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His Bundle Pacing for Pacing-Induced Cardiomyopathy: Indonesian Experience and Future Prospects: A Case Report

Muhammad Gani Ariftrianto[A], Asiyah Nurul Fadila[B], Rerdin Julario[C]

Abstract

Bradycardia is characterized by a slower heart rate caused by a malfunction in the electrical system that regulates the heart rate. This Bradycardia condition affects approximately one in every 600 people worldwide. Permanent pacemaker (PPM) implantation is suitable for patients with bradycardia and other rhythm abnormalities that require a pacemaker. However, some patients fail to tolerate conventional right ventricular (RV) pacing resulting in pacing-induced cardiomyopathy (PICM). His Bundle Pacing (HBP) prevents the occurrence of PICM. Proper management is important for the patient's outcome. This HBP technique is being used for the first time in Surabaya, which creates a lot of interest in reporting such a case. A 79-years-old Southeast Asian female was referred from a peripheral facility to Dr. Soetomo hospital with symptomatic bradycardia and hypertension. She decreased of consciousness for 4 days and sometimes dizzy without chest pain, dyspnea, or palpitation. The patient had 1 cardiac arrest and returned to spontaneous circulation after cardiopulmonary resuscitation on the 2nd day of treatment in the peripheral facility. She had fainted several times in one year before being hospitalized. In ER, she felt weak. Physical examination showed BP = 145/83 mmHg with dopamine support. The ECG suggested a sinus rhythm 66 times/minute with 2nd degree AV block Mobitz 1 with bigeminy PAC. CXR showed cardiomegaly. Low potassium and albumin level was found. In evaluation, ECG showed paroxysmal atrial fibrillation with rapid ventricular response, and returned to sinus bradycardia. Temporary pacemaker was installed. She was treated and observed in ICCU for 2 days. Afterwards, we installed His Bundle Pacing. Permanent pacemaker implantation has been on the rise recently as the population has gotten older more quickly. For patients with bradycardia, permanent pacemaker implantation is appropriate; however, some patients are unable to tolerate right ventricular (RV) pacing, which can result in pacing-induced cardiomyopathy (PICM), which results in a more than 10% decline in left ventricular ejection fraction (LVEF) after PPM implantation. Due to the preservation of physiological ventricle activation and absence of ventricular dyssynchrony, the implantation of HBP is superior to conventional RV pacing. HBP significantly reduces heart failure hospitalization and mortality when compared to RV pacing. This symptomatic bradycardia was caused by sick sinus syndrome and was treated with HBP. It is found that HBP was associated with reduced heart failure hospitalization.

Keywords: *His Bundle Pacing, Pacing-induced Cardiomyopathy, Bradycardia.*

[A]*Universitas Airlangga, Surabaya, Indonesia, Email: ganiarif92@gmail.com*
[B]*Universitas Airlangga, Surabaya, Indonesia*
[C]*Universitas Airlangga, Surabaya, Indonesia*

INTRODUCTION

Permanent pacing is a treatment method for patients with symptomatic bradycardia, AV block, or other rhythm abnormalities that require a pacemaker. As life expectancy increases in the elderly population, permanent pacemaker (PPM) implantation is increasing. Although permanent pacemaker implantation is suitable for patients with bradycardia, some patients fail to tolerate conventional right ventricular (RV) pacing resulting in pacing-induced cardiomyopathy (PICM), a decrease in left ventricular ejection fraction (LVEF) of more than 10% after PPM implantation (Carrion et al., 2019; Koo et al., 2017; Merchant, 2019). The incidence of PICM is around 5-20% within 3-4 years after implantation of a conventional RV permanent pacemaker (Merchant et al., 2018). Multiple independent predictors for PiCM have been identified, which includes male, pre-existing LV systolic dysfunction, RV apical pacing, prolonged paced QRS duration (pQRSd), prolonged paced corrected QT (QTc), increased RV pacing percentage (RVp%), and wider native QRS duration, most of which are the long-term effect of RV (Yang et al., 2021; Cho et al., 2019). A study by Perla et al. suggests that the presence of more than two predictive factors increased the chance of PICM by twelve fold. A narrow paced QRS is the only modifiable factor to alleviate PICM (Perla, 2021).

