Regional Variation in the Adoption of Invasive Hemodynamic Monitoring for Cardiogenic Shock in the United States

There has been recent interest in cardiogenic shock (CS) protocols relying on data obtained from invasive hemodynamic monitoring (IHM) performed using right heart or pulmonary artery catheterization.[1,2] While limited data is available from randomized clinical trials, several centers have reported improved mortality with the adoption of such protocols and the incorporation of shock teams in the care of patients with CS.[1,2] Limited data is available about the integration of IHM in treating patients with CS at the national level, and variation of care based on regional or hospital characteristics. Hence, this focused analysis aims to describe the regional variation in IHM utilization for the care of patients with CS in the United States.

Adult patients (≥18 years) admitted with CS during January 1st, 2004 to December 31st, 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 the ICD-9 &10 procedure codes to measure, monitor, or insert a monitoring device to check cardiac output or pulmonary artery hemodynamics. Similar methods were used in previous studies to identify patients who received IHM.[3,4] We excluded patients who are younger than 18 years, and those who were admitted electively. We assessed the utilization rates among the four different census regions as defined by the US Census Bureau: West, Midwest, Northeast, and South. Moreover, we report the trends stratified by the hospital teaching status (rural non-teaching, urban non-teaching, and urban teaching hospitals). All variables are expressed as weighted national estimates. We used the Cochrane-Armitage test for trend analysis. Statistical analyses were performed using statistical package for social science (SPSS) version 26.

From January 1st, 2004 to December 30th, 2018, a total of 1,531,878 hospitalizations had a code for CS and were included in the current analysis. During the overall study period, the utilization of IHM varied by regions as follows: Northeast (16%), Midwest (15%), West (13%), and South (11%) (p <0.01). In 2004, hospitals in the Northeast region had a higher utilization rate of IHM (17%), followed by West and Midwest regions (15% for both), and the lowest utilization reported in the South (10%). Fifteen years later, there has been an increasing trend of IHM utilization in the Northeast region, which continued to report the highest utilization rate (22%), followed by the Midwest (19%), and then South (15%). However, there has been no change in the West region (remained at 15%) (Figure 1).

As anticipated, the utilization rate of IHM is highest among urban teaching hospitals compared with urban non-teaching hospitals and rural hospitals (16%, 7%, and 6%, respectively, p <0.01). The utilization of IHM has shown a slow decline in late 2005, which corresponds to the publication of the ESCAPE [Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness] trial.[5] In this multicenter randomized clinical trial, which excluded patients with CS, the routine use of hemodynamic data did not show benefit in reducing mortality. A resurge in the utilization is observed by the year 2016, which corresponds to the recent adoption of shock algorithms relying on IHM to guide the early deployment of mechanical support devices.[1,2] The current analysis is limited due to the retrospective nature of

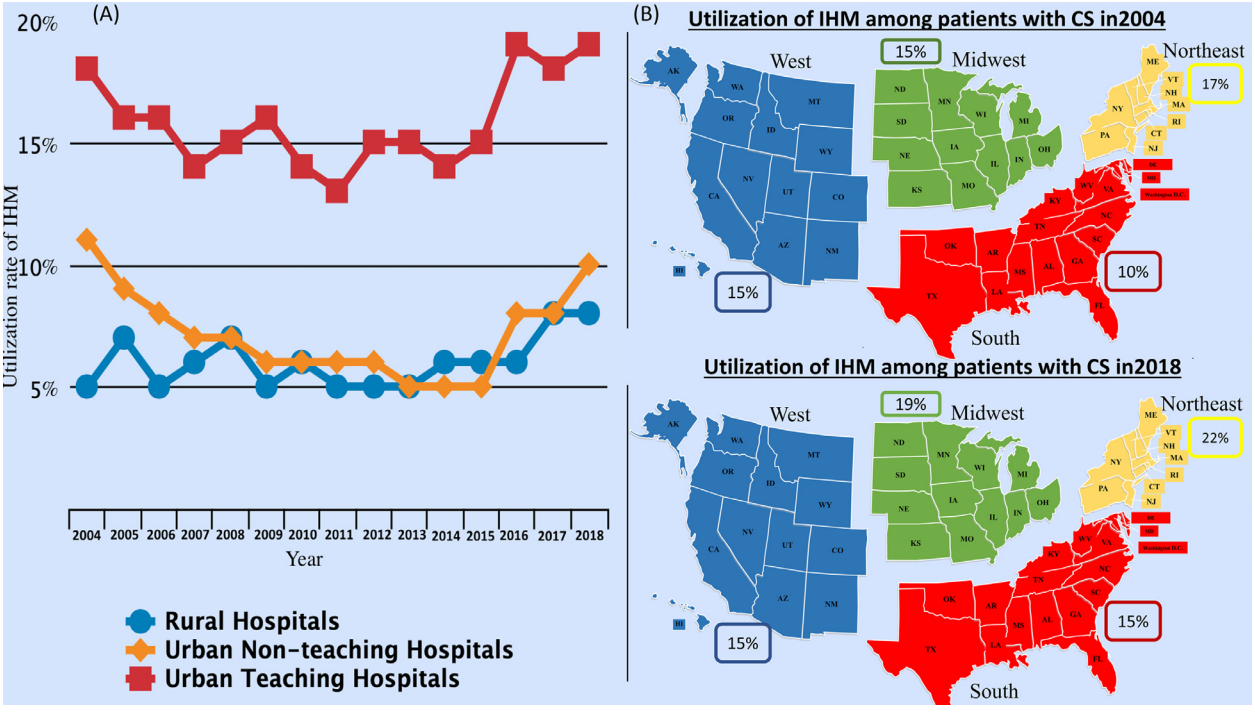

Figure 1. Trends in the utilization of invasive hemodynamic monitoring. *(A)* Stratified by hospital teaching status. *(B)* Stratified by US regions.

