MHCC - Social Determinants of Health as an Independent Factor Following a ST-segment Elevation Myocardial Infarction Percutaneous Coronary Intervention

May 17, 2022

Prior Study

- Specific Aim: The Impact of STEMI PCI Volume on Mortality.
- Methods
  - American College of Cardiology's National Cardiovascular Data Registry (ACC-NCDR) for CathPCI: 2015 – 2019.
  - Inpatient mortality identified by discharge disposition.
  - PCI indication:
    - Immediate PCI for STEMI.
    - PCI for STEMI (Unstable, >12 hours from symptom onset).
    - PCI for STEMI (Stable, >12 hours from symptom onset).
    - PCI for STEMI (Stable after successful full-dose Thrombolysis).
    - Rescue PCI for STEMI (after failed full-dose lytics).

Prior Study

- Mortality Risk-Adjustment Variables
  - Age, race, sex, body mass index, previous congestive heart failure, previous cerebrovascular disease, peripheral vascular disease, chronic lung disease, previous PCI, diabetes, admission symptom presentation, cardiogenic shock, pre-operative intra-aortic balloon pump, ejection fraction, and PCI status (elective, urgent, emergent, salvage).
- Hierarchical Logistic Regression Models

Prior Study

- Volume
  - Two Groups: Low- and high-volume hospitals based on the median counts of PCI procedures by hospital for indication from 2015 to 2019.
  - Three Groups: Hospitals categorized into three groups by terciles, using the 33rd and 66th percentile PCI counts by hospital.
- Key Finding
  - Hospitals with relatively high STEMI PCI volume have lower mortality rates after controlling for demographic and clinical factors.

INCREMENTAL EFFECT OF INCREASING STEMI PCI VOLUME

INCREMENTAL EFFECT OF INCREASING STEMI PCI VOLUME ON MORTALITY

			95% Confidence Interval	
Year	Odds Ratio	S.E.	Lower Limit	Upper Limit
2015	0.877	0.110	0.686	1.122
2016	0.908	0.105	0.724	1.141
2017	0.636	0.099	0.469	0.863
2018	0.796	0.117	0.596	1.062
2019	0.717	0.083	0.571	0.899
2015-2019	0.794	0.059	0.686	0.919

Implication: STEMI PCI volume, after controlling demographic and clinical characteristics, tend to be associated with lower mortality

EFFECT OF MEDIUM AND HIGH STEMI PCI VOLUME COMPARED TO LOW VOLUME

EFFECT OF MEDIUM AND HIGH STEMI PCI VOLUME ON MORTALITY COMPARED TO LOW VOLUME

	Medium Relative to Low Volume				High Relative to Low Volume			
			95% Confidence Interval				95% Confidence Interval	
Year	Odds Ratio	S.E.	Lower Limit	Upper Limit	Odds Ratio	S.E.	Lower Limit	Upper Limit
2015	1.268	0.341	0.748	2.148	0.847	0.227	0.500	1.433
2016	1.234	0.294	0.774	1.968	0.867	0.206	0.544	1.383
2017	0.796	0.246	0.435	1.457	0.406	0.128	0.219	0.752
2018	1.116	0.322	0.633	1.966	0.653	0.189	0.370	1.152
2019	0.981	0.234	0.614	1.567	0.525	0.126	0.327	0.842
2015-2019	1.046	0.142	0.802	1.365	0.645	0.088	0.494	0.842

Implication: STEMI PCI volume, after controlling demographic and clinical characteristics, tend to be associated with lower mortality

Prior Study

- Key Finding
  - Hospitals with relatively high STEMI PCI volume have lower mortality rates after controlling for demographic and clinical factors.

Follow Up Questions

- Appears counter intuitive given that 8 of the 12 low volume hospital are tertiary centers that perform cardiac surgery in addition to PCI.
- Low STEMI PCI volume hospitals may treat patients with higher socioeconomic deprivation.
- There are other differences between high and low STEMI PCI volume hospitals that may impact inpatient mortality beyond the effect of volume alone.
  - Transfers.
  - Rescue PCIs.

