In Hospital Outcomes of Patients With Right Bundle Branch Block and Anterior Wall ST-Segment Elevation Myocardial Infarction (From a Nationwide Study Using the National Inpatient Sample)

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Previous studies have reported worse outcomes for patients with right bundle branch block (RBBB) complicating acute ST-segment elevation myocardial infarction (STEMI). There is a paucity of data examining outcomes with RBBB and STEMI in contemporary large-scale studies. This study aims to explore the outcomes of patients with anterior wall STEMI (AW-STEMI) and RBBB. Using ICD-9 codes, we queried the National Inpatient Sample of 1999 to 2014 to identify AW-STEMI admissions and stratified them for the presence of RBBB. Primary outcome was in-hospital mortality within 30 days. Secondary outcomes included acute heart failure, complete heart block, and permanent pacemaker implantation. Cox-proportional logistic regression models were used to determine the hazard ratios of the primary outcome and secondary outcomes and interventions. Among 1,075,875 weighted anterior wall STEMI (AW-STEMI) admissions, 19,153 (1.8%) had RBBB. Compared with patients without RBBB, mortality was significantly higher for patients with RBBB (9.2% vs 15.3%; p <0.0001). RBBB in the setting of AW-STEMI was associated with a 66% increased risk of 30-day in-hospital mortality (hazard ratios [HR], 1.66; 95% confidence interval [CI], 1.52 to1.81; p <0.0001) and a higher likelihood of acute heart failure (HR, 1.37; 95% CI, 1.29 to 1.45; p <0.0001), complete heart block (HR, 2.90; 95% CI, 2.64 to 3.18; p <0.0001) and utilization of a permanent pacemaker (HR, 2.51; 95% CI, 1.89 to 3.35; p <0.0001). In conclusion, the presence of RBBB in the setting of an AW-STEMI is a significant independent predictor of a poor prognosis, including a higher rate of acute heart failure, complete heart block, need for a permanent pacemaker, and a higher 30-day in-hospital mortality. **(Am J Cardiol 2021;140:20−24)**

The presence of right bundle branch block (RBBB) on 12-lead electrocardiogram (ECG) is common in patients with acute myocardial infarction (AMI), observed in up to 16% of patients, with a wide range in reported prevalence (3% to 16%).[1−15] New RBBB is less common, occurring in about 0.3% to 4.6% of all AMI[2,4,6,9,12,16] and presumably as a result of ischemia involving the intraventricular conduction system. Blood supply to the proximal right bundle, as well as the left anterior fascicle, comes from the septal arteries. Therefore, one would expect that an AMI resulting in the development of RBBB would be associated with an occlusion of the proximal left anterior descending artery (LAD) and imply a worse prognosis. Many earlier studies have demonstrated higher short- and long-term mortality[1,3,6−14] and greater need for permanent pacemaker implantation[11,17] in patients with RBBB. These studies have been limited due to small sample sizes, inclusion of patients with and without ST-segment elevation on ECG, and variations in the management of the AMI (many of whom did not receive acute reperfusion therapies). Owing to the absence of large-scale studies, specifically examining patients with anterior wall ST-segment elevation myocardial infarction anterior wall STEMI (AW-STEMI) and RBBB, we examined the prognostic significance of RBBB in patients admitted to the hospital with acute AW-STEMI. We hypothesized that compared with patients without RBBB, the presence of RBBB in patients with AW-STEMI would be associated with increased morbidity and mortality.

Methods

The data source for this study was the healthcare cost and utilization project [19] national inpatient sample (NIS) records for years 1999 to 2014. The NIS is one of the largest publicly available databases in the United States and contains information on over 7 million hospital discharges per year. It uses a 20% stratified sample of hospital discharges from across the country. Diseases and procedures are identified using the

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international classification of diseases, ninth revision, clinical modification (ICD-9-CM)[20] and each hospitalization has a unique primary and various secondary ICD-9-CM diagnoses. Additional information including de-identified demographic details, length and costs of hospitalization, and procedural codes are also available for each patient.