Pacing of the His-Purkinje system, including HBP and LBBP, was selected as an alternative procedure for patients with bradycardia or heart failure symptoms, in which the safety and efficiency has been reported in recent studies. His Bundle Pacing (HBP) prevents the occurrence of PICM, where HBP is better at maintaining physiological ventricular activation than a conventional RV permanent pacemaker. In HBP, activation occurs via the typical conduction system, hence prolonged paced QRS duration is minimized and ventricular dyssynchrony is not produced (Ali et al., 2018). HBP has been shown to reduce hospitalizations with heart failure (HF) compared to permanent RV apical pacing or septal pacing (Mizneret al., 2022).

In Dr Soetomo hospital's ER, the patient still complains of weakness without chest pain, shortness of breath and palpitations. She looked compos-mentis. Her blood pressure = 145/83 mmHg with dopamine support 5 mcg/kg BW/minute, pulse = 53 times/minute, respiration rate = 26 times/minute, and oxygen saturation = 97% with a simple mask of 6L per minute. On cardiac auscultation, irregular S1 and S2 were found without murmurs and extrasystoles. Examination of the lungs, abdomen and extremities was normal. Then the patient underwent an electrocardiographic examination.

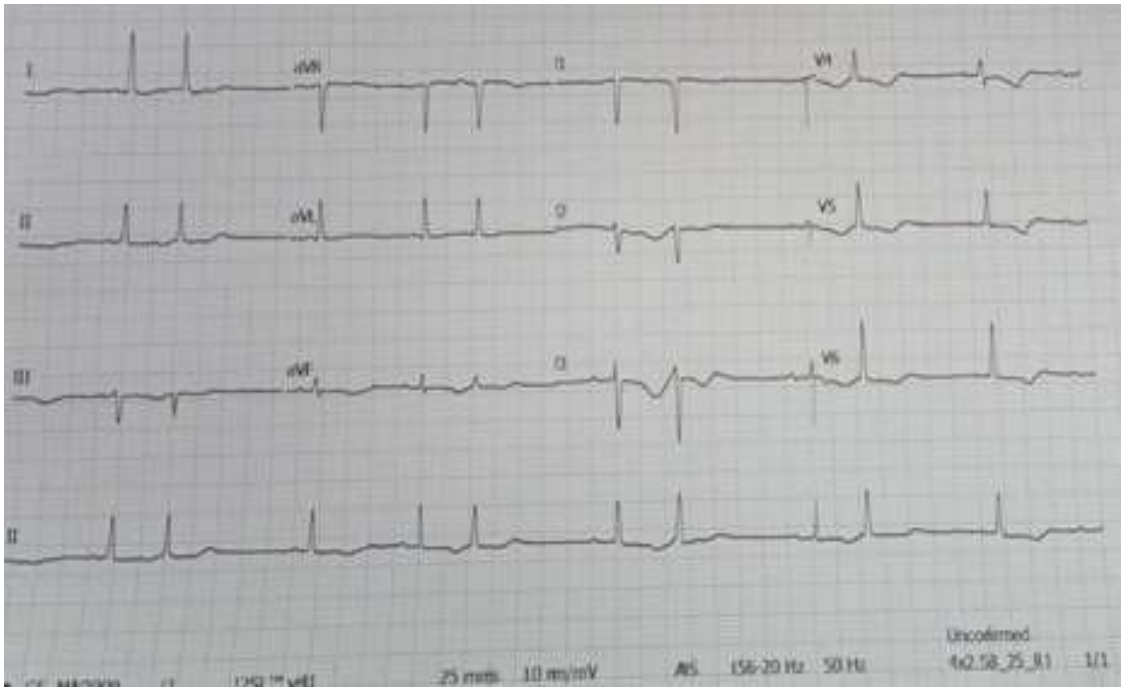

Figure 1. Electrocardiogram before permanent pacing implantation showed sinus rhythm 66 times/minute with 2nd degree AV block Mobitz 1 with bigeminy PAC

That showed sinus rhythm 66 times/minute with second-degree Atrioventricular (AV) block Mobitz 1, normal frontal and horizontal axis with bigeminy Premature Atrial Complex (PAC). Chest X-ray (CXR) in the ER.

