Prognostic value of new-onset right bundle-branch block in acute myocardial infarction patients: a systematic review and meta-analysis

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ABSTRACT

Background: Patients with acute myocardial infarction (AMI) and bundle-branch block have poor prognoses. The new European Society of Cardiology guideline suggests a primary percutaneous coronary intervention strategy when persistent ischemic symptoms occur in patients with persistent ischemic symptoms and right bundle-branch block (RBBB), but the level of evidence is not high. In fact, the presence of RBBB may lead to the misdiagnosis of transmural ischemia and mask the early diagnosis of ST-elevation myocardial infarction. Moreover, new-onset RBBB is occasionally caused by AMI. Our study aims to investigate the prognostic value of new-onset RBBB in AMI.

Methods and Results: We conducted a meta-analysis of studies to evaluate the prognostic value of RBBB in AMI patients. Of 914 primary records, five studies and 874 MI patients were included for meta-analysis. Compared with previous RBBB, AMI patients with new-onset RBBB had a higher risk of long-term mortality (RR, 1.66, 95% CI [1.31–2.09], I² = 0.0%, p = 0.000, n = 2), ventricular arrhythmia (RR, 4.86, 95% CI [2.10–11.27], I² = 0.0%, p = 0.000, n = 3), and cardiogenic shock (RR, 2.76, 95% CI [1.66–4.59], I² = 0.0%, p = 0.000, n = 3), but a lower risk of heart failure (RR, 0.66, 95% CI [0.52–0.85], I² = 2.50%, p = 0.001, n = 4). Compared with AMI patients with new-onset permanent RBBB, patients with new-onset transient RBBB had a lower risk of short-term mortality (RR, 0.20, 95% CI [0.11–0.37], I² = 44.1%, p = 0.000, n = 4).

Conclusion: New-onset RBBB is likely to increase long-term mortality, ventricular arrhythmia, and cardiogenic shock, but not heart failure in AMI patients. AMI patients with new-onset transient RBBB have a lower risk of short-term mortality than those with new-onset permanent RBBB. Revascularization therapies should be considered when persistent ischemic symptoms occur in patients with RBBB, especially new-onset RBBB.

Subjects Cardiology
Keywords Myocardial infarction, Bundle-branch block, Prognosis, Meta-analysis
INTRODUCTION

Acute myocardial infarction (AMI) patients with right bundle-branch block (RBBB) have worse prognosis than those without RBBB, yet investigators of these studies have not compared the effects of new-onset RBBB with previous RBBB (Bhalli et al., 2009; Widimsky et al., 2012). A recent systematic review (Hazem et al., 2014) has shown that patients with RBBB and AMI are at over two-fold higher risks of all-cause mortality in 30-day follow-up compared to those without bundle-branch block (BBB). Furthermore, for patients with myocardial infarction, several other studies have reported a positive association between RBBB and all-cause mortality (Kleemann et al., 2008; Widimsky et al., 2012; Wong et al., 2006), whereas others have reported no associations (Archbold et al., 1998; Juarez-Herrera & Jerjes-Sanchez, 2013).

Considering that the blood supply of the right bundle-branch is mainly provided by left anterior descending artery (LAD) or the proximal septal perforator branch separated from LAD (Stambler, Rahimtoola & Ellenbogen, 2007), new-onset RBBB may indicate the proximal occlusion of the LAD and large infarction, thus may result in severe heart failure, complete AV block, malignant arrhythmias, and a high mortality. The classification of RBBB according to onset time, duration, and its association with fascicular block is of clinical importance (Hindman et al., 1978; Lie et al., 1974; Ricou et al., 1991). Previous studies of thrombolytic therapies have demonstrated reduction in infarct size (Kloner et al., 1983; Braunwald, 1987), improvements in late ventricular morphology and function (White et al., 1987), and reduction in mortality (Yusuf et al., 1990; Grines & DeMaria, 1990; Nicod, Zimmermann & Scherrer, 1993; Fibrinolytic Therapy Trialists, 1994). Moreover, some studies have reported the relationship between the reversibility of conduction disturbances and coronary reperfusion (Roth et al., 1993; Wiseman, Ohman & Wharton, 1989), which suggests that reperfusion therapy may prevent the appearance or limit the duration of BBB. Thus, it is probable that the current reperfusion therapy has changed the overall incidence and significance of RBBB in AMI. Therefore, it is reasonable to reanalyze and review its significance in the reperfusion therapy era. Moreover, given the poor prognosis of AMI patients with RBBB and the difficulty of determining the transmurality of an infarct in the setting of RBBB, the new European Society of Cardiology (ESC) guideline (Ibanez et al., 2017) suggests a primary percutaneous coronary intervention (PCI) strategy when persistent ischemic symptoms occur in patients with RBBB, but the level of evidence for revascularization is not high. Of note, some ambiguity exists as the Widimsky’s paper referenced in the ESC guideline has mixed new-onset RBBB and presumed RBBB in their cohort.