We conducted a cross-sectional study using the NIS for years 1999 to 2014. We used ICD-9-CM codes 410.0x and 410.1x to identify all admissions with a primary diagnosis of AW-STEMI for patients aged 18 years or above. Hospitalization with information missing on age, race, gender, length of stay (LOS), cost of stay or in-hospital death were excluded. We then used ICD-9-CM code 426.4 to identify admissions with a secondary diagnosis of RBBB which may have developed before or during the particular hospitalization. The presence of RBBB was coded if there was documentation in the chart of said diagnosis.[19]

The primary outcome was defined as death that occurred in hospital within 30 days of admission. Secondary outcomes included conditions or interventions as a potential consequence of extensive myocardial injury, and included acute heart failure (ICD-9-CM 428.21), acute on chronic heart failure (ICD-9-CM 428.23), cardiogenic shock (ICD-9-CM 785.51), complete heart block (ICD-9-CM 426.0), implantation of an Intra-Aortic Balloon Pump (IABP) (ICD-9-CM Procedure Codes: 37.61), utilization of mechanical ventilation (ICD-9-CM Procedure Code: 96.7X) and the implantation of a temporary (ICD-9-CM Procedure Code: 37.78) or permanent pacemaker (ICD-9-CM Procedure Codes: 37.71, 37.81,37.82, 37.83, 00.51). Costs of Hospitalization and LOS were also examined.

We used SAS, version 9.3 (SAS Institute Inc), to carry out statistical analyses. Since NIS frequently represents a 20% stratified random sample from across the United States, we used hospital-level discharge weights through survey analysis methods to estimate national admissions with a primary diagnosis of AW-STEMI to carry out further analyses. Both hospitalizations for STEMI and prevalence of RBBB were calculated among different age groups, race, and gender. Categorical variables are expressed as number and percentage and continuous variables as mean ± standard deviation . Pearson's chi-square test was used to evaluate differences in categorical variables between patients with and without RBBB, and students *t*test and one-way analysis of variance was used to compare continuous variables. Cox-proportional logistic regression models were used to determine the hazard ratios of the primary outcome and secondary outcomes and interventions. To control and account for various characteristics among patients with and without RBBB, we used multiple covariates in the model including age, gender, race, income, insurance status, hospital type, size, location, and Charlson comorbidity index. The Charlson comorbidity index uses ICD-9-CM codes to identify various chronic secondary comorbidities which may have been present upon admission.[21] The p values reported for all analyses were 2-sided with a significance threshold of less than 0.05.

Results

We identified 1,075,875 weighted hospital admissions for AW-STEMI in the NIS database of 1999 to 2014. Among them, 19,153 patients (1.8%) also had RBBB. Table 1 depicts the baseline clinical and demographic variables along with the therapies administered for patients with and without RBBB. As compared with patients without RBBB, patients with RBBB were older, and were significantly more likely to have baseline comorbidities.

Table 1.
Demographic, clinical and treatment characteristics of patients with AW-STEMI, with and without RBBB

Variable	Right bundle branch block		p value
	Yes (N = 19,153)	No (N = 1,056,722)	
Age, mean (SD) (years)	68.5 (14.3%)	64.9 (14.6%)	<.0001
Woman	5,495 (28.6%)	381,189 (36.1%)	<.0001
Diabetes mellitus	4,759 (24.8%)	245,716 (23.3%)	.02
Hypertension	8,822 (46.1%)	495,010 (46.8%)	.35
Coronary artery disease	13,497 (70.5%)	735,818 (69.6%)	.30
Chronic kidney disease	1,235 (6.4%)	54,645 (5.2%)	<.001
Cerebrovascular disease	771 (4.0%)	46,576 (4.4%)	.24
Heart failure	6,436 (33.6%)	302,783 (28.7%)	<.001
Ventricular Tachycardia	2,590 (13.5%)	99,862 (9.4%)	<.001
White	15,256 (79.7%)	835,338 (79.1%)	<.001
Black	1,266 (6.6%)	77,629 (7.3%)	
Hispanic	1,365 (7.1%)	75,443 (7.1%)	
Others	1,258 (6.6%)	68,189 (6.5%)	
Charlson comorbidity index			
0	10,519 (54.9%)	604,937 (57.2%)	<.001
1	5,762 (30.1%)	305,790 (28.9%)	
≥2	2,872 (15.0)	145,995 (13.8%)	
Insurance Status			
Medicare	11,022 (57.7%)	510,452 (53.6%)	<.0001
Medicaid	893 (4.7%)	64,155 (6.7%)	
Private including HMO	5,428 (28.4%)	365,992 (38.4%)	
Self-pay/no charge/other	1,760 (9.2%)	113,651 (11.9%)	
Median household income (percentile)			
0-25th	3,723 (20.1%)	202,110 (19.7%)	<.0001
26-50th	4,823 (26.0%)	276,064 (26.8%)	
51-75th	4,750 (25.6%)	262,617 (25.5%)	
76-100th	5,227 (28.2%)	287,679 (28.0%)	
Hospital bed size			
Small	1,874 (9.8%)	101,640 (9.6%)	<.0001
Medium	4,726 (24.8%)	255,708 (24.3%)	
Large	1,2491 (65.4%)	696,445 (66.1%)	
Hospital Region			
Northeast	3,991 (20.8%)	244,074 (23.1%)	<.0001
Midwest or North Central	2,838 (14.8%)	175,980 (16.7%)	
South	7,828 (40.9%)	430,325 (40.7%)	
West	4,495 (23.5%)	206,343 (19.5%)	
Teaching-Hospital	8,780 (50.0%)	493,194 (51.6%)	<.0001
Therapies Administered			
Any PCI	11,267 (58.8%)	598,477 (56.6%)	.34
Early PCI (<24 hours)	9,945 (51.9%)	537,149 (50.8%)	.48
Insertion of DES	5,447 (28.4%)	288,081 (27.3%)	.11
Insertion of BMS	4,871 (25.4%)	265,130 (25.1%)	.22
Thrombolysis	1,007 (5.3%)	54,052 (5.1%)	.26
CABG	1,376 (7.2%)	9,5050 (8.9%)	.24

