One-year major adverse cardiovascular events among same-day discharged patients after primary percutaneous coronary intervention at a tertiary care cardiac centre in Karachi, Pakistan: a prospective observational study


INTRODUCTION

Overnight observation after percutaneous coronary intervention (PCI) remains a common practice mainly because of the possible risk of periprocedural adverse events comprising acute myocardial infarction (AMI), vessel occlusion and access site complications; on the other hand, it has been observed that most of the major adverse events happen in the immediate postprocedural period, within the first 6 hours of the procedure. Advancements in AMI treatment and the introduction of PCI have resulted in enhanced safety and effectiveness, allowing for same-day discharge (SDD) in a particular set of individuals with low risk of mortality, rehospitalisation or other adverse events.

With the increasing number of cardiovascular events in our population, the major challenge for hospitals is to provide the highest quality care at minimum costs; therefore, the length of stay in the hospital remains a vital determinant of increased healthcare costs, specifically for procedures like PCI. Evidence supports the idea of SDD...
with increased patient comfort and satisfaction, and that most of the patients prefer to return home after PCI.\(^4\) In addition to patient comfort, SDD has financial benefits for patients, bed occupancy, and logistic benefits for busy public sector hospitals. However, as a counterargument, there is a shared misunderstanding that the individual might have fears about SDD arising from anxiety or stress of not being monitored following a cardiac intervention.

From an operational standpoint, SDD after PCI has various essential advantages. Presently, most hospitals are incapable of meeting the admittance requirements of their emergency units. These limitations usually occur when the flow of patients is not optimally controlled in the healthcare facility, for example, the use of inpatient beds for the recovery of post-PCI patients.\(^5\) Additionally, SDD after PCI is linked to a relative decrease in as much as half (50\%) of the healthcare costs.\(^5\) SDD for PCI also results in cost reduction with a decrease in medical supplies as well as room and bed occupancy; these two undeniable essential areas lead to a reduction of at least $5000 per case.\(^6\)

A series of risk assessment tools, including the Zwolle Risk Score (ZRS), the CADILLAC Risk Score, and the second Primary Angioplasty in Myocardial Infarction II criteria have been described for assessment of the risk of adverse events post PCI to identify potential candidates for SDD.\(^7\)–\(^9\) The use of such postdischarge risk stratification systems is limited, especially in public sector high-volume PCI centres; a systematic post-PCI risk stratification for early discharge can be of good use in these centres.

Knowledge regarding the impact of SDD following primary PCI on patients' satisfaction with their healthcare and overall short-term and long-term outcomes is lacking. We performed this study to evaluate the 1-year major adverse cardiovascular events (MACE) among SDD patients after primary PCI.

**METHODS**

**Study design and participants**

This prospective cohort study was conducted at a tertiary care cardiac hospital, National Institute of Cardiovascular Diseases in Karachi, Pakistan. The study cohort consisted of consecutive patients with ST segment elevation myocardial infarction (STEMI) undergoing primary PCI from August 2019 to July 2020, discharged from the hospital on the same day of the procedure (within 24 hours) by the treating physician, with at least one successful follow-up up to 1 year. This study is a 1-year follow-up analysis of a subset of patients from an earlier study conducted by Shah et al.\(^2\) The subgroup consisted of patients who were discharged from the hospital within 24 hours of the primary PCI. The primary purpose of that study was to evaluate the safety and feasibility of early discharge after primary PCI in selected clinician-identified low-risk patients in terms of MACE during 7-day and 30-day follow-ups. The detailed inclusion and exclusion criteria of the study are presented elsewhere.\(^2\)

Consent for participation and follow-up was obtained from all the patients, and the ethical review committee of the institution approved the study protocol.