the study. Moreover, we used billing codes for IHM, which are prone to errors. However, the same codes were used by previous studies.[3,4]

In conclusion, we report a significant regional variation in the utilization of IHM for patients with CS. Hospitals in the Northeast regions have the highest utilization rates, while hospitals in the South and West regions have the lowest rates. Additionally, while all regions witnessed an increased rate of IHM utilization in the 15 years of the study, hospitals in the West region did not show a change in the utilization rate between 2004 and 2018.

Mohammed Osman, MD[a]*
Sudarshan Balla, MD[a]
Saikrishna Patibandla, MD[a]
Babikir Kheiri, MD[b]
Marco Caccamo, DO[a]
Christopher Bianco, DO[a]
George Sokos, DO[a]

[a] Division of Cardiology, West Virginia University School of Medicine, Morgantown, West Virginia
[b] Knight Cardiovascular Institute, Oregon Health and Science University, Portland, Oregon

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Meta-Analysis of Sodium-Glucose Cotransporter 2 Inhibitors in Heart Failure Patients Without Diabetes

Heart failure remains a major public health disease with high morbidity and mortality, and it is the leading cause of hospitalizations in older patients (>65 years).[1] The role of sodium-glucose cotransporter 2 inhibitors (SGLT2i) is now well-established in patients with heart failure and diabetes mellitus.[2] However, their efficacy and safety in heart failure patients without diabetes remains unclear. Therefore, we conducted a meta-analysis of randomized controlled trials (RCTs) to evaluate the role of SGLT2i in this vulnerable population.

A comprehensive search of electronic database was performed. Two investigators (MM, SS) screened the trials and extracted the data independently. The primary outcome of interest was a composite of cardiovascular death and heart failure hospitalizations. The secondary outcome was the quality-of-life (QoL) improvement as measured by the Kansas City Cardiomyopathy Questionnaire (KCCQ). We calculated

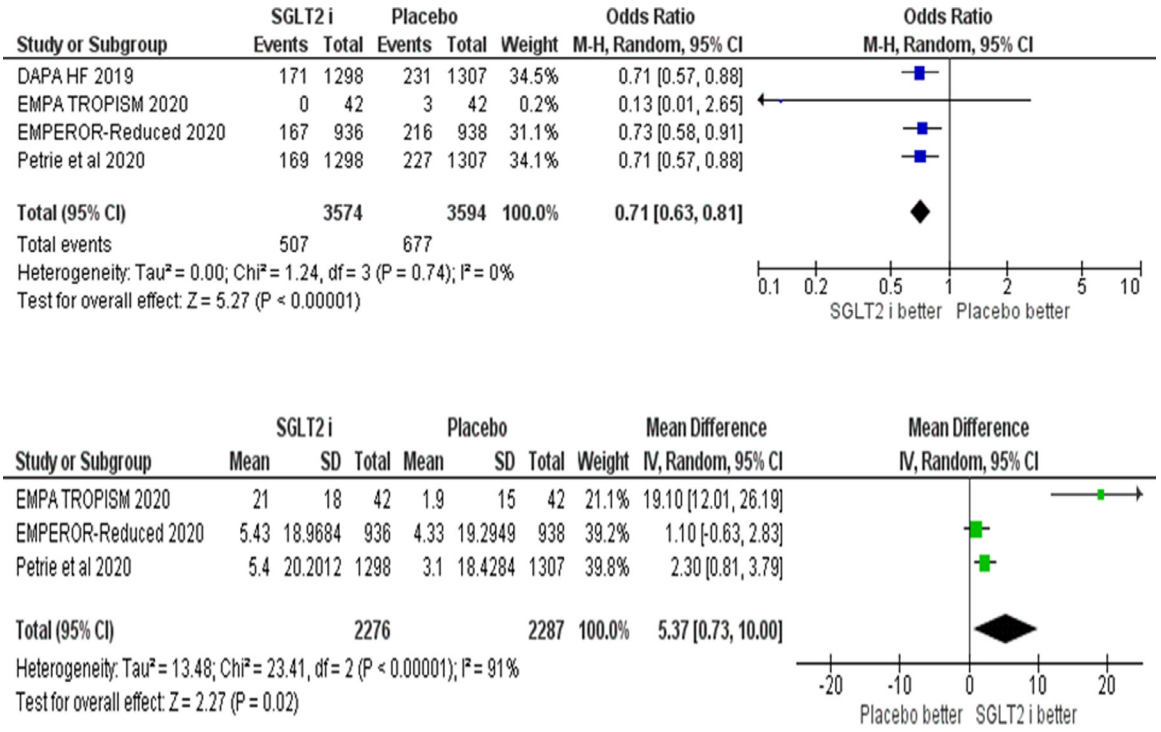

Figure 1. Forest plots for clinical outcomes.