



## Editorial

# Short-Term Mortality After Percutaneous Coronary Intervention—It Ain't Over When It's Over



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In-hospital death after percutaneous coronary intervention (PCI) is widely used as a quality metric for PCI by the National Cardiovascular Data Registry and state-level registries.<sup>1</sup> The risk factors for in-hospital mortality after PCI are well defined; however, a substantial proportion of deaths within 30 days of undergoing PCI occur after discharge from the hospital, and there is a need to understand the cause of these deaths and, ultimately, prevent them. It is possible that the risk of death after discharge may be associated with its own distinct risk factors. Understanding these risk factors might facilitate the development of process-of-care innovations to prevent postdischarge deaths.

Previous real-world studies of comprehensive PCI patient populations have demonstrated that both 30-day mortality rates<sup>2</sup> and postdischarge 30-day mortality rates are low.<sup>3</sup> The identification of actionable, modifiable factors associated with early death after discharge, whether related to the PCI procedure or not, may present a mortality-reducing intervention opportunity for outpatient providers who assume care of these patients after discharge.

In this issue of *JSCAI*, Hannan et al<sup>4</sup> sought to define the incidence of death occurring within 30 days after discharge and to identify predictive risk factors with a goal to identify actionable items that might reduce the risk. They conducted a large-scale analysis of 128,406 patients enrolled in New York State's PCI registry between 2015 and 2017 and linked these to New York's Vital Statistics data file and the National Death Index. The PCI registry included key details, including patient-level risk factors, whether procedures were emergent or non-emergent, the extent of coronary disease, ventricular function, procedural complications, types of devices used, and the discharge destination. Risk factors present in patients who died 30 days after discharge were compared with those of patients who died before discharge and to those of patients who survived beyond 30 days.

The New York State Percutaneous Coronary Interventions Reporting System is a rich data source that contains comprehensive data from all PCI-performing nonfederal hospitals in New York State. It is representative of contemporary practice while avoiding selection bias.

Overall, 1982 (1.54%) of 128,486 patients died within 30 days after the PCI procedure. A total of 1306 (1.02%) patients died before hospital

discharge and 676 (0.53%) patients died after discharge. This death after discharge group is the principal focus of the analysis. These mortality rates are remarkably congruent with the rates in the report by Bricker et al<sup>5</sup> of 115,191 patients treated with PCI in the Veterans Affairs hospital system between 2005 and 2016. In the study by Bricker et al,<sup>5</sup> a 30-day mortality rate of 1.4% was found, with an after-discharge mortality rate of 0.33%.

The data set's large size and granular data enabled robust univariate and multivariable analyses of the relationships between patient characteristics and the risk of death in hospital and after discharge. These analyses may be summarized as demonstrating that the risk of postdischarge death correlates with increasing patient age, severity of illness, acuity of presentation, and noncardiovascular comorbidity.

To examine whether postdischarge mortality might be a programmatic quality indicator, the authors examined the risk-adjusted relationships between hospital mortality and 30-day postdischarge mortality at the institutional level. They found essentially no correlation between the two. They called attention to "outlier hospitals" identified by large disparities between the 2 mortality categories; however, this analysis involved 66 individual comparisons of small event rates, and each individual comparison included only a small number of events. Consequently, because the analysis involved many comparisons, one would expect the individual hospital event rate estimates to be unstable and would expect a modest number of apparent "outliers" owing to random chance.

We can draw 3 important conclusions from the findings of the study by Hannan et al<sup>4</sup>:

1. The 30-day postdischarge death rate after PCI is small but not trivial. Postdischarge death among patients with high-risk features at presentation is sufficiently frequent that initiatives and interventions that would reduce it further would be welcome.
2. The risk of 30-day postdischarge death is highly correlated with increasing measures of patient cardiovascular disease severity, noncardiovascular comorbidities, and acuteness of presentation.

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3. The findings of Hannan et al<sup>4</sup> are important benchmarks for assessing risk-adjusted hospital and 30-day postdischarge mortality after PCI; however, the frequency of these outcomes is sufficiently low that statistical measures of death rate at the program and practitioner level are unstable and, thus, poorly suited to serve as quality measures, with the potential exception of extreme outlier values.

Perhaps this study's most stunning finding is the remarkably low mortality rate after PCI, particularly in the lower-risk patient cohorts. Among elective PCI procedures, the hospital mortality rate after PCI was 0.2% and the total 30-day mortality rate was 0.4%. Even among emergency patients, the hospital mortality rate after PCI was 3.9% and the total 30-day mortality was 4.9%. These findings were driven by the extremely high combined hospital and postdischarge mortality rate of patients who presented with either refractory or nonrefractory shock (>20%).

To formulate process-of-care interventions to reduce postdischarge mortality, it is necessary to know both which patients are at risk and the pathogenesis of their deaths. An acknowledged important shortcoming of this analysis is that the causes of death are not available. Accordingly, there is uncertainty as to how and why these patients died, whether or not the cause of death might have been related to the PCI procedure, and whether death might have been prevented by a preemptive or process-of-care intervention.

It is possible that many of the deaths were the consequence of other patient comorbidities and not related to the PCI procedure. It is noteworthy that the elective patient group without a recent acute coronary syndrome had a postdischarge mortality rate of 0.2% (1 in 500). In the study by Bricker et al<sup>5</sup> performed in the Veterans Affairs Healthcare System, where 30-day mortality events after PCI were adjudicated using patient records, only 28% of all mortality events within 30 days after PCI could be directly attributable to a cardiovascular cause and only 8% were directly related to the PCI. This resulted in an overall PCI-related mortality rate of only 0.1%.<sup>5</sup>

Although this study by Hannan et al<sup>4</sup> clearly identifies patient characteristics associated with increased risk, it does not identify the mechanisms of death. Therefore, it is not helpful for physicians endeavoring to formulate processes of care to protect identifiable high-risk patients. The next task for research in this field is to rigorously examine how these patients are dying in order to design targeted interventions to minimize these deaths.

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