Details regarding in-hospital and discharge management and collection of demographic, clinical and procedural data are mentioned in details elsewhere.\(^19\) The ZRS was calculated as per the scoring criteria defined by De Luca et al.\(^6\) based on age, Killip class at presentation, total ischaemic time (defined as symptom onset to device activation time), anterior wall myocardial infarction, postprocedure thrombolysis in myocardial infarction flow grade, and the number of diseased vessels. A telephonic and/or physical follow-up was obtained for all the patients at 1 week, 1 month, 6 months and 1 year. Patients with at least one successful follow-up were included, and the duration of follow-up was noted in accordance with the successful follow-up. Out of a total of 504 SDD patients,\(^2\) at least one successful follow-up was conducted in 97\% (489/504) of patients, with a loss to follow-up rate of 3.0\% (15/504). The outcome measure was the incidence of MACE, which included any unplanned coronary revascularisation, hospitalisation for unstable angina (UA), cerebrovascular events, myocardial infarction, cardiovascular mortality and all-cause mortality.

**Data analysis**

Data were categorised into two groups based on the occurrence of MACE, and baseline demographic, clinical, angiographic and procedural characteristics were compared between the two groups with the help of the \(\chi^2\) test/Fisher’s exact test and t-test/Mann-Whitney U test appropriately. Data were also categorised as high-risk patients or low-risk patients based on the ZRS and MACE rate compared, and risk ratio (RR) (95\% CI) was calculated for high-risk (ZRS≥4) patients. Univariate and multivariable binary logistic regression analysis was performed to determine the clinical predictor of 1 year MACE. ORs, along with 95\% CIs, are reported. All the variables which are part of the calculation of ZRS were not included as independent variables in the regression analysis. All the analyses were performed using IBM SPSS software V.21 at 0.05 level of significance.

**Patient and public involvement**

None.

**RESULTS**

A total of 489 patients were included, with men accounting for 83.2\% (407/489) patients. The mean age was 54.58±10.85 years. Overall MACE rate was 10.8\% (53), out of which 26.4\% (14/53) events occurred within 6 months of discharge, and the remaining 73.6\% (39/53) occurred in the ensuing 6 months. The study outcome measure was associated with advanced age, higher ZRS and higher Killip class at presentation (table 1).

