**Predictive value of bundle branch blocks among heart failure patients**

**Abstract**

**Introduction:**

The prognosis of left and right bundle branch blockages (LBBB and RBBB) in hospitalized heart failure (HF) patients remains unknown. There are debates over the type of bundle branch block (BBB) that is associated with an increased mortality risk in people with heart failure (HF).

**Aim**: The purpose of this study was to investigate the predictive value of bundle branch blocks in heart failure patients.

**Methods:**

This prospective observational study included all inpatient admissions with heart failure from January 2023 to December 2023 in our institution. Age group of 18- 90 years is included in this study. Data on baseline characteristics included demographics, clinical and post procedure outcomes.

**Results:**

In the present study, the ages of the individuals participating were classified. The largest age group was 70-79 years (32%), followed by 60-69 years (27.3%) and 50-59 years (21.3%), with fewer participants younger than 50 years (12%) or older than 79 years (7.3%). The study participants were predominantly male (64%), and the remaining 36% were female. In this study, the presence of bundle branch block (BBB) among participants is shown. The majority of participants (78.7%) did not have BBB, while 21.3% had BBB. Among participants with BBB, the majority had left bundle branch block (LBBB) (75%), while 25% had right bundle branch block (RBBB).

**Conclusion:**

Heart failure patients with LBBB had a significant clinical severity of heart failure at presentation and were more likely to have mortality or hospitalisation for heart failure or cardiovascular events than those without BBB. On the contrary, RBBB did not significantly predict negative outcomes.

**Keywords: Left bundle branch block, right bundle branch block, heart failure, ECG,**

**Hemodynamics**

**Introduction:**

Heart failure (HF) is a multifaceted clinical illness and a predominant cause of morbidity and mortality, impacting approximately 1 to 2% of adults in developed nations, with prevalence exceeding 10% among individuals over 70 years of age (1). Heart failure is characterized by declining heart function, frequent hospitalizations, and untimely death (2). Acute heart failure (AHF) is characterized by sudden onset of new or worsening symptoms of HF (3). Patients with AHF typically have pre-existing cardiomyopathy, resulting in acute decompensated heart failure (ADHF). Acutely decompensated chronic heart failure (ADCHF) and "de novo" AHF share similar clinical appearance and therapy. Decompensations may necessitate hospitalization or can be addressed as an outpatient (4). AHF is connected with a 30-day mortality rate of 5–10%. Multiple system, patient, and episode-related risk factors for unfavourable outcomes have been identified in AHF patients (4,5,6). An electrocardiogram (ECG) is a common routine study indicated for all patients with suspected AHF. Arrhythmias, particularly atrial fibrillation, have been extensively investigated for their impact on outcomes (7). Research indicates that atrial fibrillation may lead to negative outcomes, while fast atrial fibrillation as a cause of AHF is associated with a better prognosis. Other electrocardiographic changes, such as conduction blocks, have received far less attention in terms of their impact on prognosis (6).

Approximately 20% of the overall HF population is likely to have a prolonged QRS duration within the first year of diagnosis (8, 9). Prolonged QRS duration, with or without bundle branch block (BBB), has been linked to higher morbidity and death in chronic heart failure patients with low left ventricular ejection fraction (LVEF) (10,11,12). However, this remains a topic of debate in the global HF population. There has been more research on the relation between conduction blocks and heart failure (HF) for left bundle branch block (LBBB) compared to right bundle branch block (RBBB), with some studies indicating a greater mortality risk and others not (13-16). The effects of LBBB and RBBB on the prognosis of HF are debatable (16). Wide QRS was observed when it prolonged more than 120 ms. Complete LBBB or RBBB was defined when morphological criteria were present.

**Epidemiology of Bundle Branch Blocks**

Over the years, there has been a predominant emphasis on bundle-branch block's importance as a prognostic indicator for mortality and the presence of concurrent

cardiovascular conditions. The epidemiology data mostly originated from patients who were admitted to the hospital, which may have been influenced by the underlying purpose of doing a routine 12-lead ECG (17). Previous studies have examined individuals in good health at regular check-ups and often encountered difficulties due to the factor of age. The Framingham Heart study found that individuals with acquired bundle-branch block had a higher likelihood of experiencing or developing advanced cardiovascular symptoms, particularly in the case of males with left bundle-branch block. The other investigations did not find any evidence of an elevated mortality risk caused by coronary artery disease or hypertension in individuals with left bundle-branch obstruction. Among those under the age of 60 with right bundle-branch block, there was a clear association with hypertension (18). The prevalence of Left bundle branch block (LBBB) in the general population ranges from around 0.06% to 0.1%. Roughly one-third of those diagnosed with heart failure have left bundle branch block (LBBB) as shown in Figure 1. The frequency of occurrence rises in correlation with the severity of left ventricular dysfunction in individuals with heart failure. Right bundle branch block RBBB (Figure 2) is often a gradually worsening degenerative condition affecting the myocardium. The prevalence of right bundle branch block tends to rise with age, affecting as many as 11.3% of individuals by the time they reach 80 years old. There is no notable correlation with cardiac illness, ischemic heart disease, or cardiac risk factors (19).

