRS has shown to have excellent discriminative capability in identifying patients at high-risk of 30-day MACE and mortality among patients discharged within 72 h of primary PCI with AUC of 0.79 [95% CI: 0.68–0.90]. Tralhão A et al. [17] further provided evidence regarding applicability of ZRS for safe discharge of patients within 72 h of primary PCI with excellent AUC of 0.94 [95% CI: 0.91–0.97]. Schellings DA et al. [9] reported added advantage of baseline N-terminal pro–brain natriuretic peptide (NT-proBNP) along with ZRS to optimize the accuracy of identification of low-risk patients eligible for early (within 72 h) discharge after primary PCI. The combination of NT-proBNP ≤200 pg/mL and ZRS <2 had the optimal accuracy for predicting low-risk patients. In comparison to these earlier studies, the performance of ZRS was observed more specific (85.2%) than sensitive (38.5%) in identifying patients at high-risk of 30-day MACE after discharge within 24 h of procedure with moderate discriminating power (AUC = 0.67 [95% CI: 0.58–0.77]).

Though same-day discharge strategy has substantial implications for patients as well as for the healthcare system in optimizing and rationalizing the use of resources, optimization of patient selection is also equally important to maintain the effectiveness of primary PCI. The ZRS score, otherwise established risk stratification modality, failed to attain optimal discriminating value to detect the patients at higher risk of 30-day MACE after primary PCI. Hence, risk stratification tools, such as ZRS need calibration for identification of candidate patients for the same-day discharge after primary PCI. Echocardiographic and angiographic findings along with careful clinical evaluation of patients can provide additional power to the criteria of categorization [17]. Additionally due importance

Table 1. Demographic and clinical characteristics, angiographic and procedural details, and post-procedure complications by high- and low-risk group.

Characteristics	Total	Zwolle risk score (ZRS)		P-value
		Low-risk (≤3)	High-risk (≥4)	
Total (N)	**487**	**409**	**78**	**-**
Gender				
Male	83.2% (405)	84.1% (344)	78.2% (61)	0.202
Female	16.8% (82)	15.9% (65)	21.8% (17)	
Age (years)	54.6 ± 10.87	53.17 ± 10.42	62.08 ± 10.14	<0.001*
≤ 45 years	21.1% (103)	23.7% (97)	7.7% (6)	0.001*
46–65 years	64.1% (312)	64.8% (265)	60.3% (47)	0.444
> 65 years	14.8% (72)	11.5% (47)	32.1% (25)	<0.001*
KILLIP Class				
I	91.2% (444)	100% (409)	44.9% (35)	0.006*
II	8.8% (43)	0% (0)	55.1% (43)	
Duration of CP (minutes)	263 [150–450]	240 [150–450]	300 [135–420]	0.299
Type of myocardial infarction				
Anterior	53.2% (259)	47.4% (194)	83.3% (65)	<0.001*
Inferior	40.5% (197)	45.7% (187)	12.8% (10)	<0.001*
Posterior	4.3% (21)	4.6% (19)	2.6% (2)	0.407
Lateral	2.1% (10)	2.2% (9)	1.3% (1)	0.600
Co-morbid conditions and risk factors				
Hypertension	49.9% (243)	48.4% (198)	57.7% (45)	0.133
Diabetes	36.6% (178)	37.9% (155)	29.5% (23)	0.158
Family history of IHD	4.7% (23)	4.9% (20)	3.8% (3)	0.690
Smoking	33.9% (165)	33.7% (138)	34.6% (27)	0.881
Obesity	4.5% (22)	4.6% (19)	3.8% (3)	0.755
Access for the procedure				
Radial	49.5% (241)	49.9% (204)	47.4% (37)	0.693
Femoral	50.5% (246)	50.1% (205)	52.6% (41)	
Number of vessels involved				
Single vessel disease	23% (112)	23% (94)	23.1% (18)	0.986
Two vessel disease	37.8% (184)	39.9% (163)	26.9% (21)	0.031*
Three vessel disease	39.2% (191)	37.2% (152)	50% (39)	0.033*
Culprit coronary artery				
Left main	1.8% (9)	1.7% (7)	2.6% (2)	0.608
LAD	57.1% (278)	52.8% (216)	79.5% (62)	<0.001*
RCA	27.5% (134)	30.6% (125)	11.5% (9)	<0.001*
LCX	11.7% (57)	13% (53)	5.1% (4)	0.049*
Ramus	1.2% (6)	1.5% (6)	0% (0)	0.282
Diagonal	0.6% (3)	0.5% (2)	1.3% (1)	0.412
Pre-procedural TIMI (thrombolysis in myocardial infarction) flow grade				
0	48.9% (238)	46.7% (191)	60.3% (47)	0.028*
I	42.9% (209)	46% (188)	26.9% (21)	0.002*
II	5.1% (25)	5.1% (21)	5.1% (4)	0.998
III	3.1% (15)	2.2% (9)	7.7% (6)	0.01*
Post-procedural TIMI (thrombolysis in myocardial infarction) flow grade				
0	1% (5)	0.2% (1)	5.2% (4)	<0.001*
I	0.2% (1)	0% (0)	1.3% (1)	0.022*
II	14.4% (69)	12% (48)	27.3% (21)	<0.001*
III	84.3% (403)	87.8% (352)	66.2% (51)	<0.001*
Post-procedure complication(s)				
Total	0.82% (4)	0.73% (3)	1.28% (1)	0.504
Major bleeding	0.21% (1)	0.24% (1)	0% (0)	–
VT	0.21% (1)	0.24% (1)	0% (0)	–
Dissection	0.21% (1)	0% (0)	1.28% (1)	–
Other	0.21% (1)	0.24% (1)	0% (0)	–

*significant at 5%.