Accordingly, we conducted this meta-analysis to assess the prognostic value of both transient and permanent new-onset RBBB in AMI patients regarding mortality and major adverse cardiovascular events (arrhythmia, heart failure, cardiogenic shock, reinfarction, etc.).

METHODS AND ANALYSIS

Our study protocol has been registered in PROSPERO website (PROSPERO Registration Number: CRD42017070425) and our study complied with the PRISMA statement.
The eligibility criteria and search strategies have been illustrated in our previous article (Wang et al., 2017). New-onset RBBB was classified as transient when it disappeared at the time of hospital discharge and as permanent when the patient either died or was discharged with RBBB. According to the 2016 ESC heart failure guidelines (Ponikowski et al., 2016) and the included studies, we defined HF as a reduced cardiac output and/or elevated intracardiac pressures at rest or during stress. Cardiogenic shock was defined as hemodynamic instability in spite of increasing doses of catecholamines and/or mechanical circulatory support with critical hypoperfusion of target organs.

Database searches
On June 13, 2017, we (JTW & HXL) searched PubMed, EMBASE, Ovid, Cochrane Library, and Web of Science with terms (acute myocardial infarction OR AMI OR Acute heart infarction) AND (bundle-branch block OR bundle-branch block OR BBB) AND (prognosis OR survival analysis OR mortality OR death OR outcome OR follow-up). Reference lists of related reviews and eligible studies were manually searched to identify potential studies for inclusion.

Eligibility criteria
Original articles that reported the prognosis of AMI patients with new-onset RBBB were initially included. Then we excluded articles which did not report the comparison of new-onset and previous RBBB. Studies of missing values were also excluded.

Study records
Retrieved literature were exported from online databases and imported to NoteExpress Management software (v3.2.0.6941) to remove duplicates. Then items were uploaded to the Covidence website (https://www.covidence.org/). Two reviewers (JTW & CLK) independently screened the items to determine study eligibility online according to the patient-intervention-control-outcomes criteria. Reasons for exclusion were logged in a table. A third reviewer (HXL) was delegated to resolve the discrepancies through discussion. We used a PRISMA flow diagram (Fig. 1) to record the information of screening.

Risk of bias assessment
We assessed the quality of included studies using the risk of bias tool of Newcastle–Ottawa Quality Assessment (Mcpheeters et al., 2012). Funnel plots and Egger’s test were made to assess publication bias.

Statistical analysis
Results were expressed as relative risk (RR) with 95% CI for each study. A pooled effect size was calculated using a random-effects model. Heterogeneity was assessed using Q and $I^2$ statistics. Sensitivity analysis was performed through the influence analysis method. All statistical analyses were performed using STATA 14.0. Statistical significance was defined as $p < 0.05$. 
RESULTS

