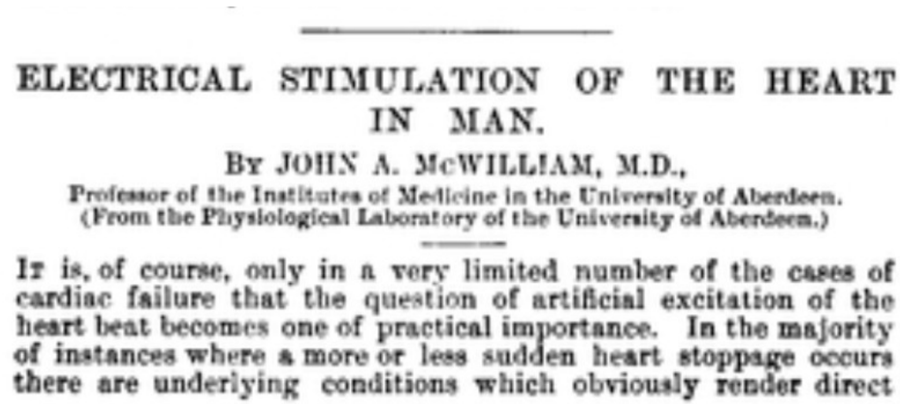
TITOLO: PRESENTE E FUTURO DELLA STIMOLAZIONE CARDIACA

RELATORE: Lorenzo Bianchini, MD
Hearth Rhythm Center – Centro Cardiologico Monzino, IRCCS

Partiamo dalle origini…

PRIMA CONTRAZIONE CARDIACA «ARTIFICIALE»

John Alexander MacWilliam
(31 July 1857 – 13 January 1937)



ELECTRICAL STIMULATION OF THE HEART IN MAN.

BY JOHN A. McWILLIAM, M.D.,
Professor of the Institutes of Medicine in the University of Aberdeen.
(From the Physiological Laboratory of the University of Aberdeen.)

It is, of course, only in a very limited number of the cases of cardiac failure that the question of artificial excitation of the heart beat becomes one of practical importance. In the majority of instances where a more or less sudden heart stoppage occurs there are underlying conditions which obviously render direct

British Medical Journal 1889:

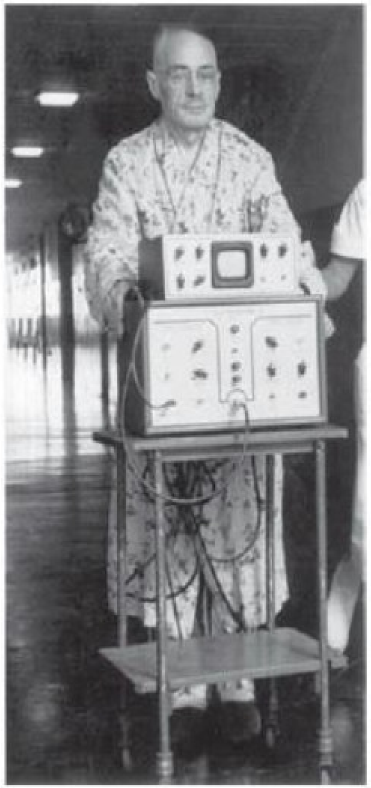
- Prima dimostrazione di evocazione di una contrazione cardiaca durante asistolia con l'applicazione di corrente elettrica

PRIMO PACEMAKER ARTIFICIALE

«HYMANOTOR», 1932

- Albert Hyman ha per primo coniato il termine "pacemaker artificiale" e realizzato il primo PM esterno.
- Corrente erogata attraverso un ago da introdurre nel cuore attraverso il torace
- FC: 30, 60 0 120 bpm
- Prime discussioni etiche sulla opportunità di prolungare la vita umana con l'utililizzo delle macchine.

<u>1950's</u>: The first Human <u>Transvenous Endocardial</u> Stimulations



Complete Heart Block

Endocardial pacing performed with the lead introduced through the basilic vein in the left antecubital fossa.

The patient ambulating in a hospital corridor pushing <u>a line powered external pacemaker with a 100-foot extension cord *</u>.

Endocardial stimulation was from the low power pacemaker output via the left arm endocardial lead.

** In 1957 a winter storm produced a power failure in Minneapolis; the hospital didn't have a backup power supply and a children paced with an external powered device remained unpaced. From this time current and voltage in an external PM was provided by an internal battery.*

1960 The first US recipient of permanent pacemaker

Figure 3. The "Bowtie Trio": William Chardack, Andrew Gage, and Wilson Greatbatch at the bedside of 1 of the first recipients of their permanent pacemaker. Source: Greatbatch Medical, courtesy of Curtis Holmes, PhD.