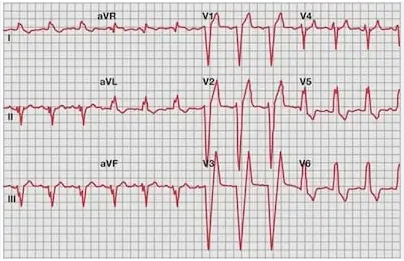


Figure 1: ECG features of LBBB



Figure 2: ECG features of RBBB

**Methodology:**

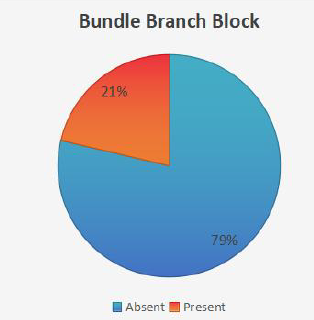
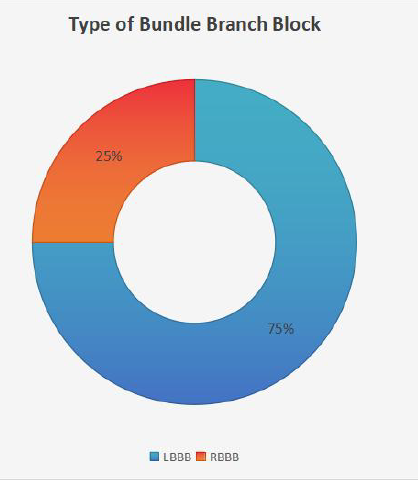
All in-patient admissions with Heart Failure, irrespective of Ejection Fraction are included in this study. The age group varies from 18- 90 years. ECG patterns of the Heart Failure is going to be analysed, includes QRS < 80 ms is considered as normal. QRS >120ms is considered as conduction block, and 80-120 ms is considered as incomplete conduction block. The pattern of conduction block is categorised as LBBB/ RBBB/ Nonspecific Conduction Block. The prognostic value in terms of mortality, ICU stay, hospitalisation duration, need for inotropes, hemodynamic stability, presence of arrythmia, NYHA classification at discharge and at 1 month were analysed. Echocardiogram parameters includes, LVEF, EDD, LV filling pressure, Pulmonary Artery Pressure (PAH), shall be analysed between Heart Failure patients with and without Bundle Branch Block. Analysis of cardiorenal syndrome among heart failure patients with and without Bundle Branch Block. The presence of anemia, Ferritin levels and transferrin saturation shall also be analysed among the two groups. The inclusion criteria is all hospitalised heart failure patients between age group 18-90 years, heart failure with HFrEF, HFpEF, HFmEF and the exclusion criteria is not willing to participate in the study, reversible causes of BBB.

**Statistical analysis:**

Data obtained was entered into excel sheet (MS office 2007). All continuous variables were assessed for normality using Shapiro–Wilk’s test. Continuous variables following Gaussian distribution were expressed as mean ± standard deviation (SD). Otherwise, they were expressed as median (inter quartile range). Comparison of continuous variables was done using independent sample t test. Comparison of categorical variables was taken care of by Chi – square test or Fishers exact test based on the number of observations. All p-values < 0.05 were considered as statistically significant. Data analysis was carried out by SPSS version 25.0.

**Results:**

In this study, the presence of bundle branch block (BBB) among participants is shown. The majority of participants (78.7%) did not have BBB, while 21.3% had BBB. Types of BBB distribution with BBB, the majority had left bundle branch block (LBBB) (75%), while 25% had right bundle branch block (RBBB).

**Figure: 3 & 4 Presence of BBB (Bundle Branch Block) Distribution and types of BBB**

**Risk Factors Distribution**

Risk factors among participants include no risk factors (44%), CKD (18%), COPD

(7.3%), and other conditions such as OSA (2.7%) and amyloidosis (2%). Some participants had multiple conditions, such as CKD and COPD (3.3%).

