Trends and predictors of Readmissions after Left ventricular assist device

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ABSTRACT:

Background:
Impella Left ventricular assist device (LVAD) is used for hemodynamic support during high risk coronary interventions and in patients with cardiogenic shock. Data on percutaneous Impella ventricular assist device related 30-day readmissions are not well studied

Methods:
The Healthcare Cost and Utilization Project National Readmission Database was used to identify index hospitalization with Impella placement in patients ≥18 years old. Multivariate logistic regression analyses were used to examine factors associated with risk of 30-day readmissions.

Results:
We evaluated 5,941 hospitalized patients who survived to discharge after index hospitalization from January through November 2018 and analyzed readmissions over 30 days after discharge. A total of 1,418 patients (24%) were readmitted within 30 days, the most common reasons for readmission included acute myocardial infarction (27%) and heart failure (15%).

Conclusions:

NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
30-day readmissions were associated with a significant increase in healthcare costs. The majority of readmissions were secondary to acute myocardial infarction and heart failure. Ongoing efforts are required to recognize and reduce potentially preventable readmissions.
INTRODUCTION:

Many prior studies have looked into readmissions after hospitalizations after common conditions. The readmission rates have been variable for instance, complex cancer surgery 14% [1], Watchman device 9.2% [2], brain tumors 13.2% [3], and carotid artery stenting 7.4%. [4]

Short term mechanical circulatory support devices (MCS) are being increasingly used for hemodynamic support in a variety of conditions ranging from prophylactic insertion for high risk coronary interventions to patients presenting with cardiogenic shock. [5,6] Impella (Abiomed, Danvers, MA) is a micro-axial flow device, which is placed retrogradely across the aortic valve into the left ventricle. Impella system is available in different sizes – 2.5, CP and 5.0. Impella 2.5 and CP are percutaneously placed from either a femoral or an axillary approach and are more commonly used. With the increasing use of percutaneous Impella MCS devices, hospitalizations, readmissions and complications have a significant impact on healthcare cost and utilization. We present the national population-based database to assess predictors of 30-day readmissions after index hospitalization with Impella placement.

METHODS

We utilized the National Readmission Database (NRD) from the Healthcare Cost and Utilization Project (HCUP) which includes data from approximately 18 million discharges each year (Weighted estimated to be roughly 36 million discharges). NRD is a database with all-payer hospital inpatient stays that is used to produce national readmissions estimate. All admissions of an individual are linked by a validated unique ID which is used to track readmissions across different hospitals and state. Overall, NRD represents 58% of all US hospitalizations. The
data and study materials are available to other researchers through the HCUP website, https://www.hcup-us.ahrq.gov, and may be used for reproduction of results. We followed the methodology as has been previously described [1-4,6] This study was exempt from IRB as we used publicly available deidentified data.

Statistical Analyses:

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 1.0.0.118 (IBM Corp., Armonk, N.Y., USA). We used 2-sided tests with a significance level of 0.05 for statistical analysis. We examined baseline characteristics of participants and tested for statistical differences using the Pearson Chi Square test for categorical variables and Mann-Whitney U-Test for continuous variables with no readmission as the reference group. To determine the predictors of readmission, with adjustments for age-group, gender, payer source, all clinically relevant variables were included in multivariable logistic regression analysis.

RESULTS:

National Readmissions database included 5941 cases of Impella placement from January 2017 to December 2017 among hospitalized patients. We excluded patients with death at index hospitalization (n=1364), and were discharged in the month of December (n= 419) and those with missing data(n=1).

Table 1 shows that mean age of the patients in the study was 68 years (SD 59-77), 28% of the patients were female. About 62% of the patients were insured by Medicare, followed by private insurance (22%), Medicaid (9%) and others (7%). After the index admission with Impella
placement, 1418 patients (24%) were readmitted. The mean age of patients that had readmission was 68 years. The mean length of stay for the readmission hospitalization was 8.52 days. Among those patients with 30-day readmissions, 429 (30%) had percutaneous coronary intervention (PCI) and 44 (3%) had coronary artery bypass surgery. The mean cost of hospitalization for primary hospitalization was $56,577. For patients with 30-day readmission, mean cost of hospitalization was $41,622. The total cost of readmission among all the patients with hospitalizations were $59,000,000.

**Predictors of 30 day readmission and costs:**

Multivariable logistic regression analysis for the predictors of 30-day readmission. The results showed that patients with complications of device, acute kidney injury (AKI), chronic obstructive pulmonary disease (COPD), diabetes, dementia have higher likelihood of readmission and patients who were treated at large hospitals, and who received revascularization with PCI or CABG during the index hospitalization had lower chance of readmission.

**DISCUSSION:**

Evaluating Impella related readmissions from Jan 2018 to Dec 2018 from a nationally representative patient cohort from the NRD database, we found a readmission rate of 24%, with majority of readmissions being myocardial infarction (27%) followed by heart failure (15%). AKI, device complications, COPD, diabetes and dementia were associated with higher rates of 30 day readmissions on a multivariable regression analysis while revascularization with either PCI or CABG was associated with lower rates of readmissions.
Other studies have found similar results. Among all patients hospitalized for Cerebral Cavernous Malformations (CCM), 14.9% (13.7-16.2%) required all cause readmission within 30 days. Multivariate logistical regression analysis showed that substance abuse (p=0.003), diabetes (p=0.018), gastrointestinal bleed (p=0.002), renal failure (p=0.027), and coronary artery disease (p=0.010) were predictive of all cause readmissions, while age group 65-74 (p=0.042), private insurance (p<0.001), and treatment at a metropolitan teaching institution (p=0.039) were protective. Approximately half of all readmissions are caused by neurological (33.9%) and infectious (14.6%) etiologies. The 30-day lesion bleeding rate after index hospitalization is 0.8% (0.5-1.2%). [7]