Pacing Evolution

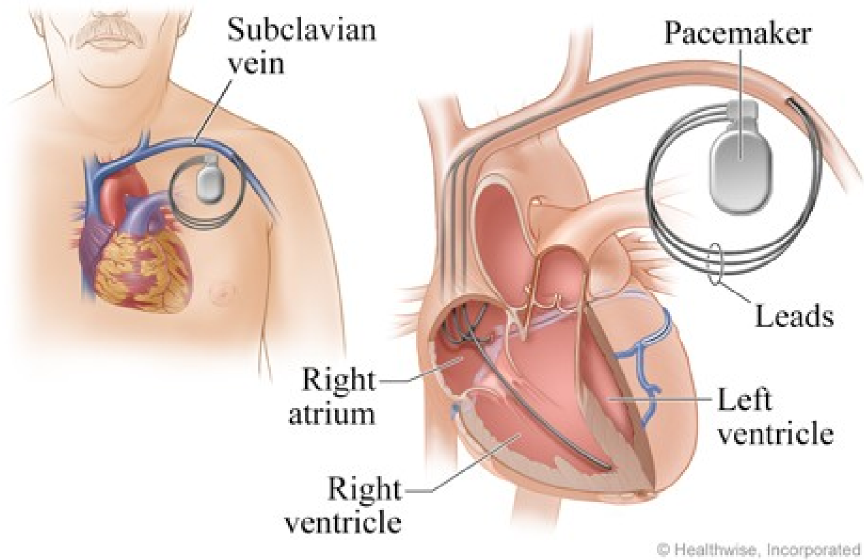
1990-2000: THE ADVENT OF BIVENTRICULAR PACING TO TREAT HF

EFFECTS OF MULTISITE BIVENTRICULAR PACING IN PATIENTS WITH HEART FAILURE AND INTRAVENTRICULAR CONDUCTION DELAY

SERGE CAZEAU, M.D., CHRISTOPHE LECLERCQ, M.D., THOMAS LAVERGNE, M.D., STUART WALKER, M.D., CHETAN VARMA, M.D., CECILIA LINDE, M.D., STÉPHANE GARRIGUE, M.D., LUKAS KAPPENBERGER, M.D., GUY A. HAYWOOD, M.D., MASSIMO SANTINI, M.D., CHRISTOPHE BAILLEUL, PH.D., AND JEAN-CLAUDE DAUBERT, M.D., FOR THE MULTISITE STIMULATION IN CARDIOMYOPATHIES (MUSTIC) STUDY INVESTIGATORS*

N Engl J Med, 2001:

Conclusions Although it is technically complex, atriobiventricular pacing significantly improves exercise tolerance and quality of life in patients with chronic heart failure and intraventricular conduction delay. (N Engl J Med 2001;344:873-80.)



THE CLINICAL EVIDENCE FOR CRT

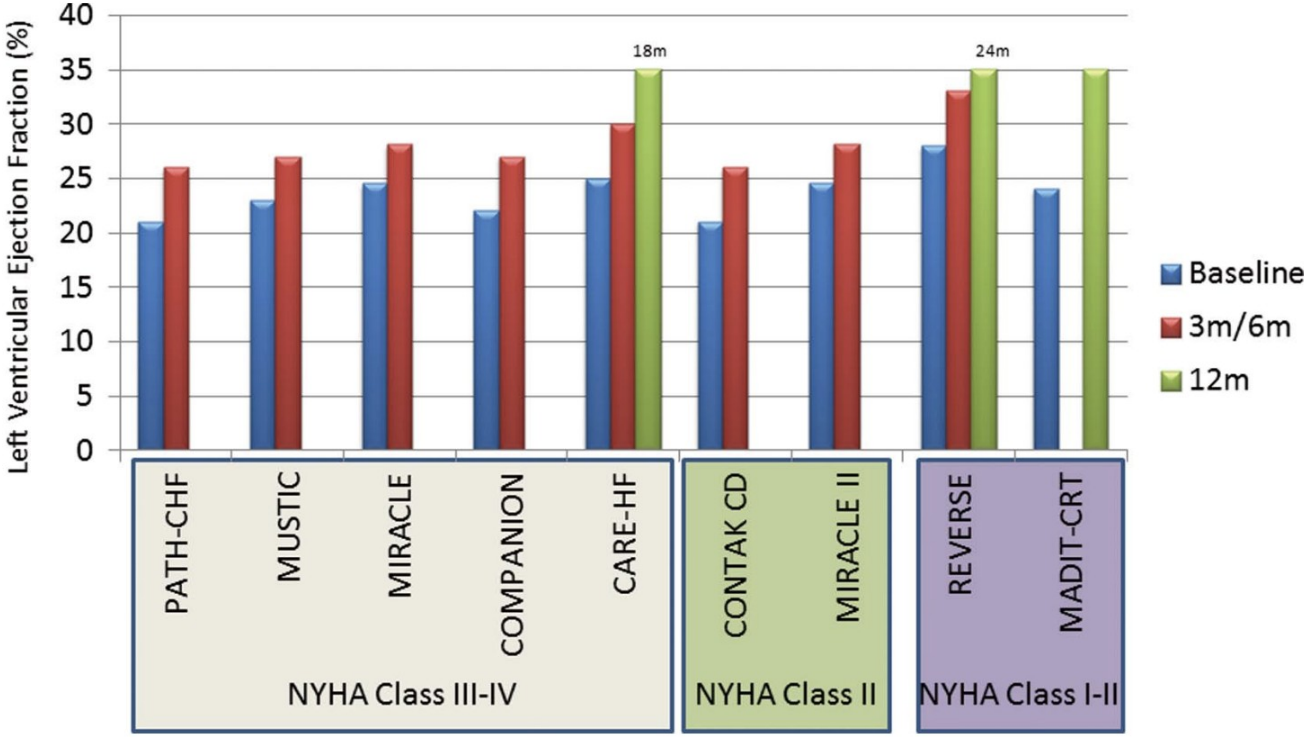


Figure 1. Change in left ventricular ejection fraction (LVEF) after cardiac resynchronization therapy (CRT) in heart failure patients with different functional classes (New York Heart Association, NYHA). In comparison to LVEF before CRT (blue bars), there was a statistical significant increase of LVEF in all studies after 3 to 6 month of treatment (red bars) or during a longer follow-up time (green bars). Of note, the LVEF change is remarkably similar in all studies with a clear small, but continuous increase over the time.