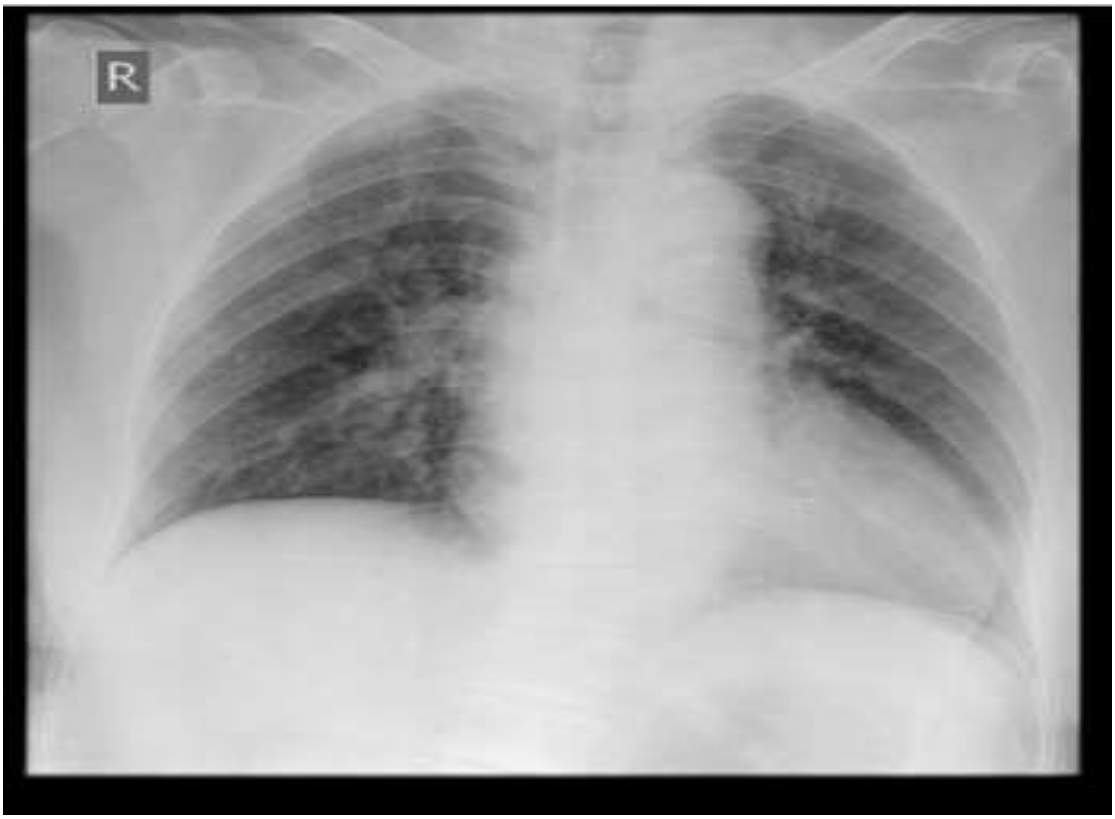

Figure 2. Chest radiograph in emergency room showed Cardiomegaly (CTR= 56%)

Showed cardiomegaly with a cardiothoracic ratio of 56%. Abnormal laboratory results were obtained for potassium (3.2 mmol/L) and albumin (3.16 g/dl). The patient experienced paroxysmal atrial fibrillation with rapid ventricular response.