AW-STEMI = anterior wall ST-elevation myocardial infarction; RBBB= right bundle branch block.

This table depicts the difference in the key demographic, clinical and treatment attributes among the study population(s).

Data is represented as the number (percentage) of patients unless otherwise indicated.

Table 2
Length of stay, cost of stay and clinical outcomes in patients with AW-STEMI and RBBB

Characteristics	Right bundle branch block		p value
	Yes (N = 19,153)	No (N = 1,056,722)	
Mortality	2,930 (15.3%)	97,138 (9.2%)	<.0001
Length of Stay, mean (SD) (days)	4.98 (4.4)	5.03 (4.4)	.49
Acute Heart Failure	3,215 (21.1%)	73,942 (18.6%)	.001
Cardiogenic Shock	2,990 (15.6%)	102,408 (9.7%)	<.0001
Complete Heart Block	2,470 (16.2%)	37,081 (9.3%)	<.0001
Intra-Aortic Balloon Pump	2,920 (15.2%)	117,017 (11.1%)	.03
Mechanical Ventilation	2,569 (13.4%)	96,566 (9.1%)	<.0001
Temporary Pacemaker	605 (3.2%)	14,035 (1.3%)	.001
Permanent Pacemaker	266 (1.4%)	6,169 (0.6%)	.01
Costs of hospitalization, mean (SD), USD	66151.6 (69713.9)	59987.5 (64644.0)	<.001

AW-STEMI = anterior wall ST-elevation myocardial infarction; RBBB= right bundle branch block.

This table illustrates the difference in clinical outcomes along with the length and costs of stay among the study population(s).

Table 2 depicts the in-hospital events, hospital LOS and cost of hospitalization, for patients with and without a diagnosis of RBBB. As compared with patients without RBBB, patients with RBBB had a significantly higher mortality and were more likely to have acute heart failure, cardiogenic shock, atrioventricular (AV) block, mechanical ventilation use, IABP implantation, and temporary and permanent pacemaker implantation (PPM).

The multivariate hazard ratios for adverse outcomes are depicted in Table 3. After adjusting for baseline clinical and demographic variables the presence of RBBB on 12 lead ECG conferred a 66% higher mortality risk. RBBB in patients with AW-STEMI was also associated with an increased incidence of cardiogenic shock and an overall increased utilization of IABP, temporary and permanent pacemaker, and mechanical ventilation.

Table 3.
Adjusted hazards of outcomes in patients with AW-STEMI and RBBB

Outcome	Adjusted hazard ratio (95% CI)	p Value
Mortality	1.66 (1.52-1.81)	<.0001
Acute Heart Failure	1.37 (1.29-1.45)	<.0001
Cardiogenic Shock	1.65 (1.51-1.80)	<.0001
Complete Heart Block	2.90 (2.64 -3.18)	<.0001
Intra-Aortic Balloon Pump	1.41 (1.29-1.54)	<.0001
Mechanical Ventilation	1.53 (1.39-1.68)	<.0001
Temporary Pacemaker	2.41 (1.99-2.92)	<.0001
Permanent Pacemaker	2.51 (1.89-3.35)	<.0001

AW-STEMI = anterior wall ST-elevation myocardial infarction; RBBB= right bundle branch block.