Study characteristics

Table 1 shows the basic characteristics of the eligible studies. Of the five studies, three were conducted in Spain, one in the United States, and one in Japan. The diagnosis of RBBB was based on electrocardiogram in all studies. The total number of participants included in this meta-analysis was 874. The study population in five studies consisted of both men and women. The studies varied with regards to follow-up duration (3.7 day–1 year) and controlled variables in the multivariate models. Four studies reported short-term mortality, four ventricular arrhythmia, and four mechanical complications and heart failure as clinical outcomes.
| First author (year) | Study design  | Country or region | Definition for RBBB | Types of included RBBB | Study participants | Study period | Sample size | RBBB                     |
|---------------------|---------------|-------------------|---------------------|------------------------|--------------------|--------------|-------------|--------------------------|
| Gann et al. (1975)  | Retrospective | USA               | rsR’, rSR or qR complex \(\geq 0.12\) s duration in the right precordial leads | RBBB, with either normal axis, left or right axis deviation | Patients with acute myocardial infarction | 1971–1972 | 75          | 35 (40)                  |
| Melgarejo-Moreno et al. (1997) | Prospective | Spain             | RBBB was defined by using standard ECG criteria; a QRS duration of \(\geq 120\) ms was required | Compared with complete AVB or not | Patients consecutively diagnosed with acute myocardial infarction | 1992.6–1994.1 | 96          | 51 (25) 26 (45)          |
| Vivas et al. (2010) | Cohort        | Spain             | BBB was present when the QRS duration was \(\geq 120\) ms. RBBB was present when the secondary R wave (\(R^\prime\)) in \(V_1\) and a wide S wave in leads \(V_5\) to \(V_6\) were detected | Compared with complete AVB or not | Consecutive patients with STEMI undergoing primary PCI | 2004.1–2008.6 | 119         | 92 (47) 42 (27)          |
| Melgarejo-Moreno et al. (2015) | Prospective | Spain             | Conduction disturbances were defined using standard electrocardiographic criteria | NA | Patients with acute MI | 1998.1–2008.1 | 465         | 212 (137) 75 (253)       |
| Iwasaki et al. (2009) | Retrospective | Japan             | (1) a QRS duration \(\geq 120\) ms, (2) the presence of an rsR’ pattern of QRS in lead \(V_1\), (3) a PQ interval \(\geq 120\) ms, and (4) a S wave in lead I and either lead \(V_5\) or \(V_6\) | NA | Acute anterior or inferior myocardial infarction within 48 h after the onset of symptoms | 1997.1.1–2006.12.31 | 119         | 99 (58) 41 (20)          |
### Table 1 (continued)

| Age                  | Male | Previous angina | Previous MI | Diabetes | Hypertension | New | Previous | LVEF, n (%) | Follow up |
|----------------------|------|-----------------|-------------|----------|--------------|-----|----------|-------------|-----------|
| 73.6                 | 72.4 | 21              | 38          |          |              |     |          |             | 3.7 day   |
| 65 ± 10              | 68 ± 9 | 30              | 37          | 13       | 26           | 8   | 15       | 14          | 20 22 27 (>1) | One year |
| 68 ± 12              | 72 ± 9 | 69              | 22          | 16       | 5            | 33  | 11       | 54          | 8 33 59 (≥II) | In-hospital  |
| 69.5                 | 73.5 | 159             | 209         | 27       | 79           | 84  | 123      | 100         | 161       | One to seven years |
| 67 ± 12              | 106  | 26              | 28          | 57       |              |     |          |             | In-hospital |

Notes:
Summary of clinical characteristics of eligible studies.
RBBB, right bundle-branch block; PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction; LVEF, left ventricular ejection fraction.
Assessment of study quality yielded a score of six to seven on the scale of the nine-point scoring system for each study. The scores of included studies were recorded in Table 2. Most included studies were high-quality.

Outcomes

Compared with previous RBBB, AMI patients with new-onset RBBB were likely associated with a higher risk of long-term (one-year) mortality (RR, 1.66, 95% CI [1.31–2.09], $I^2 = 0.0\%$, $p = 0.000$, $n = 2$), (heterogeneity, $I^2 = 0.0\%$, $p = 0.998$) (Fig. 2). The incidence of heart failure was higher in the previous RBBB group (RR, 0.66, 95% CI [0.52–0.85], $I^2 = 2.5\%$, $p = 0.001$, $n = 4$) (heterogeneity, $I^2 = 2.5\%$, $p = 0.380$) (Fig. 3). New-onset RBBB group had higher risks of ventricular arrhythmia (RR, 4.86, 95% CI [2.10–11.27], $I^2 = 0.0\%$, $p = 0.000$, $n = 3$) (heterogeneity, $I^2 = 0.0\%$, $p = 0.562$) (Fig. 4A), and cardiogenic shock (RR, 2.76, 95% CI [1.66–4.59], $I^2 = 0.0\%$, $p = 0.000$, $n = 3$) (heterogeneity, $I^2 = 0.0\%$, $p = 0.673$) (Fig. 4B).
Figure 3  Forest plots of stratified analyses for heart failure.