The mean follow-up duration was 326.98±76.71 days, during which the incidence of MACE was significantly
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total</th>
<th>1-year MACE</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (N)</td>
<td>Not occurred</td>
<td>Occurred</td>
</tr>
<tr>
<td>Total (N)</td>
<td>489</td>
<td>436 (89.2%)</td>
<td>53 (10.8%)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>83.2% (407)</td>
<td>83.3% (363)</td>
<td>83% (44)</td>
</tr>
<tr>
<td>Female</td>
<td>16.8% (82)</td>
<td>16.7% (73)</td>
<td>17% (9)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>54.5±10.85</td>
<td>53.4±10.35</td>
<td>63.7±10.71</td>
</tr>
<tr>
<td>≤45 years</td>
<td>21.3% (104)</td>
<td>23.4% (102)</td>
<td>3.8% (2)</td>
</tr>
<tr>
<td>46–65 years</td>
<td>64% (313)</td>
<td>64.9% (283)</td>
<td>56.6% (30)</td>
</tr>
<tr>
<td>&gt;65 years</td>
<td>14.7% (72)</td>
<td>11.7% (51)</td>
<td>39.6% (21)</td>
</tr>
<tr>
<td>ZRS</td>
<td>2.33±1.63</td>
<td>2.22±1.54</td>
<td>3.23±2.04</td>
</tr>
<tr>
<td>Low-risk (≤ 3)</td>
<td>85.1% (416)</td>
<td>86.9% (379)</td>
<td>69.8% (37)</td>
</tr>
<tr>
<td>High-risk (≥ 4)</td>
<td>14.9% (73)</td>
<td>13.1% (57)</td>
<td>30.2% (16)</td>
</tr>
<tr>
<td>Killip class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>91.2% (446)</td>
<td>92.2% (402)</td>
<td>83% (44)</td>
</tr>
<tr>
<td>II</td>
<td>8.8% (43)</td>
<td>7.8% (34)</td>
<td>17% (9)</td>
</tr>
<tr>
<td>Duration of chest pain (minutes)</td>
<td>453.89±790.34</td>
<td>442.92±749.44</td>
<td>544.06±1074.31</td>
</tr>
<tr>
<td>Type of myocardial infarction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>53.4% (261)</td>
<td>52.8% (230)</td>
<td>58.5% (31)</td>
</tr>
<tr>
<td>Inferior</td>
<td>40.3% (197)</td>
<td>41.3% (180)</td>
<td>32.1% (17)</td>
</tr>
<tr>
<td>Posterior</td>
<td>4.3% (21)</td>
<td>3.9% (17)</td>
<td>7.5% (4)</td>
</tr>
<tr>
<td>Lateral</td>
<td>2% (10)</td>
<td>2.1% (9)</td>
<td>1.9% (1)</td>
</tr>
<tr>
<td>Risk factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>49.9% (244)</td>
<td>48.6% (212)</td>
<td>60.4% (32)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>36.6% (179)</td>
<td>36.2% (158)</td>
<td>39.6% (21)</td>
</tr>
<tr>
<td>Family history of CAD</td>
<td>4.7% (23)</td>
<td>4.8% (21)</td>
<td>3.8% (2)</td>
</tr>
<tr>
<td>Smoking</td>
<td>33.9% (166)</td>
<td>35.1% (153)</td>
<td>24.5% (13)</td>
</tr>
<tr>
<td>Obesity</td>
<td>4.5% (22)</td>
<td>4.6% (20)</td>
<td>3.8% (2)</td>
</tr>
<tr>
<td>Access for the procedure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radial</td>
<td>49.5% (242)</td>
<td>49.1% (214)</td>
<td>52.8% (28)</td>
</tr>
<tr>
<td>Femoral</td>
<td>50.5% (247)</td>
<td>50.9% (222)</td>
<td>47.2% (25)</td>
</tr>
<tr>
<td>Number of vessels involved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single vessel disease</td>
<td>23.3% (114)</td>
<td>24.5% (107)</td>
<td>13.2% (7)</td>
</tr>
<tr>
<td>Two vessel disease</td>
<td>37.6% (184)</td>
<td>37.8% (165)</td>
<td>35.8% (19)</td>
</tr>
<tr>
<td>Three vessel disease</td>
<td>39.1% (191)</td>
<td>37.6% (164)</td>
<td>50.9% (27)</td>
</tr>
<tr>
<td>Culprit coronary artery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left main</td>
<td>1.8% (9)</td>
<td>2.1% (9)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>LAD</td>
<td>57.3% (280)</td>
<td>56.9% (248)</td>
<td>60.4% (32)</td>
</tr>
<tr>
<td>Right coronary artery</td>
<td>27.4% (134)</td>
<td>27.3% (119)</td>
<td>28.3% (15)</td>
</tr>
<tr>
<td>Left circumflex artery</td>
<td>11.7% (57)</td>
<td>12.2% (53)</td>
<td>7.5% (4)</td>
</tr>
<tr>
<td>Ramus</td>
<td>1.2% (6)</td>
<td>0.9% (4)</td>
<td>3.8% (2)</td>
</tr>
<tr>
<td>Diagonal</td>
<td>0.6% (3)</td>
<td>0.7% (3)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>TIMI (preprocedural flow)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>48.9% (239)</td>
<td>48.9% (213)</td>
<td>49.1% (26)</td>
</tr>
<tr>
<td>I</td>
<td>42.9% (210)</td>
<td>43.6% (190)</td>
<td>37.7% (20)</td>
</tr>
<tr>
<td>II</td>
<td>5.1% (25)</td>
<td>4.8% (21)</td>
<td>7.5% (4)</td>
</tr>
<tr>
<td>III</td>
<td>3.1% (15)</td>
<td>2.8% (12)</td>
<td>5.7% (3)</td>
</tr>
</tbody>
</table>

Continued
higher among patients with ZRS ≥4 at baseline with the incidence rate of 21.9% (16/73) vs 8.9% (37/416); p=0.001 against patients with ZRS ≤3, respectively (table 2). For the high-risk patients (ZRS≥4), the calculated RR (95% CI) was 2.88 (1.5–5.5) for MACE, 3.29 (1.64–6.61) for all-cause mortality, 12 (2.16–66.77) for myocardial infarction, 2.11 (0.74–6.05) for cardiovascular death and 5.83 (0.81–42.07) for the incidence of hospitalisation due to UA (table 2).