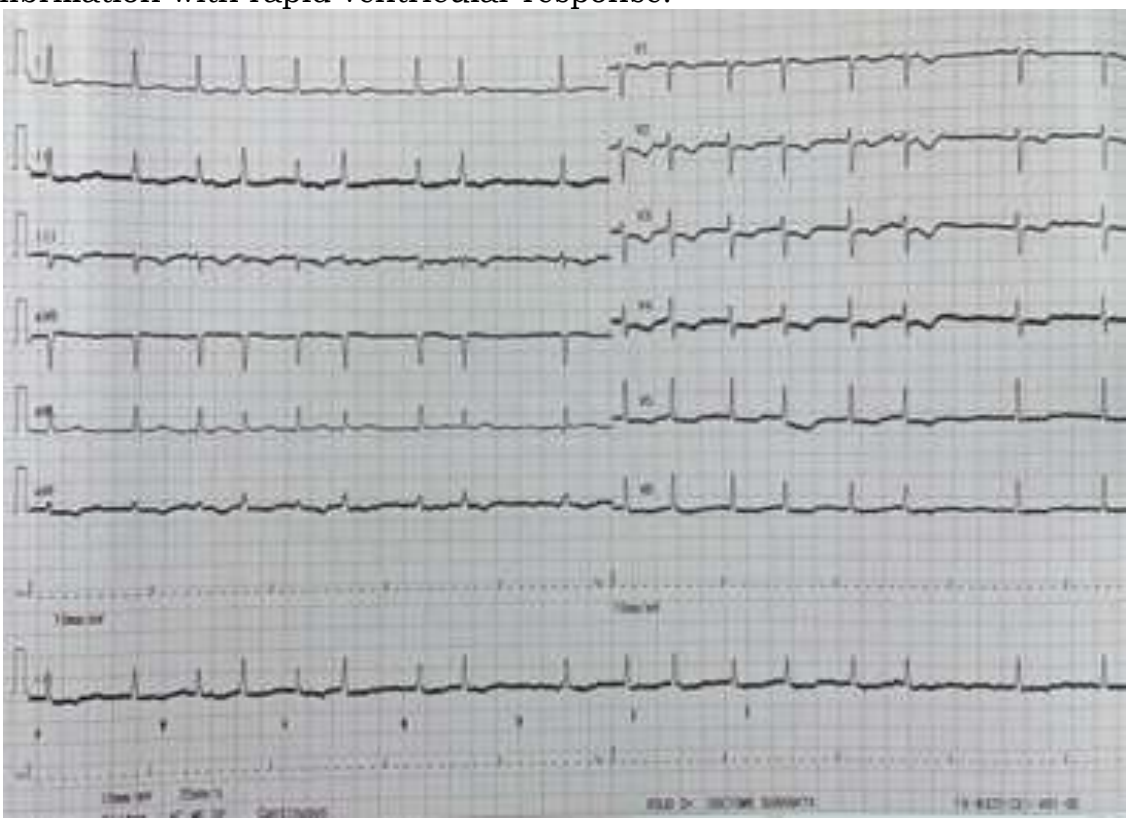

Figure 3. Electrocardiogram suggested Paroxysmal Atrial Fibrillation with Rapid Ventricular Response

Then the rhythm returned to sinus bradycardia. The diagnosis of symptomatic bradycardia with suspicion of sick sinus syndrome and paroxysmal atrial fibrillation was established, afterwards a temporary pacemaker was installed. The patient was treated and observed in the ICCU for 2 days with a temporary pacemaker on standby. After 2 days of treatment and observation in the ICCU, His Bundle Pacing was installed.