Figure 4  Forest plots of stratified analyses for ventricular arrhythmia (A) and cardiogenic shock (B).
Compared with new-onset permanent RBBB, AMI patients with new-onset transient RBBB had a lower risk of short-term (in-hospital/30-day) mortality (RR, 0.20, 95% CI [0.11–0.37], $I^2 = 44.1\%$, $p = 0.000$, $n = 4$) (heterogeneity, $I^2 = 44.1\%$, $p = 0.147$) (Fig. 5).

The short-term mortality risk (RR, 0.91, 95% CI [0.34–2.46], $I^2 = 0.0\%$, $p = 0.858$, $n = 3$) of new-onset transient RBBB vs. previous RBBB in AMI patients was not different (Fig. 6) based on current evidence.

We also assessed the risks between new-onset RBBB and previous RBBB in terms of other variables. These risks included short-term mortality (RR, 2.26, 95% CI [0.94–5.43], $I^2 = 72.4\%$, $p = 0.068$, $n = 4$) (Fig. 7A) and other outcomes, like chronic arrhythmias (second-degree or higher atrioventricular block) (RR, 2.78, 95% CI [0.13–58.38], $I^2 = 88.2\%$, $p = 0.510$, $n = 2$) (Fig. 7B), reinfarction (RR, 1.67, 95% CI [0.44–6.25], $I^2 = 0.0\%$, $p = 0.448$, $n = 2$) (Fig. 7C), post-MI angina (RR, 1.35, 95% CI [0.36–5.07], $I^2 = 0.0\%$, $p = 0.041$, $n = 2$) (Fig. 7D).
\[ I^2 = 24.4\%, \ p = 0.657, \ n = 2 \] (Fig. 7D), asystole (RR, 1.07, 95% CI [0.11–10.22], \[ I^2 = 51.7\%, \ p = 0.951, \ n = 2 \] (Fig. 7E), and mechanical complications (RR, 0.98, 95% CI [0.11–8.65], \[ I^2 = 0.0\%, \ p = 0.984, \ n = 2 \] (Fig. 7F). Most studies showed low to moderate heterogeneity. Specifically, reinfarction (\[ I^2 = 0.0\%, \ p = 0.476 \]), mechanical complications (\[ I^2 = 0.0\%, \ p = 0.946 \]), post-MI angina (\[ I^2 = 24.4\%, \ p = 0.250 \]), and asystole (\[ I^2 = 51.7\%, \ p = 0.250 \]) showed low to moderate insignificant heterogeneity, but short-term mortality (\[ I^2 = 72.4\%, \ p = 0.012 \]), and chronic arrhythmias (\[ I^2 = 88.2\%, \ p = 0.004 \]) showed relatively high significant heterogeneity.

Pooled RRs of sensitivity analysis (Fig. S1) did not change substantially, which indicated that most of the current results were statistically reliable.

**DISCUSSION**

This study focuses on mortality and other major cardiovascular adverse events in AMI patients with new-onset RBBB. The effects of permanent and transient new-onset RBBB are also assessed. To our knowledge, this is the first meta-analysis of observational studies on the prognostic value of new-onset RBBB in the context of AMI. In summary, we identified five studies of 874 patients and evaluated the prognostic value of new-onset RBBB in AMI. The results show that new-onset RBBB is associated with an increased long-term mortality and higher risk of ventricular arrhythmia and cardiogenic shock but not heart failure in patients with AMI. Other outcomes could not be assessed on the current data. Previous RBBB may have more relations with heart failure than new-onset RBBB in AMI patients.