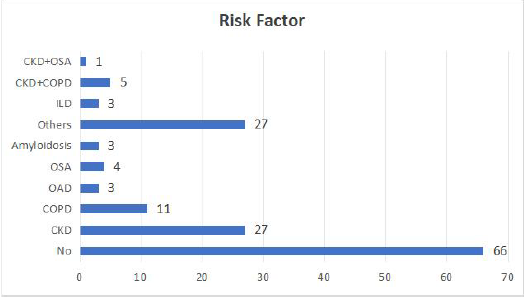


Figure 5: **Risk Factors Distribution**

**Medications Prescribed**

The most commonly prescribed medications were beta-blockers (71.3%), diuretics (71.3%), and MRAs (56%). Other medications include SGLT2 inhibitors (39.3%), ARNI (26.7%), and others.

|  |  |  |
| --- | --- | --- |
| **Medications** | **Frequency** | **Percent** |
| Beta-blockers | 107 | 71.3 |
| ARNI | 40 | 26.7 |
| SGLT2 Inhibitors | 59 | 39.3 |
| Diuretics | 107 | 71.3 |
| Digoxin | 7 | 4.7 |
| Vericiguat | 14 | 9.3 |
| Ivabradine | 0 | 13.3 |
| ARB | 12 | 8.0 |

Table 1: **Medications Prescribed**

**Device Therapy or Surgery**

Most participants (68.7%) had no device therapy or surgery.

A graph of medical therapy

AI-generated content may be incorrect.

Figure 6: **Device Therapy or Surgery**

This table focuses on clinical outcomes and functional status both before and after

treatment. The New York Heart Association (NYHA) classification, which assesses heart

failure severity, had a mean score of 3.41 prior to treatment, indicating that most participants experienced severe limitations, with a relatively low standard deviation of 0.677. Post treatment, the NYHA class improved to a mean of 1.720, reflecting a significant improvement in heart failure symptoms, with a standard deviation of 0.6252. The mean duration of 67 hospitalization was 6.873 days, with a wide variation (standard deviation of 4.6966), suggesting differing lengths of hospital stays among participants. The 6-minute walk test (6MWT), which measures exercise tolerance, showed a mean distance of 220.1 meters prior to treatment, with substantial variability (standard deviation of 113.1734). Post-treatment, the 6-minute walk test results improved, with a mean distance of 461.4 meters, reflecting enhanced physical capacity, though the standard deviation remained high (198.6896). NT-proBNP, a marker for heart failure severity, decreased after treatment, with a mean of 3052.133 pg/mL and a standard deviation of 3744.2621. Finally, the filling pressure post-treatment had a mean of 10.247 mmHg, indicating improved diastolic function, with a moderate variability (standard deviation of 3.5425).

|  |  |  |
| --- | --- | --- |
|  | **Mean** | **Standard deviation** |
| NYHA class prior | 3.41 | .677 |
| NYHA class post treatment | 1.720 | .6252 |
| Duration of hospitalisation (days) | 6.873 | 4.6966 |
| 6min walk test (meters)-prior | 220.100 | 113.1734 |
| 6 min walk test (meters)- post treatment | 461.400 | 198.6896 |
| NTPROBNP-post | 3052.133 | 3744.2621 |
| LV filling pressure-post | 10.247 | 3.5425 |

Table 2: **Parameters before and after intervention**

**Discussion:**

Heart failure (HF) remains a leading cause of morbidity and mortality worldwide, affecting millions of people and placing a significant burden on healthcare systems. The complex interplay between structural heart disease, impaired myocardial function, and neurohormonal activation often leads to various electrophysiological abnormalities, including conduction system disturbances such as bundle branch block (BBB). BBB, whether right bundle branch block (RBBB) or left bundle branch block (LBBB), can have significant implications for both the pathophysiology and management of heart failure (17). BBB in heart failure patients disrupts the normal sequence of ventricular depolarization, potentially worsening left ventricular dysfunction and contributing to adverse clinical outcomes. LBBB, in particular, has been associated with dyssynchronous ventricular contraction, which may exacerbate heart failure symptoms and increase the risk of arrhythmias and sudden cardiac death. While cardiac resynchronization therapy (CRT) has shown benefit in select patients with LBBB. The impact of other BBB patterns, including RBBB and non-specific intraventricular conduction delay (IVCD). On long-term, outcomes remain less well understood (18). This study aims to examine the prognostic significance of different bundle branch block patterns in patients with heart failure. In this study, the prevalence of bundle branch block (BBB) among participants revealed that a significant majority (78.7%) did not exhibit any form of BBB, while 21.3% were identified as having the condition. Among those with BBB, left bundle branch block (LBBB) was the most prevalent, occurring in 75% of cases, while right bundle branch block (RBBB) accounted for 25%. These findings align with the literature, as studies by Baldasseroni et al.(18) and Tabrizi et al.(20) report that LBBB is notably common in heart failure patients, affecting approximately 20% to 25% of this population. Conversely, the occurrence of RBBB in heart failure patients is less frequent. Research by Abdel-Qadir et al. (21) and Barsheshet et al. (22) indicates that RBBB typically affects only about 7% to 10% of this patient group. Our results support these observations, underscoring the tendency for LBBB to be more prevalent than RBBB in heart failure contexts.