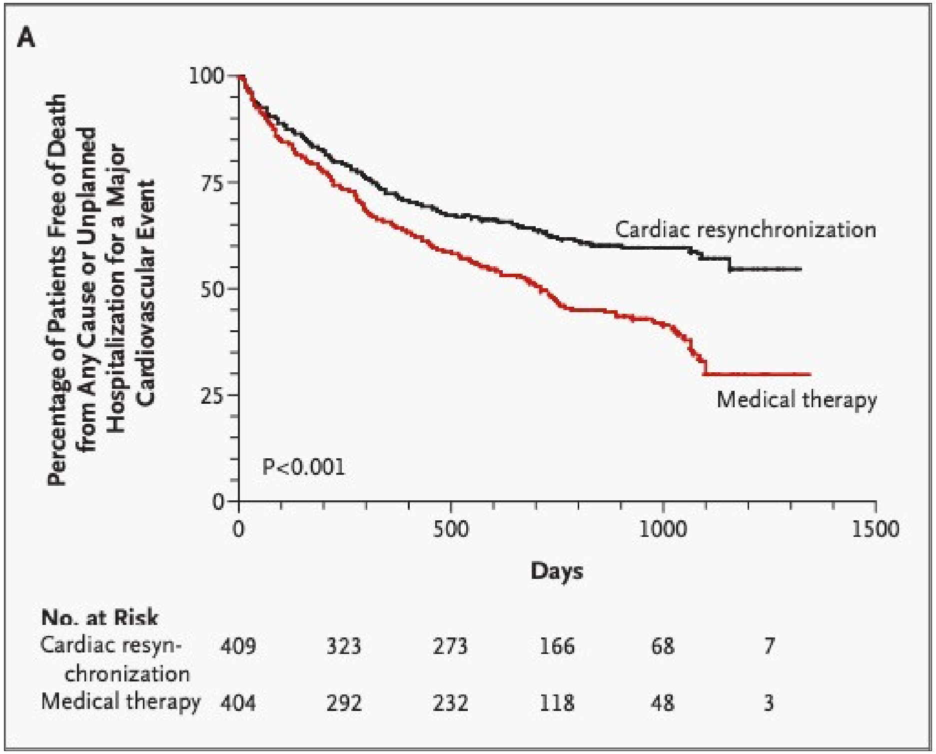
Auricchio A, Prinzen FW. Non-responders to cardiac resynchronization therapy: the magnitude of the problem and the issues. Circ J. 2011;75(3):521-7. doi: 10.1253/circj.cj-10-1268. Epub 2011 Feb 11. PMID: 21325727.