Heart failure may be worse in the previous RBBB group. Based on the basic characteristics of the included studies, patients in previous RBBB group have a higher
median age and more comorbidities (hypertension, diabetes mellitus, etc.), especially previous myocardial infarction and previous angina. It may explain the higher proportion of heart failure in previous RBBB group, but the accurate pathophysiological changes should be further investigated. Studies (Xiang et al., 2016; Widimsky et al., 2012) have shown that new-onset RBBBs in AMI subjects often suggest LAD lesion, proximal occlusion of coronary artery and large infarct size. It is also associated with more complications including heart failure, arrhythmias, and increasing mortality compared with non-RBBB group. Our study showed new-onset RBBB is associated with poor prognosis, including long-term mortality, ventricular arrhythmia, and cardiogenic shock in patients with AMI.

The following facts may explain the poor prognosis of new-onset RBBB in AMI. Firstly, right bundle-branch runs in interventricular septum, and the blood supply is mostly provided by the first septal branch separated from LAD. Therefore, new-onset RBBB is likely caused by proximal occlusion of LAD. New-onset RBBB in AMI is frequently caused by the complete occlusion of the infarct-related artery, the first septal branch separated from LAD or LAD per se, and sometimes even left main coronary artery (Widimsky et al., 2012). So, it is not hard to imagine that, the myocardial infarct size is likely larger in these patients (Widimsky et al., 2012). Therefore, ventricular arrhythmia and cardiogenic shock may happen frequently in AMI patients with new-onset RBBB. Secondly, previous guidelines (Steg et al., 2012; Antman et al., 2004) did not include RBBB as an indication for emergency revascularization, it might mislead clinical doctors to underestimate even ignore the diagnostic value of new-onset RBBB in AMI. Widimsky has also pointed out that even large infarcts may occur without typical STEs in AMI, thus a life-threatening AMI may be missed when ST elevation is strictly required (Widimsky et al., 2012). Clinicians should consider urgent reperfusion therapies in the setting of new-onset RBBB and ongoing ischemic symptoms. As demonstrated by our meta-analysis, there is an increasing risk of long-term mortality in patients with new-onset RBBB and AMI. Therefore, serious consequences may occur if neither urgent coronary angiography/PCI nor thrombolysis therapy is administered. So, a higher mortality can be present in AMI patients with new-onset RBBB. The guideline suggests revascularization therapies for RBBB patients with persistent ischemic symptoms, however the patients with new-onset RBBB may need more attention.

A previous study (Iwasaki et al., 2009) has indicated that, new-onset permanent RBBB is one of significant independent risk factors for predicting adverse in-hospital events. Compared with new-onset permanent RBBB in patients with AMI, the short-term mortality of new-onset transient RBBB may be different (Fig. 5), and current evidence remains lacking. Our previous study (Jie, 2016) has shown that emergency interventional therapy could result in resolution of new-onset RBBB in AMI patients. Thus, early identification of new-onset RBBB in AMI may help clinicians to make appropriate treatment therapies and improve prognosis of patients.

LBBB masks ST-segment shifts. LBBB masks the repolarization phase changes or Q waves, while RBBB does not. However, ST depression and T inversion in precordial leads (V1–V3) can also mask minor ST elevation, therefore ST-elevation myocardial infarction
(STEMI) can be missed. In other words, the presence of RBBB may also confound the diagnosis of STEMI. Thus, a number of patients with persistent ischemic symptoms and new-onset RBBB may suffer from STEMI. Therefore, we cannot ignore the diagnostic value of new-onset RBBB in AMI.

**LIMITATIONS**

This study has some limitations. Since only five studies were eligible, it might lead to unavoidable bias. Some outcomes could not be assessed. It is difficult to identify the relationship between the infarct related artery and the new-onset RBBB based on the included studies. Neither long-term prognosis nor other outcomes of the two types of new-onset RBBB were analyzed. Yet, the effects of different interventions for AMI patients with new-onset RBBB were not evaluated. Larger clinical studies with rigorous designs are needed to further evaluate the prognostic value of new-onset RBBB in patients with AMI.

