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### Reviving Invasive Hemodynamic Monitoring in Cardiogenic Shock. Invasive Hemodynamic Monitoring in Cardiogenic Shock

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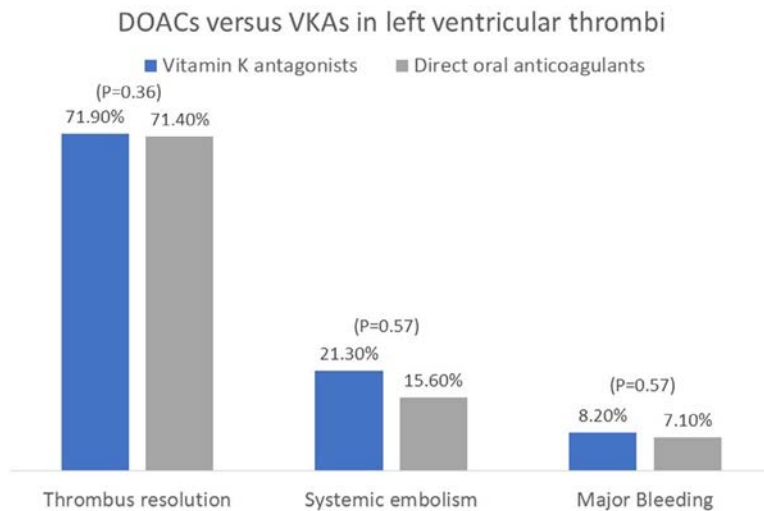


Figure 2. Efficacy and safety of DOACs and VKA in management of left ventricular thrombus. DOACs = direct oral anticoagulants; VKA = Vitamin K antagonists.

## Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Reviving Invasive Hemodynamic Monitoring in Cardiogenic Shock. Invasive Hemodynamic Monitoring in Cardiogenic Shock



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The use of invasive hemodynamic monitoring (IHM) through pulmonary artery catheters to assist in the management of heart failure has been surrounded by controversy. Early enthusiasm for IHM faded after the publication of the Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness (ESCAPE) trial in 2005; which

demonstrated that IHM did not reduce mortality compared to standard care.<sup>1</sup> Major limitations of the trial were the lack of a unified treatment algorithm to direct clinical care and the exclusion of patients with cardiogenic shock (CS).<sup>1</sup> In the years after the ESCAPE trial, there was a decrease in the utilization of IHM in patients with CS.<sup>2</sup> Technological advancements in temporary mechanical circulatory support devices have led to the diffusion of shock management from cardiac surgeons to critical care, heart failure, and interventional cardiology subspecialties and the dawning of multidisciplinary shock teams. This was best exemplified in the National Cardiogenic Shock Initiative, which used a shock protocol for the treatment of acute myocardial infarction complicated by cardiogenic shock (AMI-CS).<sup>3,4</sup> The rationale for routine use of IHM was that it allowed for early identification of patients with CS and helped guide decisions such as the need for treatment escalation and the ability to guide medical and MCS weaning.<sup>3,4</sup> This was similarly emphasized by other shock working groups including INOVA, the University of Utah and the Cardiogenic Shock Working Group. This focused analysis aims to describe the recent trends in IHM utilization among patients with CS.

Adult patients (≥18 years) admitted with CS from January 1, 2004–December 31, 2018, were identified in the National Inpatient Sample (NIS) using the International Classification of Disease 9th/10th Revision Clinical Modification Codes 78551& R570. We then identified patients who underwent IHM using ICD-9 &10 procedure codes to measure, monitor, or insert a monitoring device to check cardiac output or pulmonary artery hemodynamics. Similar methods have been used to identify patients receiving IHM.<sup>2</sup> We excluded the following patients: (1) patients with missing mortality, age, or gender, data, (2) patients who are younger than 18 years, (3) patients who were admitted electively to the hospital. We assessed the trends in IHM utilization during the study period and compared the rates of IHM use in three-time intervals: (1) pre-ESCAPE trial (2004–2005), (2) post-ESCAPE trial (2006–2015), and (3) the era of shock teams (2016–2018). Moreover, we report the trends among patients with AMI-CS