The NEW ENGLAND JOURNAL of MEDICINE

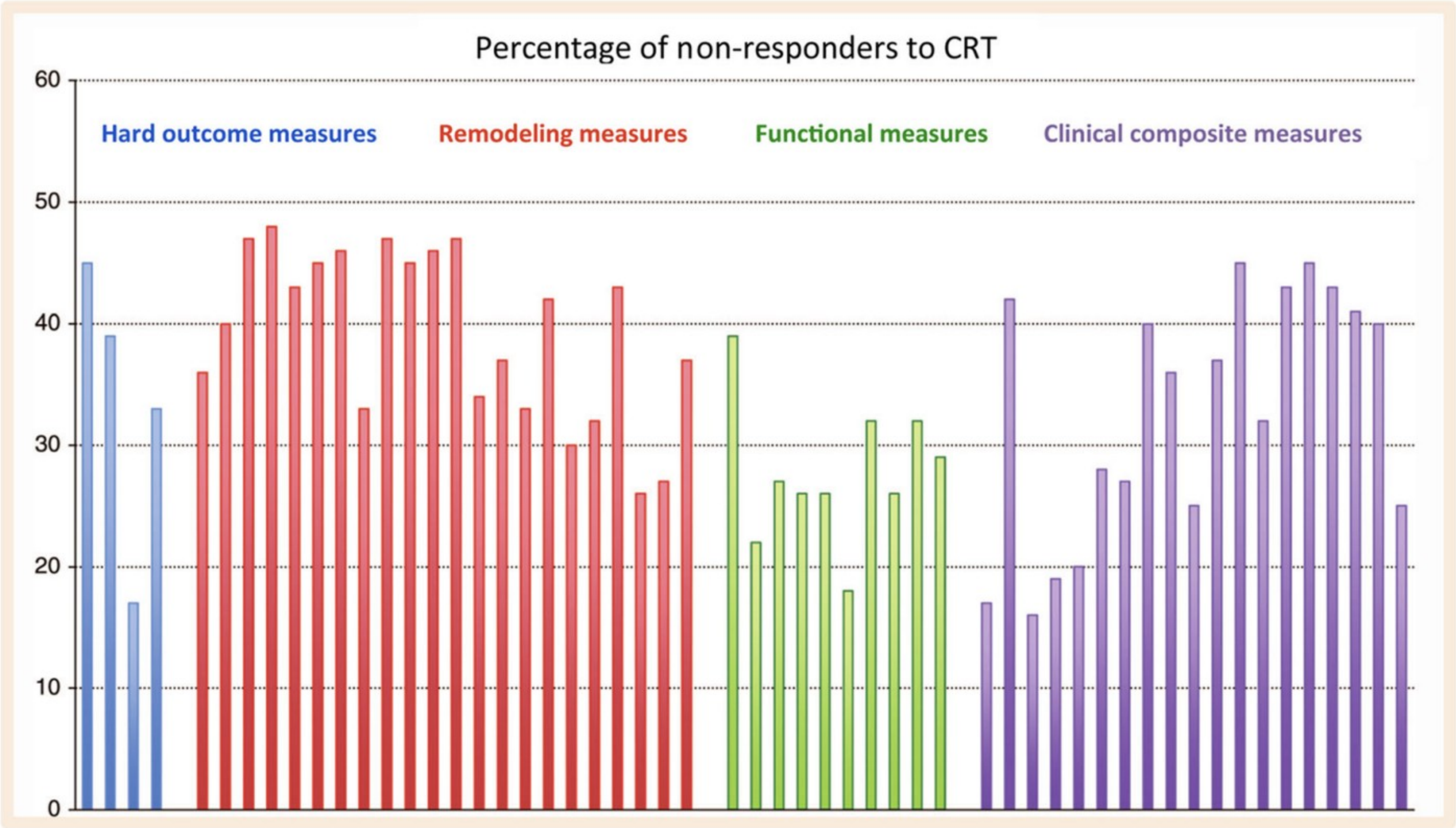
ORIGINAL ARTICLE

The Effect of Cardiac Resynchronization on Morbidity and Mortality in Heart Failure

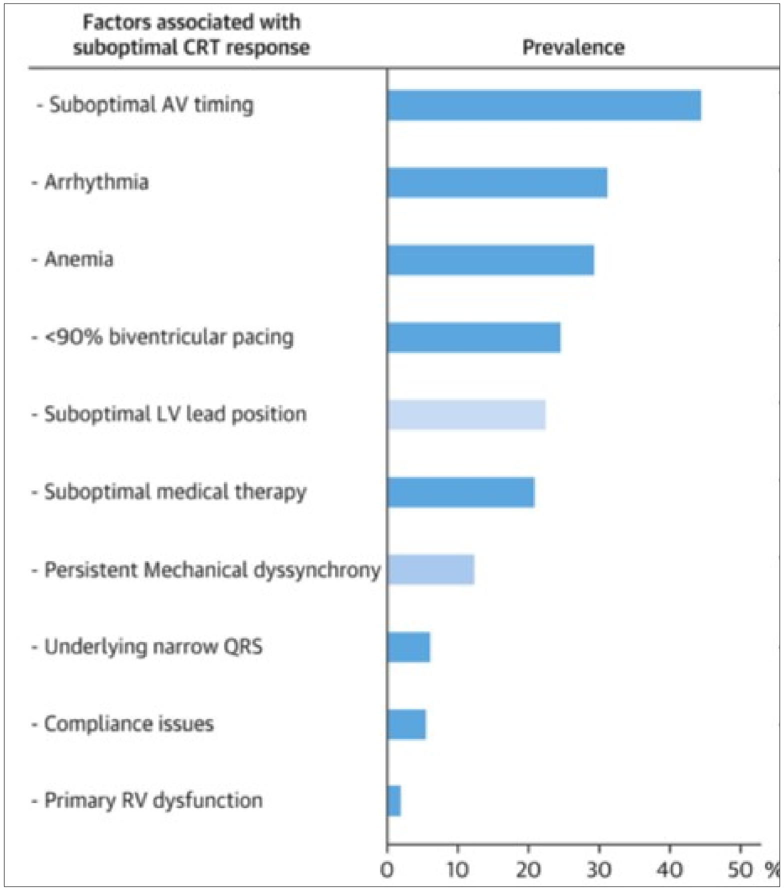
John G.F. Cleland, M.D., Jean-Claude Daubert, M.D.,
Erland Erdmann, M.D., Nick Freemantle, Ph.D., Daniel Gras, M.D.,
Lukas Kappenberger, M.D., and Luigi Tavazzi, M.D.,
for the Cardiac Resynchronization — Heart Failure (CARE-HF) Study Investigators*