In our current study most common complaints among participants were found to be shortness of breath (90.7%), followed by palpitations (13.3%), angina (18%), pulmonary embolism (24%), and others such as oliguria (5.3%) and fatigue (4%). Hindman et al.,(23,24) found that patients with LBBB may experience symptoms such as dyspnea (shortness of breath), chest pain, and palpitations. LBBB is often associated with more severe cardiac conditions and may lead to worsened symptoms due to impaired ventricular function. Brugada et al.,(25) found patients with RBBB may experience syncope (fainting), fatigue, and dizziness. In certain cases, RBBB has also been associated with an increased risk of arrhythmias and sudden cardiac death when accompanied by other ECG abnormalities. The findings from our study, which categorized the QRS complex into Normal conduction (78.7%) and Bundle Branch Block (21.3%), align with previous research emphasizing the clinical significance of QRS morphology in various conduction disorders. Notably, Kabutoya et al.(26) demonstrated that a larger preprocedural QRS area in patients with left bundle branch block (LBBB) was predictive of a favourable prognosis for those undergoing cardiac resynchronization therapy (CRT). Their observation that LBBB patients exhibited a significantly larger QRS area (218 ± 99 μVs) compared to those with right bundle branch block (RBBB) and other conduction delays highlights the potential for QRS area as a prognostic marker in CRT. Conversely, Datino et al. (27) shed light on the dynamic nature of QRS morphology, particularly in patients with organic RBBB. Their study revealed that significant changes in QRS morphology could occur during rapid atrial pacing (RAP) and supraventricular tachycardia (SVT), with these alterations being independent of the original bundle branch block pattern. Notably, such changes were observed more frequently in RBBB

In our study, we found that participants with coronary artery disease (CAD) exhibited a lower prevalence of bundle branch block (BBB) at 13.1% compared to those with other conditions, with this difference being statistically significant (P=0.001). Interestingly, other conditions such as diabetes mellitus (DM) and hypertension (SHT) did not show a significant association with the presence of BBB. These findings contrast with the work of Hamby et al.,(28) who reported that patients with left bundle branch block (LBBB) and CAD experienced significantly greater impairment of left ventricular function than those without LBBB. Their study underscored the relationship between LBBB and more severe forms of CAD, as well as worsening heart failure symptoms. Importantly, they did not find significant differences related to the presence of diabetes or hypertension, aligning with our results and suggesting that CAD may be a more critical factor in the context of LBBB. Additionally, Heinsimer et al (29) examined patients with exercise-induced LBBB and found that those with underlying CAD were more likely to develop permanent LBBB, with worse long-term outcomes. Over their follow-up period, 7 out of 8 patients who transitioned to permanent LBBB had underlying CAD, further emphasizing the profound influence of CAD on the progression of LBBB.

**Conclusion:**

In conclusion, this study highlights the significant impact of BBB patterns, particularly LBBB, on the long-term outcomes of heart failure patients. LBBB is associated with worse cardiac function, longer hospital stays, and less improvement in functional status following treatment. The findings underscore the importance of considering advanced heart failure therapies, such as CRT, in these patients to improve outcomes. Clinicians should remain vigilant in identifying BBB patterns in heart failure patients, as early intervention could significantly affect prognosis.

**Limitations and Future Research**

While this study provides valuable insights into the impact of BBB patterns on heart failure outcomes, several limitations must be acknowledged. First, the study did not stratify outcomes based on the duration of heart failure, which could influence the prevalence of BBB and its associated outcomes. Additionally, the relatively small sample size may limit the generalisability of the findings to broader populations.