**CONCLUSION**

Compared with new-onset permanent RBBB, AMI patients with new-onset transient RBBB have a lower risk of short-term mortality. Compared with those with previous RBBB, AMI patients with new-onset RBBB may have higher risks of long-term mortality, ventricular arrhythmia, and cardiogenic shock and a lower risk of heart failure. Risks of other outcomes could not be assessed based on current evidence. Revascularization therapies should be considered when persistent ischemic symptoms occur in patients with RBBB, especially with new-onset RBBB.

**ABBREVIATIONS**

| Abbreviation | Description |
|--------------|-------------|
| RBB | right bundle-branch |
| RBBB | right bundle-branch block |
| AMI | acute myocardial infarction |
| ESC | European Society of Cardiology |
| CI | confidence interval |
| RR | relative risk |
| PCI | percutaneous coronary intervention |
| LAD | left anterior descending artery |

**ADDITIONAL INFORMATION AND DECLARATIONS**

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**Competing Interests**

The authors declare that they have no competing interests.
Author Contributions

- Juntao Wang conceived and designed the experiments, performed the experiments, analyzed the data, contributed reagents/materials/analysis tools, prepared figures and/or tables, authored or reviewed drafts of the paper, approved the final draft.
- Hongxing Luo conceived and designed the experiments, performed the experiments, contributed reagents/materials/analysis tools, prepared figures and/or tables, authored or reviewed drafts of the paper, approved the final draft.
- Chunling Kong performed the experiments, authored or reviewed drafts of the paper, approved the final draft.
- Shujuan Dong conceived and designed the experiments, authored or reviewed drafts of the paper, approved the final draft.
- Jingchao Li conceived and designed the experiments, authored or reviewed drafts of the paper, approved the final draft.
- Haijia Yu conceived and designed the experiments, authored or reviewed drafts of the paper, approved the final draft.
- Yingjie Chu conceived and designed the experiments, authored or reviewed drafts of the paper, approved the final draft.

Data Availability

The following information was supplied regarding data availability:

The raw data are provided in the Supplemental Dataset Files.

Supplemental Information

Supplemental information for this article can be found online at http://dx.doi.org/10.7717/peerj.4497#supplemental-information.

REFERENCES

Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Manty C, Ornato JP, Pearle DL, Sloan MA, Smith SJ, Alpert JS, Anderson JL, Fuster V, Gibbons RJ, Gregoratos G, Halperin JL, Hiratzka LF, Hunt SA, Jacobs AK, Oronti JP. 2004. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of Patients with Acute Myocardial Infarction). Circulation 110(5):588–636 DOI 10.1161/01.cir.0000134791.68010.fa.

Archbold RA, Sayer JW, Ray S, Wilkinson P, Ranjadayalan K, Timmis AD. 1998. Frequency and prognostic implications of conduction defects in acute myocardial infarction since the introduction of thrombolytic therapy. European Heart Journal 19(6):893–898 DOI 10.1053/euhj.1997.0857.

Bhalli MA, Khan MQ, Samore NA, Mehreen S. 2009. Frequency and clinical outcome in conduction defects in acute myocardial infarction. Journal of Ayub Medical College Abbottabad 21(3):32–37.

Braunwald E. 1987. The path to myocardial salvage by thrombolytic therapy. Circulation 76:12–17.

Fibrinolytic Therapy Trialists. 1994. Indications for fibrinolytic therapy in suspected acute myocardial infarction: collaborative overview of early mortality and major morbidity results.
from all randomized trials of more than 1000 patients. Fibrinolytic Therapy Trialists’ (FTT) Collaborative Group. *Lancet* 343(8893):311–322 DOI 10.1016/s0140-6736(94)91161-4.

Gann D, Balachandran PK, Sherif NE, Samet P. 1975. Prognostic significance of chronic versus acute bundle branch block in acute myocardial infarction. *Chest* 67(3):298–303.

Grines CL, DeMaria AN. 1990. Optimal utilization of thrombolytic therapy for acute myocardial infarction: concepts and controversies. *Journal of the American College of Cardiology* 16(1):223–231 DOI 10.1016/0735-1097(90)90482-5.

Hazem A, Sharma S, Sharma A, Leitch C, Sharadanant R, Urell M, Neutzling K, Wang Z, Brironuevo Moreno P, LeBlanc A, Sorita A, Vilesni L, Prokop L, Makkuni P, Ting HH, Murad MH. 2014. Abstract 309: is right bundle branch block associated with poor outcomes in the setting of an acute coronary syndrome? A systematic review and meta-analysis. *Circulation: Cardiovascular Quality and Outcomes* 7:A309.