THE ISSUE OF NON-RESPONDERS TO CRT



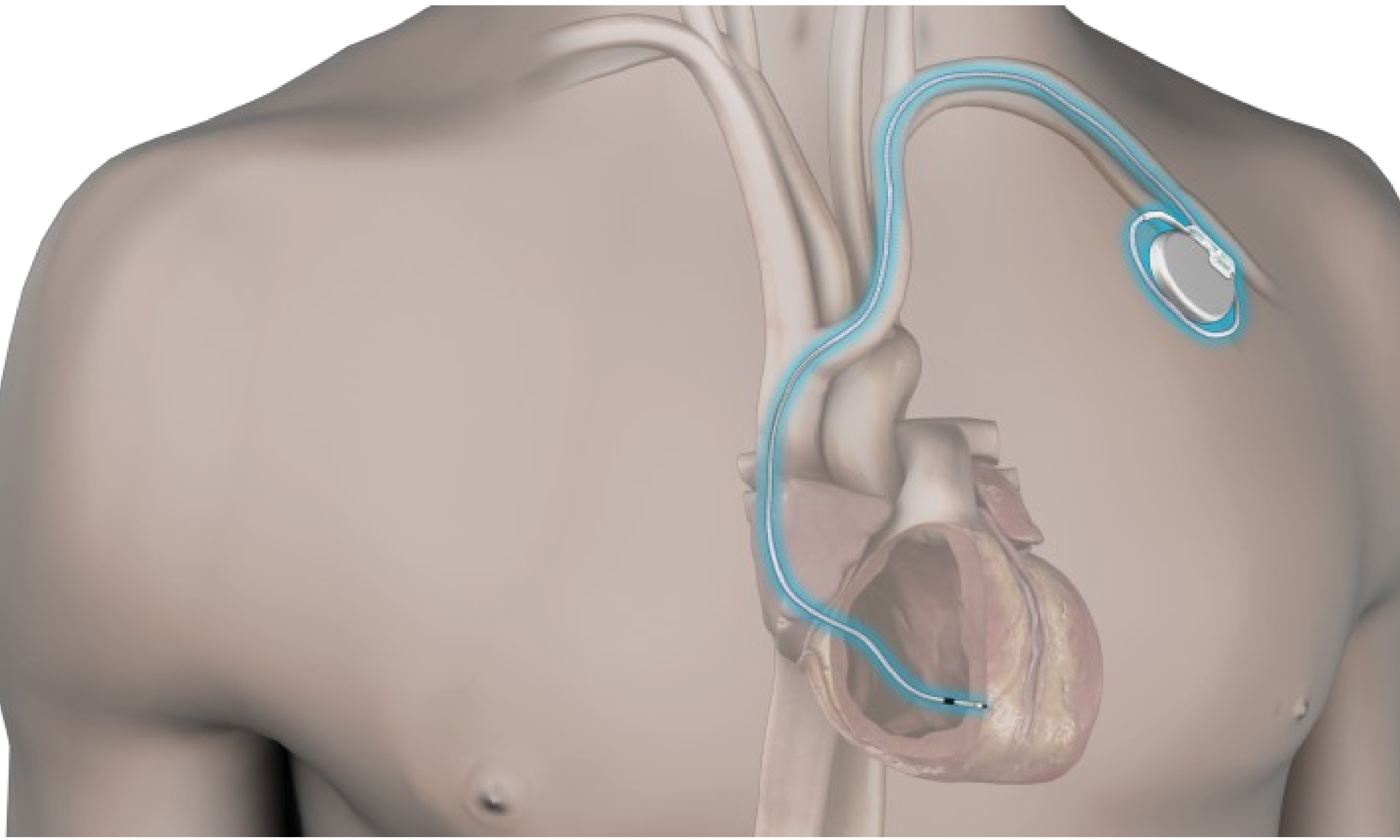
Sieniewicz BJ, Gould J, Porter B, Sidhu BS, Teall T, Webb J, Carr-White G, Rinaldi CA. Understanding non-response to cardiac resynchronisation therapy: common problems and potential solutions. Heart Fail Rev. 2019 Jan;24(1):41-54. doi: 10.1007/s10741-018-9734-8. PMID: 30143910; PMCID: PMC6313376.



STRATEGIES TO ADDRESS THE CHALLENGE OF NON-RESPONSIVENESS

- CAREFUL SELECTION OF PATIENTS
- OPTIMAL DEVICE IMPLANTATION
- POST-IMPLANT DEVICE PROGRAMMING WITH LONG-TERM MONITORING.
- NEW PACING TECHNIQUES, ESPECIALLY PHYSIOLOGICAL PACING (HBP AND LBBP).

1950, 60, 70, 80, 90, 2000, 2010…….



Pacing Evolution

Nanostim: il pacemaker senza fili

16 Gennaio 2014 NOTIZIE

Dall'inizio di dicembre 2013 sono iniziati in Italia i primi impianti del pacemaker leadless **Nanostim** di St Jude Medical. **Nanostim** è il primo e unico pacemaker al mondo senza elettrocateteri che ha ottenuto il marchio CE.

Il pacemaker St. Jude Medical Nanostim è l'unico pacemaker disponibile in pratica clinica che stimola il cuore senza cateteri e che viene impiantato direttamente all'interno del ventricolo destro; il posizionamento avviene mediante un sistema di introduzione steerable, manovrabile attraverso la vena femorale.