Future research should focus on larger, multicentre studies to validate these findings and explore the long-term effects of CRT in patients with different BBB patterns. Moreover, studies that assess the role of emerging therapies, such as SGLT2 inhibitors, in heart failure patients with BBB would be valuable in determining whether these therapies can improve outcomes in this high-risk population.

Ethical Approval and consent:

This study was approved by the ethics committee bearing the IEC no------ and informed consent was obtained from all the participants.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

References:

1. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, Burri H, Butler J, Čelutkienė J, Chioncel O, Cleland JGF, Coats AJS, Crespo-Leiro MG, Farmakis D, Gilard M, Heymans S, Hoes AW, Jaarsma T, Jankowska EA, Lainscak M, Lam CSP, Lyon AR, McMurray JJV, Mebazaa A, Mindham R, Muneretto C, Francesco Piepoli M, Price S, Rosano GMC, Ruschitzka F, Kathrine SA (2021) 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: developed by the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) With the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J 42(48):4901.
2. Butler J, Yang M, Manzi MA, Hess GP, Patel MJ, Rhodes T, Givertz MM (2019) Clinical course of patients with worsening heart failure with reduced ejection fraction. J Am Coll Cardiol 73(8):935–944.
3. Kurmani S, Squire I (2017) Acute heart failure: defnition, classifcation and epidemiology. Curr Heart Fail Rep 14(5):385–392.
4. Sinnenberg L, Givertz MM (2020) Acute heart failure. Trends Cardiovasc Med 30(2):104–112.
5. Miró Ò, López-Díez MP, Cardozo C, Moreno LA, Gil V, Jacob J, Herrero P, Llorens P, Escoda R, Richard F, Alquézar-Arbé A, Masip J, García-Álvarez A, Martín-Sánchez FJ, ICA-SEMES group (2022) Impact of hospital and emergency department structural and organizational characteristics on outcomes of acute heart failure. Rev Esp Cardiol (Engl Ed). 75(1):39–49.
6. Miró Ò, Aguirre A, Herrero P, Jacob J, Martín-Sánchez FJ, Llorens P (2015) PAPRICA-2 study: role of precipitating factor of an acute heart failure episode on intermediate term prognosis. Med Clin (Barc) 145(9):385–389.
7. Madias JE (2007) The resting electrocardiogram in the management of patients with congestive heart failure: established applications and new insights. Pacing Clin Electrophysiol 30(1):123–128.
8. Shenkman HJ, Pampati V, Khandelwal AK, McKinnon J, Nori D, Kaatz S, Sandberg KR, McCullough PA (2002) Congestive heart failure and QRS duration: establishing prognosis study. Chest 122(2):528–534.
9. Sandhu R, Bahler RC (2004) Prevalence of QRS prolongation in a community hospital cohort of patients with heart failure and its relation to left ventricular systolic dysfunction. Am J Cardiol 93(2):244–246.
10. Kashani A, Barold SS (2005) Signifcance of QRS complex duration in patients with heart failure. J Am Coll Cardiol 46(12):2183– 2192.
11. Fabiszak T, Łach P, Ratajczak J, Koziński M, Krupa W, Kubica J (2020) Infuence of QRS duration and axis on response to cardiac resynchronization therapy in chronic heart failure with reduced left ventricular ejection fraction: a single center study including patients with left bundle branch block. Cardiol J 27(5):575–582.
12. Park SJ, On YK, Byeon K, Kim JS, Choi JO, Choi DJ, Ryu KH, Jeon ES (2013) Short- and long-term outcomes depending on electrical dyssynchrony markers in patients presenting with acute heart failure: clinical implication of the frst-degree atrioventricular block and QRS prolongation from the Korean Heart Failure registry. Am Heart J 165(1):57-64.e2.
13. Breidthardt T, Christ M, Matti M, Schraf D, Laule K, Noveanu M, Boldanova T, Klima T, Hochholzer W, Perruchoud AP, Mueller C (2007) QRS and QTc interval prolongation in the prediction of long-term mortality of patients with acute destabilised heart failure. Heart 93(9):1093–1097.
14. Lund LH, Jurga J, Edner M, Benson L, Dahlström U, Linde C, Alehagen U (2013) Prevalence, correlates, and prognostic signifcance of QRS prolongation in heart failure with reduced and preserved ejection fraction. Eur Heart J 34(7):529–539.