Specific Aims

- Analysis #1: to evaluate the relationship between STEMI PCI volume and social determinants of health.
- Analysis #2: to determine the impact of local area socioeconomic deprivation, along with STEMI PCI volume, on inpatient mortality.
- Analysis #3: to assess other differences between high and low STEMI PCI volume hospitals that may impact inpatient mortality beyond the effect of volume alone.

Area Deprivation Index (ADI)

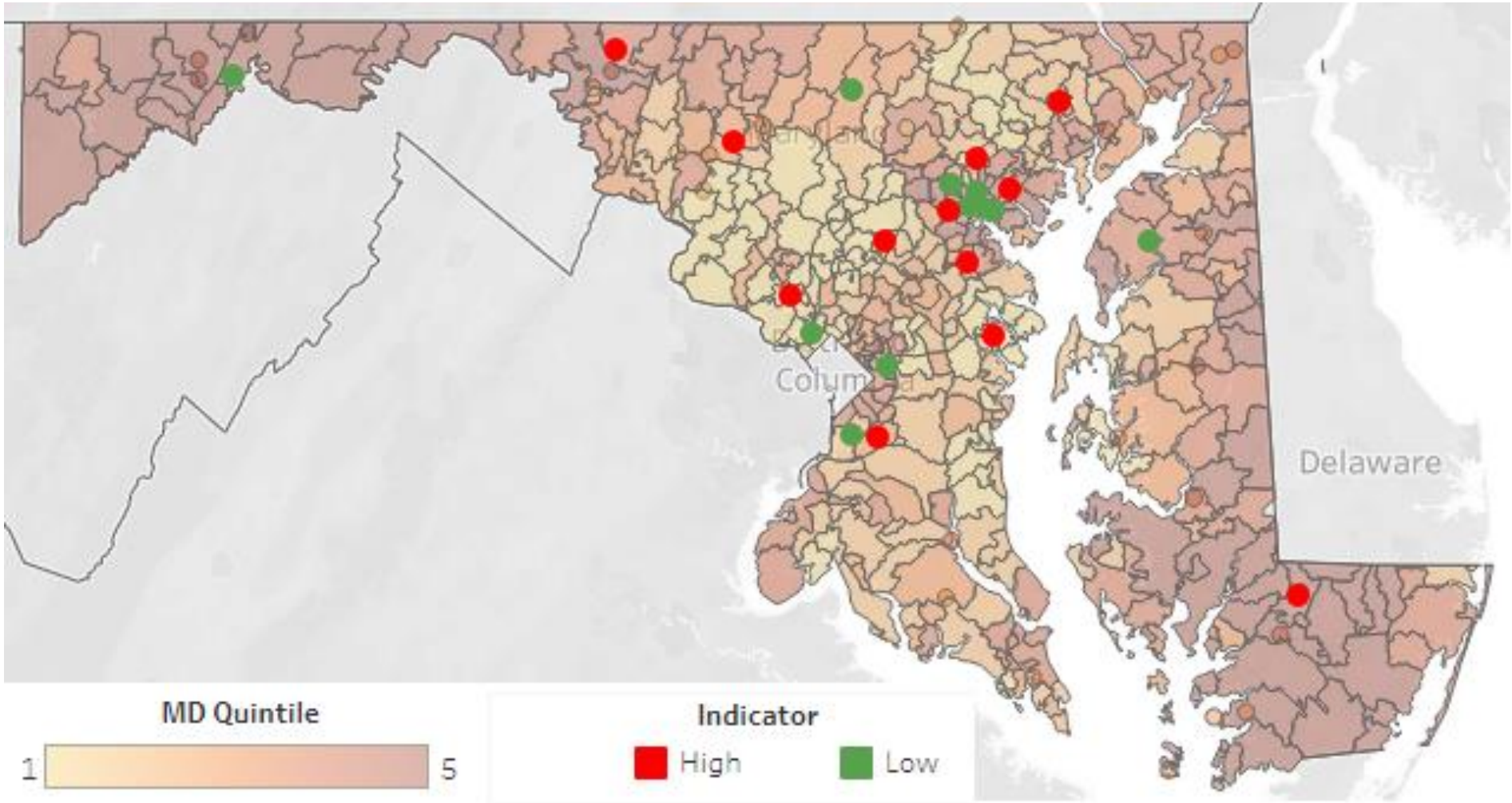
ADI Calculation

- American Community Survey (ACS)
- ZIP Code Tabulation Area (ZCTA)
- Singh Coefficients
- Quintiles