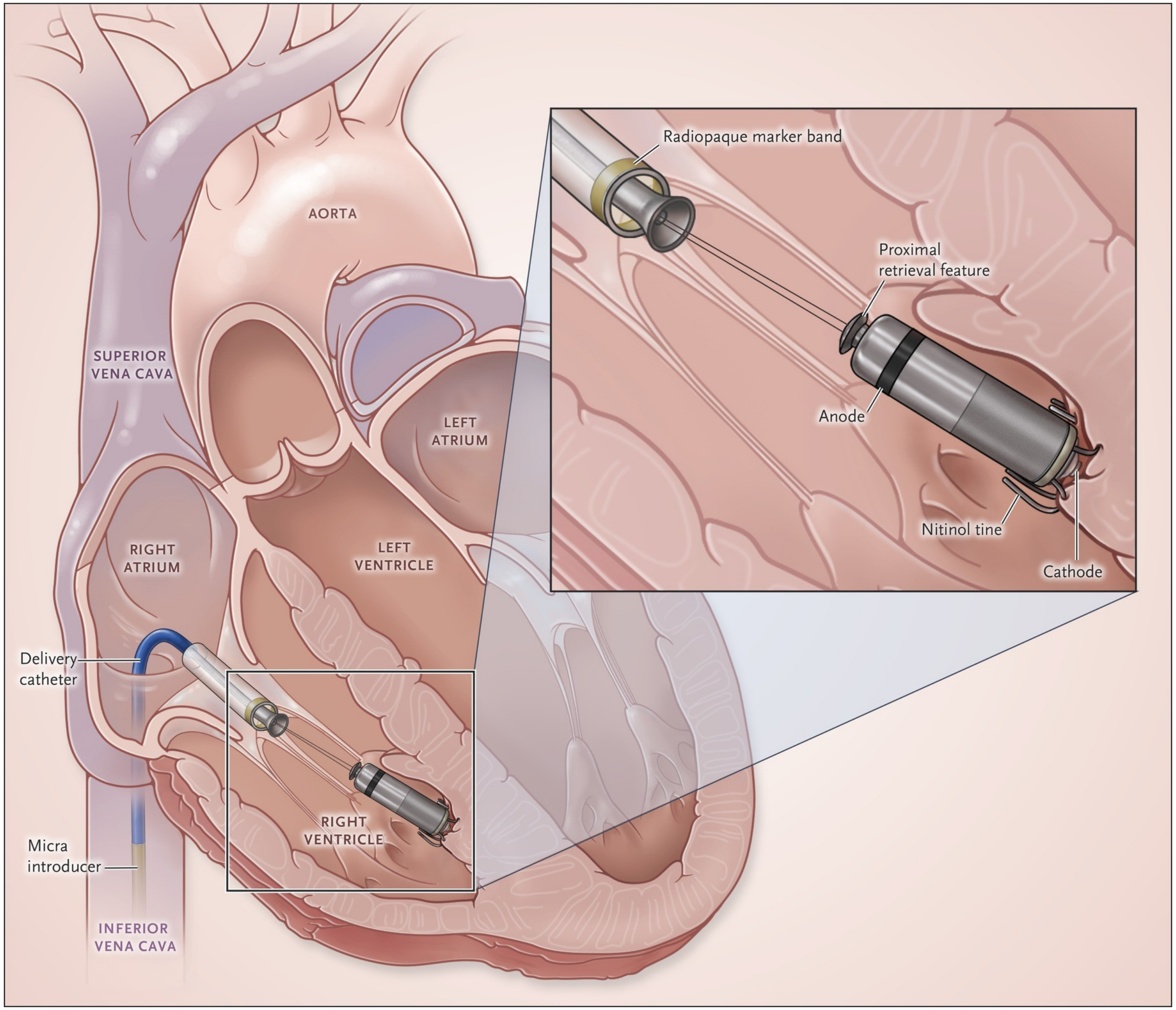
Nanostim è stato progettato in modo tale da essere completamente recuperabile; si può riposizionarlo rapidamente durante la procedura d'impianto e recuperarlo successivamente se necessario, come ad esempio per la sostituzione di routine della batteria la cui longevità è comunque paragonabile a quella dei normali pacemaker.

Tra i circa 100 centri che nel mondo sono stati individuati per la fase iniziale l'Italia, con circa 20 centri, viene posta in una posizione di leadership internazionale.

Per saperne di più

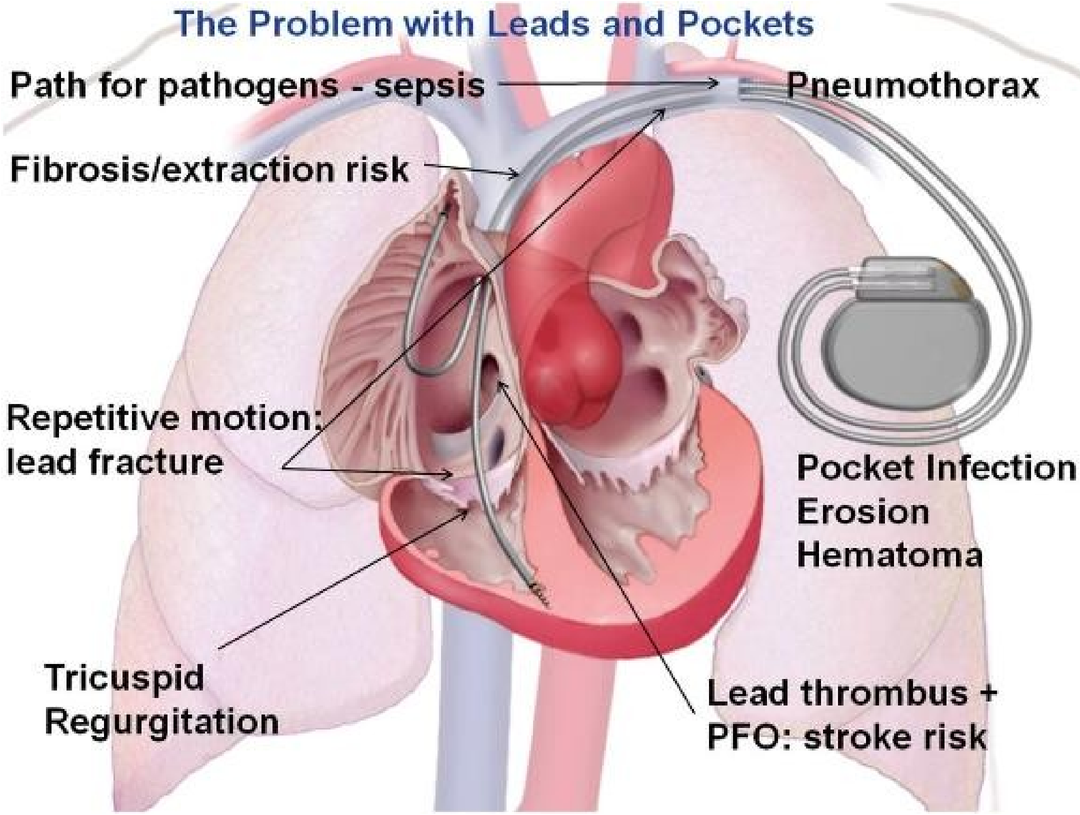
Pacemaker Leadless St Jude Medical NanostimTM (PDF: 130 Kb)