The univariate and multivariable binary logistic regression analysis of 1-year MACE results are presented in table 3. ZRS≥4 was found to be an independent predictor of 1-year MACE with an unadjusted and adjusted OR of 2.88 (1.50–5.50) and 2.97 (1.53–5.79), respectively.

**DISCUSSION**

This study evaluated the incidence of 1-year MACE among SDD patients after primary PCI. The overall MACE rate was 10.8%, with a majority of events (73.6%) occurring in a 6-month to the 1-year period after discharge. MACE incidence was associated with advanced age, ZRS at baseline and Killip class at presentation. Prior study has revealed the safety of SDD; however, most of the studies are from healthcare facilities where SDD was not a common practice, and high-risk PCI cases (STEMI) were not included in the analysis. Most of the available evidence on SDD after PCI is for elective procedures, however, data on safety of SDD in the context of primary PCI are very limited. Due to the misbalanced ratio of procedures and resources in our part of the world, SDD after uncomplicated primary PCI remains a common practice but reported evidence regarding this is very limited. The only available data in this regard is from a recent study by Shah et al, who reported safety of SDD strategy with a minimal rate of 7-day (3.5%) and 30-day (4.9%) MACE. Further, ZRS has been reported to have a moderate discriminating potential for identifying low-risk patients and the need to calibrate ZRS has been suggested for the recognition of ideal patients for SDD following primary PCI. Adequate risk assessment and a more scientific and systematic approach to patient identification for SDD are crucial to improve the efficacy and effectiveness of SDD strategy for primary PCI patients.

In contemporary practice, SDD after PCI is a reasonable option in patients with secure vascular access permitting safe ambulation, good procedural outcomes, adequate adherence to the dual antiplatelet therapy, and early outpatient follow-up with ample family and social support.
support.\textsuperscript{11} For effective application of this process, it is vital to evaluate individuals suitable for SDD following successful PCI precisely. It is essential to detect high-risk patient-related and procedural characteristics which caution against SDD. It is also imperative to examine elements such as health literacy, frailty and the social supports in place that can contribute to the success of this strategy.\textsuperscript{13} Pre-PCI triage, typically comprising demographics, patient’s health records and some basic laboratory tests, is critical to determine the feasibility of SDD. Patient’s residence within 2 hours from a catheterisation laboratory and angioplasty carried out in the early hours of the day are significant factors favouring SDD.\textsuperscript{17}

Despite the fact that SDD has been proven to be economically effective and improves patient satisfaction,\textsuperscript{5, 6} it is still not being acknowledged widely in day-to-day clinical practice. There has been a challenge to alter the belief and practices which have been followed from the initial days of coronary intervention. It has been observed that the rate of acceptance of the SDD strategy was not optimal despite implementation of a multistage eligibility assessment.\textsuperscript{25} Some common barriers include limited literature, concerns about outcomes, fear among both patient and treating physician, inadequate allotted resources for close follow-up, and unfamiliarity with existing literature and evidence. Additionally, healthcare personnel were found to be aware of the benefits of SDD but not its safety.\textsuperscript{23} Broadly speaking, there could be four potential major challenges that could lead to hesitation in shifting current clinical practice. First, the medico-legals concerns from the hospitals, healthcare members and medical community regarding the safety of SDD. Second, the doctors, nurses and facilities at large may have certain concerns regarding the adequacy of time for rehabilitation, counselling and education of the patient regarding the diseases and procedures before discharge. Third, in most healthcare systems, there remains a misunderstanding that SDD may offer disincentives to doctors and facilities. Lastly, regarding acceptability to patients, some individuals might be unwilling to agree on the SDD approach following PCI.\textsuperscript{14} In order to effectively implement this practice, it is imperative to evaluate patients for appropriateness regarding SDD precisely. An expert consensus document from the Society for Cardiovascular Angiography and Interventions has put forward a framework for SDD focusing on the ‘3 Ps’, procedure, patient and programme,\textsuperscript{24} centring on the patient, procedure and institutional elements.