Hindman MC, Wagner GS, JaRo M, Atkins JM, Scheiman MM, DeSanctis RW, Hutter AJ, Yeatman L, Rubenfire M, Pujura C, Rubin M, Morris JJ. 1978. The clinical significance of bundle branch block complicating acute myocardial infarction. 1. Clinical characteristics, hospital mortality, and one-year follow-up. *Circulation* 58(4):679–688 DOI 10.1161/01.cir.58.4.679.

Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, Caforio ALP, Crea F, Goudevenos JA, Halvorsen S, Hindricks G, Kaab A, Lenzen MJ, Mohty M, N腭tou D, Altman DG, Moher D. 2017. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *European Heart Journal* 39(2):119–177 DOI 10.1093/eurheartj/ehx393.

Iwasaki J, Kono K, Katayama Y, Takahashi N, Takeuchi K, Tanakaya M, Osawa K, Shiraki T, Saito D. 2009. Prognostic significance of right bundle branch block in patients with acute inferior myocardial infarction. *Acta Medica Okayama* 63(1):25–33 DOI 10.18926/AMO/31857.

Jie LJCD. 2016. Analysis on related factors of new transient RBBB in AMI patients. *Journal of Medical Forum* 2016(11):22–24.

Juarez-Herrera U, Jerjes-Sanchez C. 2013. Risk factors, therapeutic approaches, and in-hospital outcomes in Mexicans with ST-elevation acute myocardial infarction: the RENASICA II multicenter registry. *Clinical Cardiology* 36(5):241–248 DOI 10.1002/clc.22107.

Kleemann T, Juenger C, Gitt AK, Schiele R, Schneider S, Senges J, Darius H, Seidl K. 2008. Incidence and clinical impact of right bundle branch block in patients with acute myocardial infarction: ST elevation myocardial infarction versus non-ST elevation myocardial infarction. *American Heart Journal* 156(2):256–261 DOI 10.1016/j.ahj.2008.03.003.

Kloner RA, Ellis SG, Lange R, Braunwald E. 1983. Studies of experimental coronary artery reperfusion. Effects on infarct size, myocardial function, biochemistry, ultrastructure and microvascular damage. *Circulation* 68(2 Pt 2):18–115.

Lie KI, Wellens HJ, Schuilenburg RM, Becker AE, Durrer D. 1974. Factors influencing prognosis of bundle branch block complicating acute antero-septal infarction. The value of his bundle recordings. *Circulation* 50(5):935–941 DOI 10.1161/01.cir.50.5.935.

Mcpheeters ML, Kripalani S, Peterson NB, Idowu RT, Jerome RN, Potter SA, Andrews JC. 2012. Closing the quality gap: revisiting the state of the science (vol. 3: quality improvement interventions to address health disparities). *Evidence Report/Technology Assessment* 2083:1–475.
Melgarejo-Moreno A, Galcera-Tomas J, Consuegra-Sanchez I, Alonso-Fernandez N, Diaz-Pastor A, Escudero-Garcia G, Jaulet-Huertas L, Vicente-Gilabert M, Galcera-Jornet E, Padilla-Serrano A, de Gea-Garcia J, Pinar-Bermudez E. 2015. Relation of new permanent right or left bundle branch block on short- and long-term mortality in acute myocardial infarction bundle branch block and myocardial infarction. *American Journal of Cardiology* 116:1003–1009 DOI 10.1016/j.amjcard.2015.07.019.

Melgarejo-Moreno A, Galcera-Tomas J, Garcia-Alberola A, Valdes-Chavarri M, Castillo-Soria FJ, Mira-Sanchez E, Gil-Sanchez J, Allegue-Gallego J. 1997. Incidence, clinical characteristics, and prognostic significance of right bundle-branch block in acute myocardial infarction: a study in the thrombolytic era. *Circulation* 96(4):1139–1144.