2015: MEDTRONIC MICRA SYSTEM



LEADLESS PM PATIENT SELECTION CONSIDERATIONS

- COMPLICATIONS WITH TRANSVENOUS DEVICE
- INFECTION RISK
- ANATOMICAL/VASCULAR ISSUES
- INFREQUENT PACING EXPECTED
- AGE
- PATIENT PREFERENCE



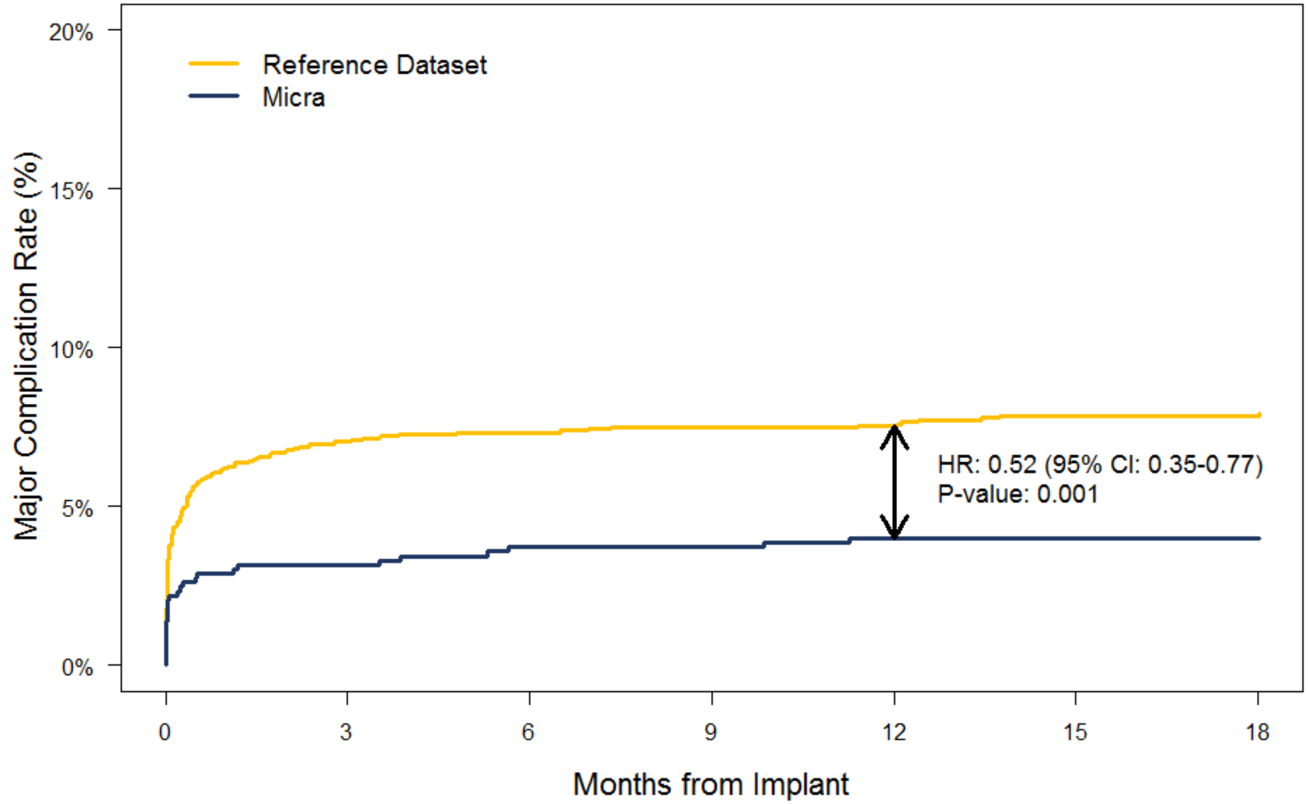
Leadless pacing using the transcatheter pacing system (Micra TPS) in the real world: initial Swiss experience from the Romandie region

Valérian Valiton[1,2], Denis Graf[2,3], Etienne Pruvot[3], Patrice Carroz[3,4], Martin Fromer[3], Laurence Bisch[3], Vân Nam Tran[3], Stéphane Cook[2], Christoph Scharf[5], and Haran Burri[1]*

Methods and results

Retrospective observational, multi-centre study designed to assess initial safety and efficacy of the Micra TPS in the Swiss Romande region. A total of 92 patients were included from four different centres with an implantation success rate of 97.8% (90 of 92). Thresholds were overall low at implantation (median 0.38 V/0.24 ms, ranging from 0.13 to 2.88 V/0.24 ms) and remained stable over 1-year follow-up. The perioperative serious adverse event rate was 6.5% in six patients which lead to prolonged hospitalization in five patients and death in one patient. In addition, three further major events (3.3%) occurred during an average follow-up of 1 year, requiring implantation of a standard transvenous pacemaker in two patients, and surgical explantation of the Micra TPS in one patient due to intractable ventricular tachycardia.