IHD = ischemic heart diseases, CP = chest pain, RCA = right coronary artery, LAD = left anterior descending artery, LCx = left circumflex artery, VT = ventricular tachycardia.

Table 2. 30-day major adverse cardiac event stratified by low- and high-risk group.

Characteristics	Total	Zwolle risk score (ZRS)		P-value
		Low-risk (≤3)	High-risk (≥4)	
N	487	409	78	–
MACE	5.3% (26)	3.9% (16)	12.8% (10)	0.004*
All-cause death	2.5% (12)	1.5% (6)	7.7% (6)	0.006*
Re-infarction	0.6% (3)	0.5% (2)	1.3% (1)	0.408
Bleeding events	0.6% (3)	0.7% (3)	0% (0)	>0.999
Cerebrovascular events	1.4% (7)	1.5% (6)	1.3% (1)	>0.999
Hospitalization for HF	0.4% (2)	0.5% (2)	0% (0)	>0.999
Repeat-revascularization	1.4% (7)	1% (4)	3.8% (3)	0.085

*significant at 5%.
HF = heart failure, MACE = major adverse cardiac event.

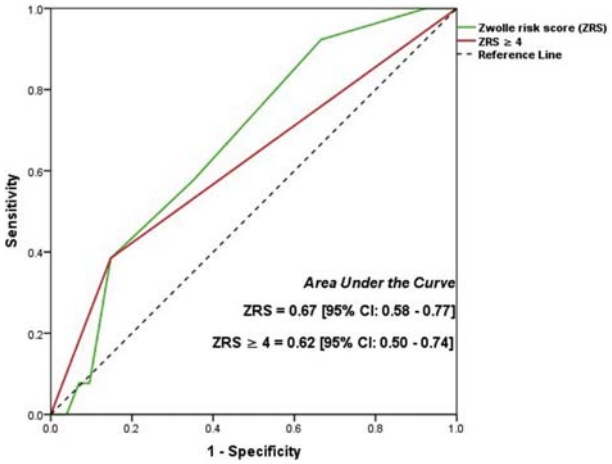

Fig. 1. Receiver operating characteristic of Zwolle risk score for prediction of 30-day major adverse cardiac events.

should be given to various patient related factors such as ejection fraction, renal function, frailty score, age, presence of arrhythmias, and hemodynamic status to help prevent unnecessary discharge of higher risk patients. Along with appropriate measures to improve cardiac rehabilitation, patient education, and drug titration as some researchers have shown concern regarding these with the early discharge strategy [24].

Even though this is first study evaluating utility of ZRS for the prediction of high-risk patients after discharge within 24 h of primary PCI. However, limitations of the study include single center coverage, relatively small sample size, and non-randomized study design. Hence, further large scale randomized studies are needed to validate the use of ZRS to facilitate physicians in clinical decision making regarding same-day discharge.

6. Conclusion

The ZRS showed moderate discriminating potential in identifying patients with high-risk of MACE at 30-day after same-day (within 24 h) discharge after primary PCI. Further large scale randomized studies are needed for the calibration of ZRS to optimize categorization of patients that can potentially benefit from the same-day discharge after primary PCI.

Disclaimer

None to declare.

Author contributions

Conception: Jehangir Ali Shah, Bashir Ahmed Solangi. Literature review: Jehangir Ali Shah, Mahesh Kumar Batra, Kamran Ahmed Khan, Gulzar Ali, Muhammad Hassan. Methodology: Jehangir Ali Shah, Mahesh Kumar Batra, Ghazanfar Ali Shah, Gulzar Ali, Muhammad Zubair, Musa Karim. Software, Analysis and/or Interpretation: Jehangir Ali Shah, Ghazanfar Ali Shah, Mehwish Zehra, Muhammad Hassan, Muhammad Zubair, Musa Karim. Investigation, Resources: Jehangir Ali Shah, Bashir Ahmed Solangi, Mahesh Kumar Batra, Kamran Ahmed Khan, Ghazanfar Ali Shah, Gulzar Ali, Mehwish Zehra, Muhammad Hassan. Data collection and/or Processing: Mahesh Kumar Batra, Kamran Ahmed Khan, Gulzar Ali, Muhammad Hassan, Muhammad Zubair, Musa Karim. Writer-Original draft: Jehangir Ali Shah, Kamran Ahmed Khan, Ghazanfar Ali Shah, Gulzar Ali, Mehwish Zehra, Muhammad Hassan. Writing- Review & Editing: Jehangir Ali Shah, Bashir Ahmed Solangi, Kamran Ahmed Khan, Mehwish Zehra. Visualization: Jehangir Ali Shah, Mehwish Zehra. Supervision: Bashir Ahmed Solangi, Kamran Ahmed Khan. Project Administration: Jehangir Ali Shah, Muhammad Zubair, Musa Karim. Fundings: Jehangir Ali Shah, Bashir Ahmed Solangi. Other: Jehangir Ali Shah, Bashir Ahmed Solangi, Mahesh Kumar Batra, Kamran Ahmed Khan, Ghazanfar Ali

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Conflict of interest

None to declare.

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