To the best of our knowledge, this is the first ever study on the effectiveness of SDD strategies for low-risk primary PCI patients in our populations. This study provides valuable insights into the possibility of SDD for the optimal utilisation of healthcare resources. The SDD approach is the need of the times for the healthcare system of low-income and middle-income countries, such as Pakistan, with limited healthcare facilities and an increasing burden of cardiovascular diseases. However, it is also essential to acknowledge the methodological limitation of the study. Although this study was concluded at the largest primary PCI centre in the country, the observational nature of the study and single-centre coverage remained the major methodological limitations towards the generalisability of the study findings. Second, the lack of systematic evaluation of low-risk patients for SDD and the lack of a control group with regular discharge are also the limitations of this study. Further studies with systematic evaluation of patients for SDD after primary PCI are needed to optimise patient outcomes.

**CONCLUSION**

The SDD strategy after primary PCI carries a significant burden of short-term MACE; most of these events occurred after 6 months of SDD and mainly for patients with ZRS≥4. Through systematic risk stratification, it is quite possible to identify a subset of patients that can benefit the most from the SDD strategy. Hence, with the added economic advantage along with higher patient satisfaction and acceptability, the transition from a conventional extended hospital stay to the SDD model appears

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**Table 3** Univariate and multivariable binary logistic regression analysis of 1-year MACE

<table>
<thead>
<tr>
<th></th>
<th>Univariate OR (95% CI)</th>
<th>P value</th>
<th>Multivariable OR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>1.02 (0.48 to 2.17)</td>
<td>0.965</td>
<td>0.72 (0.32 to 1.62)</td>
<td>0.428</td>
</tr>
<tr>
<td>ZRS≥4</td>
<td>2.88 (1.50 to 5.50)</td>
<td>0.001</td>
<td>2.97 (1.53 to 5.79)</td>
<td>0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.61 (0.90 to 2.88)</td>
<td>0.108</td>
<td>1.53 (0.82 to 2.87)</td>
<td>0.182</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.15 (0.64 to 2.07)</td>
<td>0.629</td>
<td>0.99 (0.53 to 1.86)</td>
<td>0.973</td>
</tr>
<tr>
<td>Family history of CAD</td>
<td>0.77 (0.18 to 3.4)</td>
<td>0.736</td>
<td>0.83 (0.17 to 4.1)</td>
<td>0.817</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.60 (0.31 to 1.16)</td>
<td>0.128</td>
<td>0.59 (0.29 to 1.19)</td>
<td>0.137</td>
</tr>
<tr>
<td>Obesity</td>
<td>0.82 (0.19 to 3.59)</td>
<td>0.788</td>
<td>0.97 (0.20 to 4.77)</td>
<td>0.966</td>
</tr>
<tr>
<td>Preprocedural TIMI 0 flow</td>
<td>1.01 (0.57 to 1.78)</td>
<td>0.978</td>
<td>0.90 (0.50 to 1.62)</td>
<td>0.723</td>
</tr>
</tbody>
</table>

CAD, coronary artery disease; MACE, major adverse cardiovascular events; TIMI, thrombolysis in myocardial infarction; ZRS, Zwolle Risk Score.
to be a viable option for patients with low-risk features. However, systematic risk assessment based on the ‘3 Ps’, should be an integral component in the success of the strategy. Further randomised trials with sufficient power are needed to evaluate short-term and long-term MACE for the global implementation of the SDD strategy.

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Contributors JAS accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish. JAS, RK, BAS, KAK, JASial, TA and NO contributed to the concept and design of the study. SK, JAS, TS and MK contributed to the analysis and interpretation of data. JAS, RK, BAS, GA, JASial and MZ collected data and drafted the manuscript. MZ, JAS, TS, JASial, NO and MK critically analysed for content. All authors approved the final draft to the manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the ethical review committee of the National Institute of Cardiovascular Diseases (NICVD), Karachi (ERC-38/2019). Verbal informed consent was obtained from all the patients regarding their participation in the study and publication of data while maintaining confidentiality and anonymity. Due to the observational nature of the study, ERC waived the written consent. Verbal consent was approved by the ERC.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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REFERENCES