This table depicts the adjusted hazards of outcomes in patients with RBBB compared with those without it who present to the hospital with AW-STEMI.

Discussion

In our study of over one million hospital admissions with AW-STEMI from the NIS, RBBB was reported in 1.8% of patients. Patients with RBBB were typically older and had a higher incidence of significant comorbidities. We found that patients presenting with RBBB in the setting of Anterior Wall STEMI had a 66% percent increase in the risk of in-hospital mortality and a higher likelihood of congestive heart failure, complete heart block and utilization of a permanent pacemaker. Multivariate analyses demonstrated that the presence of RBBB was an independent predictor of 30-day mortality, which is consistent with prior reports.[1−15] Many of the prior reports of outcome in patients with RBBB were limited by small numbers[3,6,17,18,22] or a mixture of both STEMI and non-STEMI.[1,7,10,12,17,22] Furthermore, many of these studies were done in the prereperfusion era[16,17,22] or during the days of thrombolytic therapy[23−25] with few reflecting the contemporary practices for the treatment of STEMI.[7,10,11,15] Our study, the largest analysis available to date, focused on patients with AW-STEMI and thus provides novel data on the prevalence and outcomes of RBBB complicating AW-STEMI in current times.

Studies have shown that the majority of cases of RBBB in AMI occur in the setting of anterior wall infarction.[9−11,13,15] The right bundle receives its blood supply from various sources.[22,26] The proximal part of the right bundle is supplied by the AV nodal artery which generally arises off the right coronary artery in 90% of cases. The middle part of the bundle travels within the muscular ventricular septum and therefore is supplied by the septal arteries of the LAD. Compromise to blood flow in the proximal LAD may result in compromise to the integrity of this portion of the right bundle, with the potential for increased risk for complete heart block, particularly if both the left anterior fascicle and the right bundle are involved. Our findings which demonstrated a higher rate of complete heart block and a higher rate of PPM implantation support this concept and are consistent with findings from earlier reports.[11,17] Additionally, since the right bundle receives blood flow from various sources, damage to it could potentially indicate more extensive coronary artery disease (CAD). Prior studies have shown that patients with RBBB are more likely to have triple vessel disease,[3,8] Left Ventricle dysfunction,[1,3,8,12] and CHF[2,3,5,9] compared with patients without intraventricular conduction delays. This could, in part, explain our findings of higher rates of heart failure, need for IABP, PPM implantation, and worse outcomes for this group of patients.

The prevalence of RBBB in our sample of patients is lower than that previously reported. It is possible that the lower prevalence reflects the limitations of the use of administrative databases and the potential for incomplete coding of every patient with RBBB. Alternatively, since many instances of RBBB develop after initial presentation, it is possible that the lower reported rates reflect the effectiveness of the reperfusion therapy provided, thus improving flow to the septal arteries, with less resultant damage to the conduction system.

Our study has several limitations. Since the source of the study was a database that relies on the coding used for billing hospital admissions, there are several important clinical aspects that may have been overlooked. One of them is the diagnosis of RBBB. The ICD-9-CM for RBBB does not allow us to differentiate new-onset RBBB from a previously existing RBBB or one that developed during the hospital stay. Additionally, we may not have adequately captured the use of thrombolytic therapy. Thrombolytic therapy is considered a medication, and may not always be coded as a procedure. This could explain the low rates of reperfusion reported especially during the prepercutaneous coronary intervention era. Another important limitation of our study is the inability to observe long term outcomes occurring outside of acute hospitalization. Finally, since this is an observational analysis, one cannot account for unmeasured confounders that may influence outcomes.

In conclusion, RBBB in the setting of an acute AW-STEMI is associated with a worse outcome including a higher rate of congestive heart failure, AV block, need for PPM implantation, and a higher 30 day in-hospital mortality. When treating patients with AW-STEMI who have RBBB, it is important that physicians are cognizant of the increased risk imposed on these patients. Physicians should be especially vigilant in care, ensuring rapid and early reperfusion therapy, close monitoring of conduction defects (using continuous telemetry monitoring), and frequent assessment of vital status and physical signs, in an effort to identify and treat complications and improve outcomes.

Authors' Contribution

To the editorial staff:

I was uncertain what Credit Author Statement referred to.

I could not proceed to submission until I did this but since we are overdue in our submission, I did not want to delay further. I would be happy to submit a credit author statement if one were to inform me how to do this.

Disclosures

The authors have no conflicts of interest to disclose None of the co-authors had any industry relation to disclose.

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