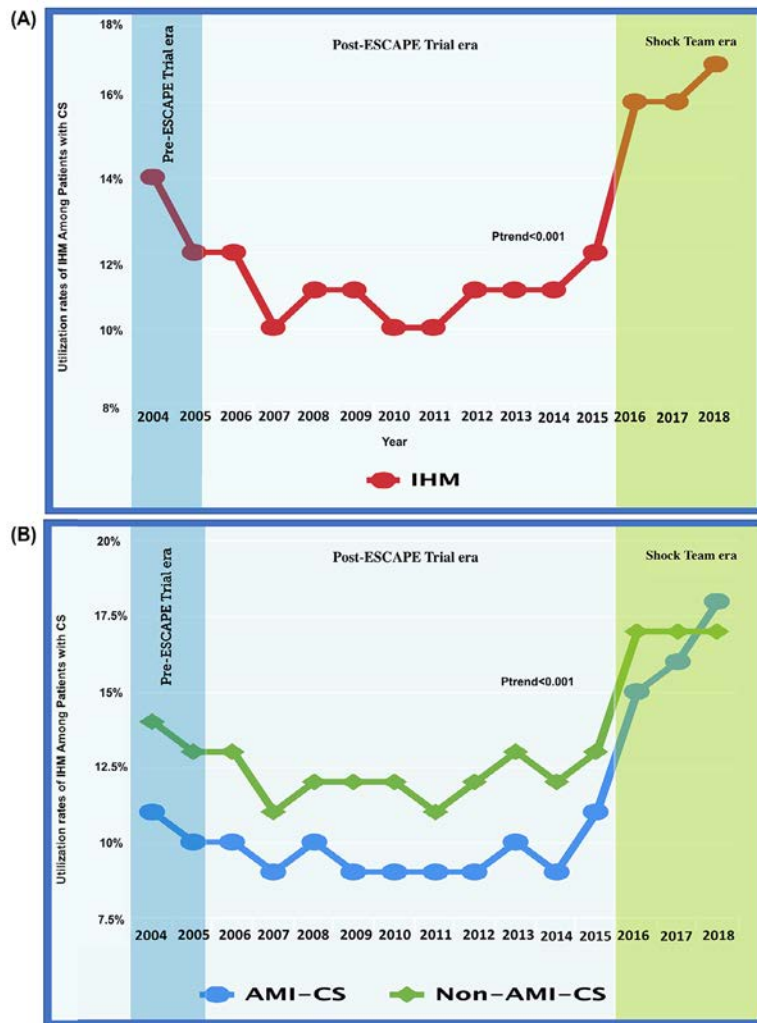


Figure 1. Trends in the utilization of invasive hemodynamic monitoring among (A) patients with cardiogenic shock. (B) Patients with AMI-CS and non-AMI-CS. AMI-CS, acute myocardial infarction complicated by cardiogenic shock

and non-AMI-CS. AMI-CS was identified by selecting patients with the principal diagnosis of AMI (ST-segment elevation myocardial infarction or non-ST-segment elevation myocardial infarction) and concomitant code for CS. While the non-AMI-CS cohort was identified by selecting patients with CS who did not have a concomitant code for AMI. Institutional review board approval was not required as the NIS database is de-identified and publicly available. All variables are expressed as weighted national estimates. We used the Cochran–Armitage test for trend analysis.

Among a total of 563,949,644 hospitalizations during the study period; 1,531,878 (0.3%) were due to CS. After an initial decline in IHM utilization from 13% in the pre-ESCAPE era to 10% in the post-ESCAPE era, a steady increase has been observed in the trends of IHM use which reached 17% in 2018 ( $p_{trend} < 0.001$ ). Similar trends were observed in patients with AMI-CS and non-AMI-CS (Figure 1).

The current analysis is limited due to its retrospective nature and the utilization of billing codes.

In conclusion, we report a rising use of IHM among patients with CS after

an initial decline in use following the ESCAPE trial publication. Randomized clinical studies assessing the routine use of IHM in patients with CS remains warranted.

## Disclosures

M.B.B. is a consultant for Abbott Vascular, Abiomed, Cardiovascular Systems, Chiesi, Zoll. W.W.O. is a consultant for Abiomed, Boston Scientific, and Medtronic. The remaining authors have nothing to disclose.

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