ADI Domains

- Education
- Income/Employment
- Housing
- Household Characteristics

Distribution of STEMI PCIs by High and Low STEMI Volume Hospitals and ADI Quintiles



STEMI PCIs by High and Low STEMI Volume Hospitals and ADI Quintiles

Low Deprivation

High Deprivation

Quintile	High STEMI PCI Volume		Low STEMI PCI Volume	
	Count	Percent	Count	Percent
Lowest 20th Percentile	4,169	59.3%	1,701	42.6%
20-40th Percentile	1,627	23.1%	765	19.1%
40-60th Precentile	555	7.9%	477	11.9%
60-80th Percentile	126	1.8%	392	9.8%
Highest 20th Percentile	73	1.0%	162	4.1%
Unknown	481	6.8%	499	12.5%

Implication: The STEMI patients receiving PCIs at high volume hospitals tended to be from areas with less deprivation than low volume hospitals

Mean ADI Quintiles for High and Low STEMI PCI Hospitals(2015 – 2019)

Variable	Observations	Mean	St. Dev.	95% Confidence Interval
High STEMI PCI Volume	6,550	0.197	0.159	0.193 - 0.201
Low STEMI PCI Volume	3,497	0.291	0.240	0.283 - 0.299
Combined	10,047	0.230	0.196	0.226 - 0.234
Difference	0.095			0.087 - 0.102

Implication: The representative STEMI patient at a high STEMI volume hospital was in the 20th percentile of ADI, compared to the representative STEMI patient treated at a low STEMI volume hospital who was in the 30th percentile of ADI

Impact of ADI Quintile on Inpatient Mortality

Low Deprivation

High Deprivation

Quintile	Odds Ratio	St. Err.	P-value	95% Confidence Interval
Lowest 20th Percentile	0.539	0.168	0.047	0.293 - 0.991
20-40th Percentile	0.638	0.203	0.157	0.342 - 1.188
40-60th Precentile	0.716	0.243	0.325	0.369 - 1.392
60-80th Percentile	0.93	0.328	0.838	0.466 - 1.857
Highest 20th Percentile (Referent)	1			

Implication: After controlling for individual characteristics, clinical patient profiles, and the hospital STEMI PCI volume, the area socioeconomic deprivation index had an impact on inpatient mortality for STEMI PCI patients following PCI.

Source of Admission for High and Low STEMI PCI Hospitals (2015 – 2018Q1)

	2015		2016		2017		2018Q1		2015 - 2018Q1	
Admit Source	High	Low	High	Low	High	Low	High	Low	High	Low
Emergency Department	1,371	561	1,274	578	1,229	552	348	173	4,222	1,864
Transfer in from another acute care facility	175	164	167	122	154	120	36	31	532	437
Other/Unknown	43	11	30	26	67	26	9	8	149	71

Implication: Transfers from another acute care facility make up 19.5 percent of the admissions for low STEMI volume hospitals compared to 9.2 percent ($p < 0.001$) for high STEMI volume hospitals.

STEMI Delay Differences Between High and Low STEMI PCI Hospitals

	Mean	S.E.	95 % Confidence Interval	
High STEMI Volume	0.133	0.007	0.119	0.147
Low STEMI Volume	0.147	0.009	0.130	0.164
Difference: High vs Low	-0.0138	p = 0.225		

Implication: With respect to the proportion of STEMI cases that had a delay in the PCI procedure, there was no statistically significant difference between high and low volume hospitals.