In the last few years, percutaneous Impella MCS are used more commonly for performing high risk percutaneous interventions and for patients with cardiogenic shock. FDA approved Impella 2.5 and Impella CP to treat selective advanced heart failure patients undergoing elective and urgent percutaneous coronary interventions and also in cardiogenic shock [8]

One of the research looking into readmissions in patients with right heart failure, found that patients with history of Coronary artery bypass grafting (p=0.033; OR 2.359; 95% CI 1.071 - 5.197), Chronic kidney disease (p<0.001; OR 1.607; 95% CI 1.402 - 1.843), atrial fibrillation (p=0.014; OR 1.417; 95% CI 1.072-1.873) had high odds of unplanned 30 day readmissions while obesity (p<0.001; OR 0.686; 95% CI 0.594 - 0.792) had negative odds of such readmissions. [9]
A value based analysis of the PROTECT II trial by Gregory et al showed that Impella reduced critical care and readmission length of stay and cost of readmission at 90 day follow up compared to balloon pump but the study included only patients with Impella 2.5. [10]

Hospital readmissions affects the quality of life, increases morbidity and mortality and adds to healthcare costs significantly. Reducing hospital readmissions has become a focus of healthcare delivery. [11] Therefore it is of utmost importance to identify the factors that contribute to readmissions. In our study, we found that 24% of the patients who underwent percutaneous Impella placements were readmitted with 30 days of discharge. Acute myocardial infarction was the leading cause of readmission in our study accounting to one fourth of the readmitted patients. Overall in all cause readmissions, prior research showed that Age group 18-44 years, 45-64 years, 65 to 74 years and age over 75 years had 7.0%, 12.0%, 11.7%, and 12.3% readmissions respectively. Female gender, private insurance and elective admissions were negative predictors for readmissions. For age group 18-44 years schizophrenia and diabetes mellitus complications, while in all older age groups septicemia and heart failure were the most frequent primary diagnosis for readmissions. [12]
LIMITATIONS:

Our study is based on the database which relies on ICD-10-CM and Clinical Classification Software code. The database does not have other clinical and laboratory data. The database also does not track mortality data on patients who died outside of a hospital setting or in the emergency department.

CONCLUSION

In conclusion, 30-day readmission are frequent after Impella implantation. Most readmissions are due to acute myocardial infarction or heart failure. Device complication, AKI, COPD, Diabetes Mellitus and dementia are associated with increased risk of readmissions. Healthcare costs associated with such readmissions were high and will have a significant impact on the total cost of healthcare.
**Table 1:** Individual and Hospital level factors associated within 30 days of index hospitalization with Impella implantation

|                                | No 30d readmission | 30d readmission | Overall | P Value |
|--------------------------------|--------------------|-----------------|---------|---------|
| Age (in years), median [IQR]   | 69 (60-77)         | 68 (59-77)      | 68 (59 – 77) | 0.027   |
| Women                          | 1263(27.9%)        | 416(29.3%)      | 1679(28.3%) | 0.302   |
| Elective                       | 376(8.3%)          | 121(8.5%)       | 497(8.4%)  | 0.794   |
| Weekend admission              | 1065(23.5%)        | 335(23.6%)      | 1400(23.6%)| 0.952   |
| **Insurance status**           |                    |                 |         | <0.001  |
| Medicare                       | 2731 (60.4%)       | 947 (66.9%)     | 3678 (62%)|         |
| Medicaid                       | 403(8.9%)          | 126(8.9%)       | 529(8.9%)  |         |
| Private                        | 1068(23.6%)        | 259(18.3%)      | 1327(22.4%)|         |
| Self-pay                       | 125(2.8%)          | 29(2%)          | 154(2.6%)  |         |
| No charge                      | 14(0.3%)           | 4(0.3%)         | 18(0.3%)   |         |
| Other                          | 179(4%)            | 51(3.6%)        | 230(3.9%)  |         |
| **Cost of hospitalization in US$, median [IQR]** | 42663 (12423-83464) | 59589 (34020-91431) | 56577 (26131 – 89935) | <0.001 |
| LOS, median [IQR]              | 7 (4-15)           | 8 (4-15)        | 8 (4-15)  | 0.584   |
| **Hospital teaching status**   |                    |                 |         | 0.046   |
| Metropolitan, non-teaching     | 827(18.3%)         | 301(21.2%)      | 1128(19%)  |         |
| Metropolitan, teaching         | 3486(77.1%)        | 1057(74.5%)     | 4543(76.4%)|         |
| Non-metropolitan               | 211(4.7%)          | 61(4.3%)        | 272(4.6%)  |         |
| **Discharge location**         |                    |                 |         | 0.001   |
| Home self care                 | 2226(49.2%)        | 692(48.8%)      | 2918(49.1%)|         |
| Transfer to short-term hospital| 257(5.7%)          | 46(3.2%)        | 303(5.1%)  |         |
| Transfer Other                 | 1059(23.4%)        | 362(25.5%)      | 1421(23.9%)|         |
| Home Health Care               | 925(20.5%)         | 291(20.5%)      | 1216(20.5%)|         |
| Against medical advice         | 51(1.1%)           | 27(1.9%)        | 78(1.3%)   |         |
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