Nicod P, Zimmermann M, Scherrer U. 1993. The challenge of further reducing cardiac mortality in the thrombolytic era. *Circulation* 87(2):640–642 DOI 10.1161/01.cir.87.2.640.

Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JGF, Coats AJ, van der Meer P. 2016. 2016 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure. *European Journal of Heart Failure* 18:891–975 DOI 10.1002/ejhf.592.

Ricou F, Nicod P, Gilpin E, Henning H, Ross JJ. 1991. Influence of right bundle branch block on short- and long-term survival after acute anterior myocardial infarction. *Journal of the American College of Cardiology* 17(4):858–863 DOI 10.1016/0735-1097(91)90865-7.

Roth A, Miller HI, Glick A, Barbash GI, Laniado S. 1993. Rapid resolution of new right bundle branch block in acute anterior myocardial infarction patients after thrombolytic therapy. *Pacing and Clinical Electrophysiology* 16(1):13–18 DOI 10.1111/j.1540-8159.1993.tb01529.x.

Steg PG, James SK, Atar D, Badano LP, Blomstrom-Lundqvist C, Borger MA, Di Mario C, Dickstein K, Ducrocq G, Fernandez-Aviles F, Gershlick AH, Giannuzzi P, Halvorsen S, Huber K, Juni P, Kastrati A, Knuuti J, Lamas M, Mahaffey KW, Mancini MG, van’t Hof A, Widimsky P, Zahger D. 2012. ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *European Heart Journal* 33:2569–2619 DOI 10.1093/eurheartj/ehs215.

Vivas D, Perez-Vizcayno MJ, Hernandez-Antolin R, Fernandez-Ortiz A, Banuelos C, Escaned J, Jimenez-Quevedo P, De Agustin JA, Nunez-Gil I, Gonzalez-Ferrer JJ, Macaya C, Alfonso F. 2010. Prognostic implications of bundle branch block in patients undergoing primary coronary angioplasty in the stent era. *American Journal of Cardiology* 105:1276–1283 DOI 10.1016/j.amjcard.2009.12.044.

Wang J, Zhu J, Luo H, Kong C, Zhang C, Chu Y. 2017. Diagnosis, prognostic significance, and characteristics of new-onset right bundle-branch block in patients with acute myocardial infarction: protocol for a systematic review and meta-analysis. *Current Research: Cardiology* 4(3):40–44 DOI 10.4172/2368-0512.1000090.

White HD, Norris RM, Brown MA, Takayama M, Maslowski A, Bass NM, Ormiston JA, Whitlock T. 1987. Effect of intravenous streptokinase on left ventricular function and early survival after acute myocardial infarction. *New England Journal of Medicine* 317(14):850–855 DOI 10.1056/NEJM198710013171402.
Knot J, Bilkova D, Fischerova M, Vondrak K, Maly M, Lorencova A. 2012. Primary angioplasty in acute myocardial infarction with right bundle branch block: should new onset right bundle branch block be added to future guidelines as an indication for reperfusion therapy? European Heart Journal 33(1):86–95 DOI 10.1093/eurheartj/ehr291.

Wiseman A, Ohman EM, Wharton JM. 1989. Transient reversal of bifascicular block during acute myocardial infarction with reperfusion therapy: a word of caution. American Heart Journal 117(6):1381–1383 DOI 10.1016/0002-8703(89)90422-5.

Wong CK, Stewart RA, Gao W, French JK, Raffel C, White HD. 2006. Prognostic differences between different types of bundle branch block during the early phase of acute myocardial infarction: insights from the Hirulog and Early Reperfusion or Occlusion (HERO)-2 trial. European Heart Journal 27(1):21–28 DOI 10.1093/eurheartj/ehi622.

Xiang L, Zhong A, You T, Chen J, Xu W, Shi M. 2016. Prognostic significance of right bundle branch block for patients with acute myocardial infarction: a systematic review and meta-analysis. Medical Science Monitor 22:998–1004 DOI 10.12659/MSM.895687.

Yusuf S, Sleight P, Held P, McMahon S. 1990. Routine medical management of acute myocardial infarction. Lessons from overviews of recent randomized controlled trials. Circulation 82(3 Suppl):I117–I134.