Time From Symptom Onset to First Device for Differences Between High and Low STEMI PCI Hospitals (2018Q2 – 2019)

	Mean	S.E.	95 % Confidence Interval	
High STEMI Volume	55.446	3.257	49.060 -	61.833
Low STEMI Volume	42.603	3.008	36.704 -	48.502
Difference: High vs Low	12.843	p = 0.004		

Implication: Low STEMI PCI volume hospitals had a shorter time (42.6 minutes) from recorded symptom onset to first device relative to high volume hospitals (55.4 minutes). The 12.8-minute difference was statistically significant (p = 0.004). Approximately 15.4 percent of the STEMI cases were missing a symptom onset time for STEMI cases which makes the onset to device time difficult to interpret.

Time From Arrival to First Device for Differences Between High and Low STEMI PCI Hospitals

	Mean	S.E.	95 % Confidence Interval		
High STEMI Volume	19.245	1.481	16.342	-	22.149
Low STEMI Volume	20.440	1.898	16.718	-	24.161
Difference: High vs Low	-1.194	p = 0.620			

Implication: The difference between high and low STEMI PCI volume hospitals was not statistically significant for arrival to first device time.

Impact of STEMI Time and Delay on Inpatient Mortality (2018Q2 – 2019)

Variable	Odds Ratio	St. Err.	P-value	95% Confidence Interval
Delay	5.445	1.121	0.000	3.637 - 8.152
Time: Sympton Onset to First Device	1.000	0.001	0.813	0.998 - 1.002
Time: Arrivl to First Device	1.000	0.001	0.836	0.997 - 1.002

Implication: STEMI PCIs with a recorded delay in PCI procedures had 5.4 greater odds of inpatient death relative to cases without PCI delay. The onset-to-device time and arrival-to-device time did not independently have a statistically significant impact on inpatient mortality.

Reasons for PCI Delay for High and Low STEMI PCI Hospitals (2018Q2 – 2019)

PCI Delay Reason	High PCI Volume		Low PCI Volume	
	Count	Percent	Count	Percent
Cardiac Arrest and/or need for intubation before PCI	125	40.5%	92	37.9%
Difficult Vascular Access	50	16.2%	26	10.7%
Difficulty crossing the culprit lesion	54	17.5%	50	20.6%
Emergent placement of LV support device prior to PCI	6	1.9%	6	2.5%
Other/Unknown	58	18.8%	49	20.2%
Patient delays in providing consent for PCI	16	5.2%	20	8.2%

Implication: Cardiac Arrest and/or need for intubation before PCI was the most frequently occurring reason for PCI delay at high and low volume hospitals, followed by difficulty crossing the culprit lesion and difficult vascular access, for the known reasons.

Transfer and Salvage Cases for High and Low STEMI PCI Hospitals (2015 – 2018Q1)

	2015		2016		2017		2018Q1		2015 - 2018Q1	
Case Type	High	Low	High	Low	High	Low	High	Low	High	Low
Transfer	174	163	162	117	152	114	36	29	524	423
Salvage	24	17	21	27	9	24	1	9	55	77
Transfer & Salvage	1	1	5	5	2	6	0	2	8	14

Transfer and Salvage Cases for High and Low STEMI PCI Hospitals (2015 – 2018Q1)

Implication: When both salvage and transfer cases are removed, the sample is reduced by 1,101 cases (15.2%). The odds ratio for mortality of STEMI patients at high vs low volume hospitals increases to 1.002 (p = 0.991). This suggests that when both the salvage and transfer cases are removed from the analysis, the impact of volume on mortality for STEMI patients dissipates.

Conclusions

- Socioeconomic Deprivation
  - Low STEMI PCI volume hospitals do treat patients with higher socioeconomic deprivation factors that include income and educational level.
  - Local area socioeconomic deprivation, along with STEMI PCI volume, has a significant impact on inpatient mortality, at least for STEMI patients from areas with the least and most socioeconomic deprivation.
- Other Factors Associated with Inpatient Mortality
  - Low STEMI PCI volume hospitals tend to receive a higher proportion of transfer patients from other acute care hospitals.
  - Low volume hospitals have a higher proportion of salvage STEMI PCIs compared to high volume hospitals, which significantly impacts the inpatient mortality rate.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Questions ?