15. Gouda P, Brown P, Rowe BH, McAlister FA, Ezekowitz JA (2016) Insights into the importance of the electrocardiogram in patients with acute heart failure. Eur J Heart Fail 18(8):1032–1040.
16. Harjola VP, Follath F, Nieminen MS, Brutsaert D, Dickstein K, Drexler H, Hochadel M, Komajda M, Lopez-Sendon JL, Ponikowski P, Tavazzi L (2010) Characteristics, outcomes, and predictors of mortality at 3 months and 1 year in patients hospitalized for acute heart failure. Eur J Heart Fail 12(3):239–248.
17. Savarese G, Lund LH. Global Public Health Burden of Heart Failure. Card Fail Rev. 2017 Apr;3(1):7-11. doi: 10.15420/cfr.2016:25:2. PMID: 28785469; PMCID: PMC5494150.
18. Scherbak D, Shams P, Hicks GJ. Left Bundle Branch Block. [Updated 2024 Oct 5]. In:StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan
19. Eriksson P, Hansson PO, Eriksson H, Dellborg M. Bundle-branch block in a general male population: the study of men born 1913. Circulation. 1998 Dec 01;98(22):2494-500
20. Baldasseroni, S., Gentile, A., Gorini, M., Marchionni, N., Marini, M., Masotti, G.,Porcu, M., & Maggioni, A. (2003). Intraventricular conduction defects in patients with congestive heart failure: left but not right bundle branch block is an independent predictor of prognosis. A report from the Italian Network on Congestive Heart Failure (IN-CHF database).. *Italian heart journal : official journal of the Italian Federation of Cardiology*, 4 9, 607-13.
21. Tabrizi, F., Englund, A., Rosenqvist, M., Wallentin, L., & Stenestrand, U. (2007). Influence of left bundle branch block on long-term mortality in a population with heart failure.. *European heart journal*, 28 20, 2449-55.
22. Abdel-Qadir, H., Tu, J., Austin, P., Wang, J., & Lee, D. (2011). Bundle branch block patterns and long-term outcomes in heart failure.. *International journal of cardiology*, 146 2, 213-8 .
23. Barsheshet, A., Goldenberg, I., Garty, M., Gottlieb, S., Sandach, A., Laish-Farkash, A., Eldar, M., & Glikson, M. (2011). Relation of bundle branch block to long-term (fouryear) mortality in hospitalized patients with systolic heart failure.. *The American journal of cardiology*, 107 4, 540-4 . <https://doi.org/10.1016/j.amjcard.2010.10.007>.
24. Hindman, M., Wagner, G., Jaro, M., Atkins, J., Scheinman, M., Desanctis, R., Hutter, A., Yeatman, L., Rubenfire, M., Pujura, C., Rubin, M., & Morris, J. (1978). The Clinical Significance of Bundle Branch Block Complicating Acute Myocardial Infarction. *Circulation*, 58, 679–688. <https://doi.org/10.1161/01.CIR.58.4.679>.
25. Brugada, J., Brugada, R., & Brugada, P. (1998). Right bundle-branch block and STsegment elevation in leads V1 through V3: a marker for sudden death in patients without demonstrable structural heart disease.. *Circulation*, 97 5, 457-60 . <https://doi.org/10.1161/01.CIR.97.5.457>.
26. Kabutoya, T., Imai, Y., Yokoyama, Y., Yokota, A., Watanabe, T., Komori, T., & Kario, K. (2018). A larger vectorcardiographic QRS area is associated with left bundle branch block and good prognosis in patients with cardiac resynchronization therapy.. *Journal of electrocardiology*, 51 6, 1099-1102.
27. Datino, T., Almendral, J., González-Torrecilla, E., Atienza, F., Garcia-Fernandez, F.,Arenal, Á., Atéa, L., & Fernández‐Avilés, F. (2008). Rate-related changes in QRS morphology in patients with fixed bundle branch block: implications for differential diagnosis of wide QRS complex tachycardia.. *European heart journal*, 29 19, 2351-8 . <https://doi.org/10.1093/eurheartj/ehn340>.
28. Hamby, R., Weissman, R., Prakash, M., & Hoffman, I. (1983). Left bundle branch block: a predictor of poor left ventricular function in coronary artery disease.. *American heart journal*, 106 3, 471-7. <https://doi.org/10.1016/0002-8703(83)90688-9>.
29. Heinsimer, J., Irwin, J., & Basnight, L. (1987). Influence of underlying coronary artery disease on the natural history and prognosis of exercise-induced left bundle branch block.. *The American journal of cardiology*, 60 13, 1065-7 . https://doi.org/10.1016/0002-9149(87)90353-5.