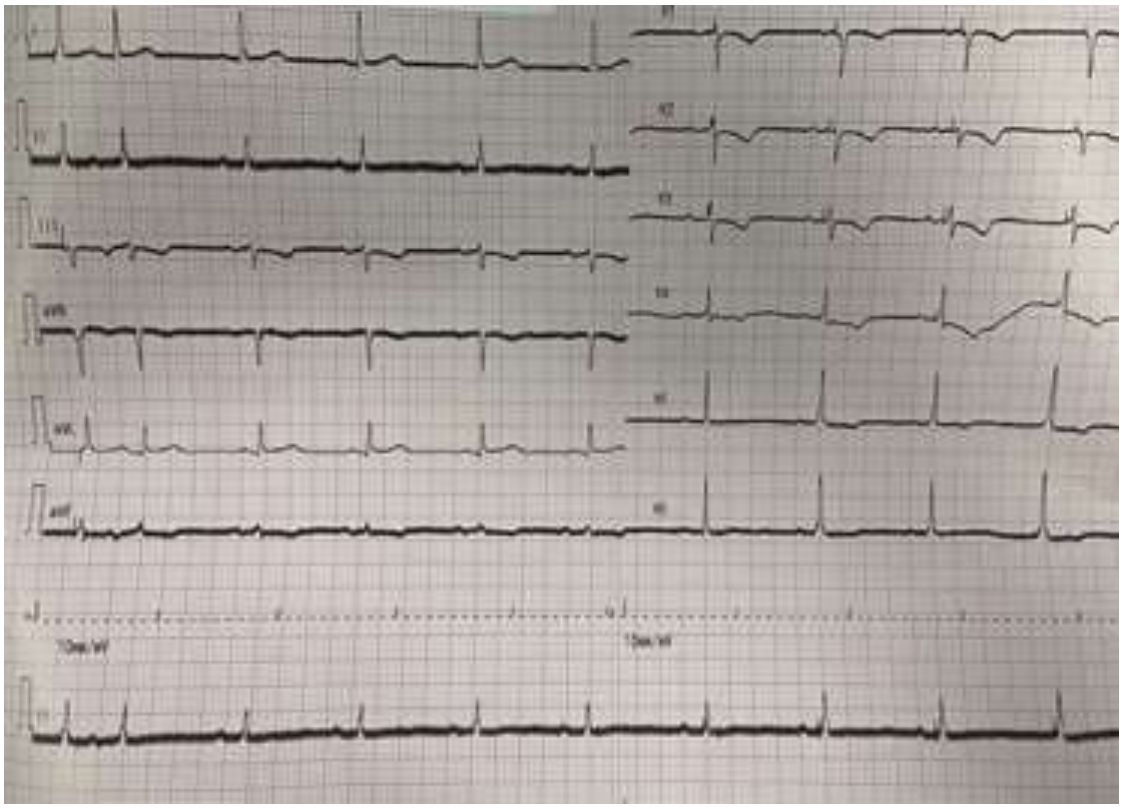

Figure 4. Electrocardiogram evaluation after His Bundle Pacemaker placement

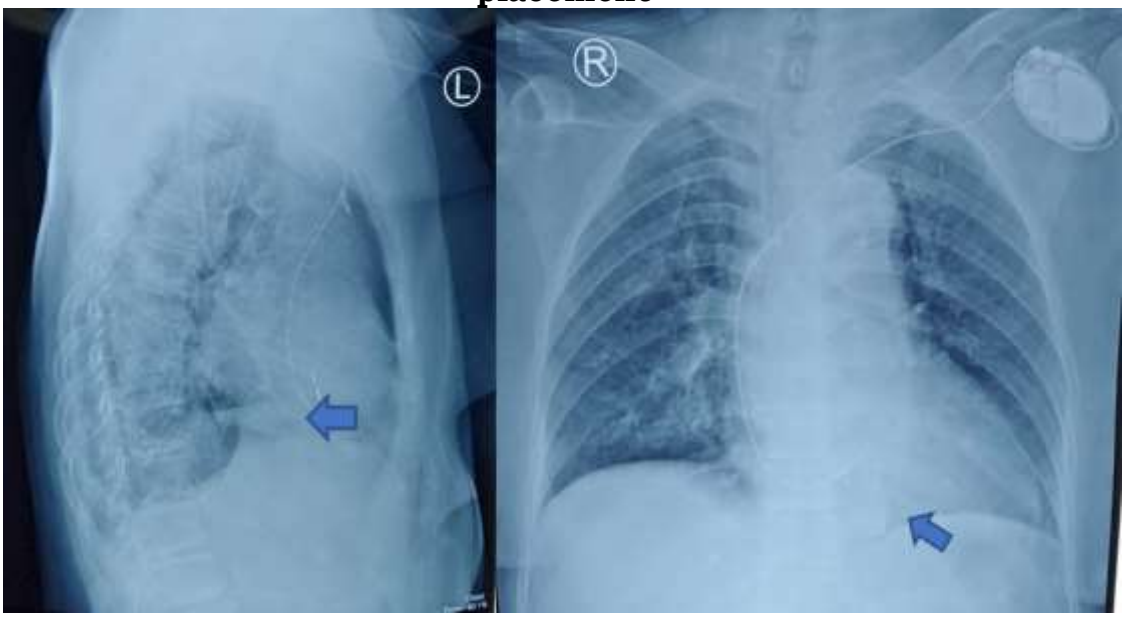

Figure 5. Chest radiograph evaluation after His Bundle Pacemaker placement. The arrow shows the lead position of His Bundle

METHOD

This article aims to describe the methodology and results of a case study on the use of His Bundle Pacing (HBP) in patients with Pacing-Induced Cardiomyopathy (PICM) in Indonesia. The article also discusses future prospects for this approach. This Article report a case of his bundle pacing in a 79-year-old female patient who had symptomatic bradycardia

caused by sick sinus syndrome as an effort to prevent PICM. This work has been reported in line with the SCARE criteria.

A 79-year-old Southeast Asian female with symptomatic bradycardia was referred to Dr Soetomo hospital's emergency room (ER) from a peripheral facility in Surabaya, Indonesia. Her chief complaint is decreased consciousness in the past 4 days. She felt weak and sometimes dizzy while being treated at the peripheral facility. There was no chest pain, shortness of breath or palpitations. The patient has a history of fainting, approximately 6-7 times, a year before treatment at the peripheral facility. On the 2nd day, the patient had 1 cardiac arrest, so cardiopulmonary resuscitation was performed for 1 minute, and she returned to spontaneous circulation. From her previous history, the patient had hypertension for more or less 20 years and was an active smoker before being hospitalized. She denied a history of diabetes and coronary heart disease. Her family had neither similar complaints nor heart disease.

RESULT AND DISCUSSION

There has been an escalating trend of permanent pacemaker implantation in the past years, with the increasing aging population. However, the inter- and intra-ventricle permanent pacemakers create a new problem 2-5 years post-implantation (Bradshaw et al., 2014). The pacemaker, typically placed in the RV, bypasses the AV node, which synchronizes ventricular contraction. This placement leads to slow myocyte-to-myocyte signal transmission with a single electrical signal breaking through the stimulation site, either RV apex or septum. This resulted in a disproportional RV depolarization and delayed LV remote segment depolarization called electro-mechanical ventricular dyssynchrony. The dyssynchrony is noticeable immediately after the start of pacing. The asymmetrical activation of individual LV segments leads to asymmetrical remodeling due to uneven workloads of the early-activated septum and late-activated LV lateral wall segments. The workload of the septal wall decreases while the workload of the LV lateral wall increases; hence thinning of the septum and hypertrophy of the LV lateral wall occur. RV pacing also changes ventricular perfusion, neurohormonal innervation, fatty acid metabolism, and myocardial oxygen demand (Mizner et al., 2022).

Later, ventricular dyssynchrony may manifest as pacing-induced cardiomyopathy, a complication of single- and dual-chambered pacemakers that present in 10-20% of patients after 3-4 years of RV pacing.[12] PICM in the first-year post-implantation is also prevalent, accounting for up to 9% of patients.[13] PICM is defined as a drop of LVEF in the setting of chronic, high-burden RV pacing. It is traditionally considered a form of heart failure with reduced ejection fraction, with LVEF < 40%. However, the definition of PICM varies, and the most clinically relevant one is the absolute reduction in LVEF > 10%, regardless of baseline (Somma, et al., 2022).

PICM is treated by ameliorating the extent of dyssynchrony that is expected to reverse cardiomyopathy. Several strategies to prevent or treat PICM include placing RV lead in the septum as opposed to the traditional apical placement, reducing RV pacing, and placing alternative forms of pacing such as cardiac resynchronization therapy (CRT) or His bundle pacing (HBP). A study by Kaye et. al. reported that the placement of RV lead in the septal wall fails to bring beneficial outcomes as there was no significant difference in the rate of heart failure hospitalization, death, and atrial fibrillation (Kaye et al., 2016). A meta-analysis that included 4119 patients who underwent randomized clinical trials reveals that the reduction of RV pacing showed no significant difference in all-cause mortality, all-cause hospital admission, and atrial fibrillation.[16] The use of CRT is studied in two randomized clinical trials, the BIOPACE study and the BLOCK HF study, which show contradicting results (Curtis et al., 2016; Gould et al., 2018).

The implantation of HBP is better than conventional RV pacing as it preserves the physiological ventricle activation, engages activation of both ventricles, and does not induce ventricular dyssynchrony. It is a dual chamber pacemaker, whose lead is placed directly in the bundle of His for selective capture (only the His bundle is stimulated) or placed in combination with a ventricular septum for non-selective capture (capturing septal myocardium before the His-Purkinje axis). HBP is proven to significantly reduce heart failure hospitalization and death compared to RV pacing (Beer et al., 2019; Lewis et al., 2019).

With the current guidelines and algorithms promoting the attenuation of RV pacing whenever possible, HBP may serve as an option to deliver a more physiological pattern of ventricular pacing and may mitigate the adverse events of chronic RV pacing.

CONCLUSION

Given the deleterious adverse consequences of RV pacing attributed to ventricular dyssynchrony, HBP is the most potential solution compared to the other strategies. The selection of HBP is associated with better outcomes in patients indicated for permanent pacemakers as it mimics physiological ventricular activation, thus preventing the event of PICM. HBP may call for a more tolerable permanent pacemaker option for RV, including an alternative strategy to CRT when it is not possible. List of Abbreviations:

- AV : Atrioventricular
- BP : Blood Pressure
- CXR : Chest X-ray
- ECG : Electrocardiogram
- ER : Emergency Room
- HBP : His Bundle Pacing
- HF : Heart Failure
- ICCU : Intensive Coronary Care Unit
- LVEF : Left Ventricular Ejection Fraction
- PAC : Premature Atrial Complex

- PICM : Pacing-Induced Cardiomyopathy
- PPM : Permanent Pacemaker
- RV : Right Ventricular

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