48% FEWER MAJOR COMPLICATIONS WITH MICRA VS TRANSVENOUS PACEMAKERS[1]

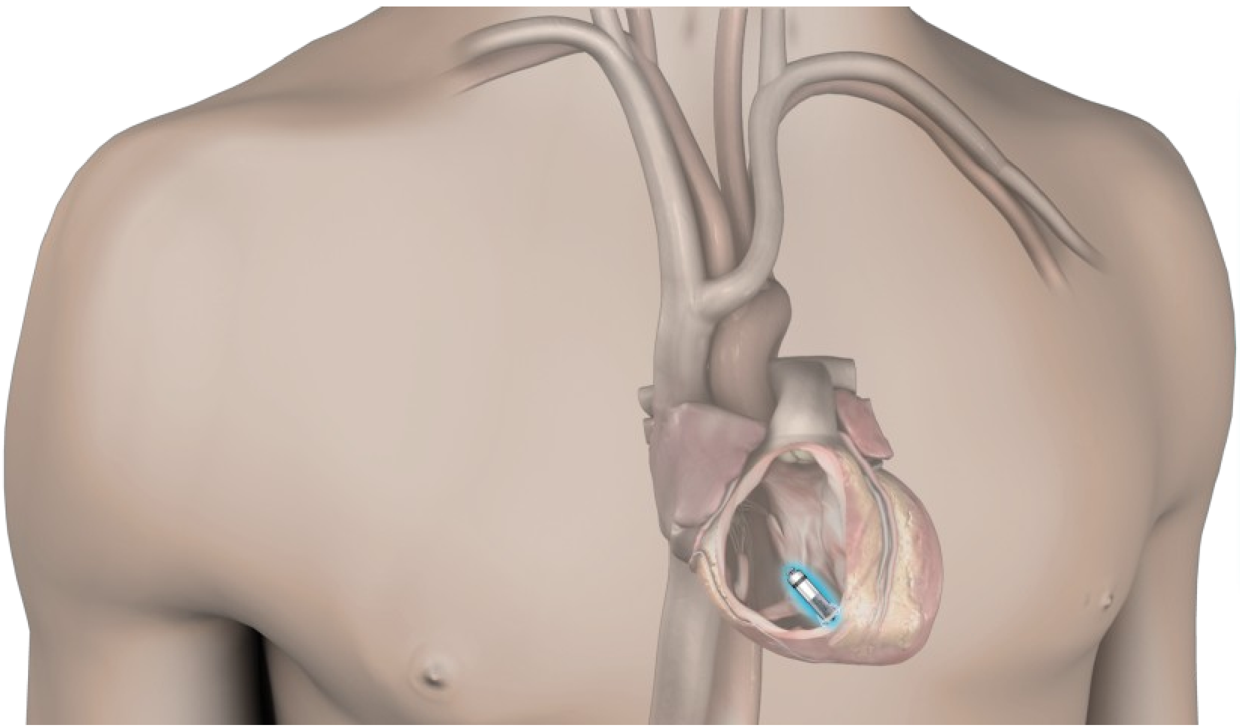


Number at Risk

	0	3	6	9	12	15	18
Reference	2667	2260	1965	1698	1537	1319	1212
Micra	726	684	671	658	643	432	251

[1] Duray GZ et al., Micra Long-term performance of a transcatheter pacing system: 12-Month results from the Micra Transcatheter Pacing Study. *Heart Rhythm* (2017), doi: 10.1016/j.hrthm.2017.01.035.

From 2013 to ?????????



2020: the single chamber VDD MICRA AV LEADLESS PM

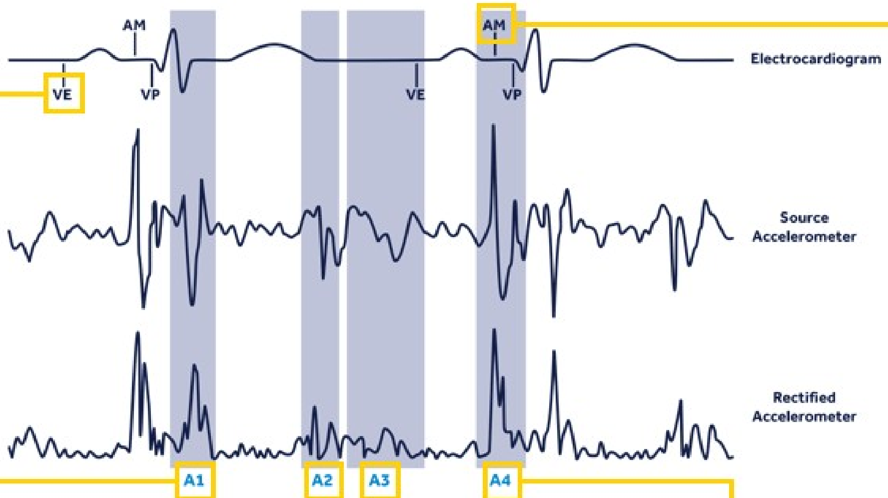
Atrioventricular Synchronous Pacing Using a Leadless Ventricular Pacemaker

Results From the MARVEL 2 Study

- Micra AV's accelerometer detects mechanical atrial activity and uses this information to deliver AV synchronous ventricular pacing.
- New, integrated circuitry capable of sustaining new AV synchrony functionality.
- Estimated average battery longevity of 8-13 years, dependent on the patient's degree of AV block.

Micra™ AV

ACCELEROMETER SIGNALS



Ventricular end (VE) marker
The end of the A1–A3 ventricular-event signals.

Atrial mechanical (AM) marker
Marker that indicates the device detected the atrial mechanical contraction or A4.

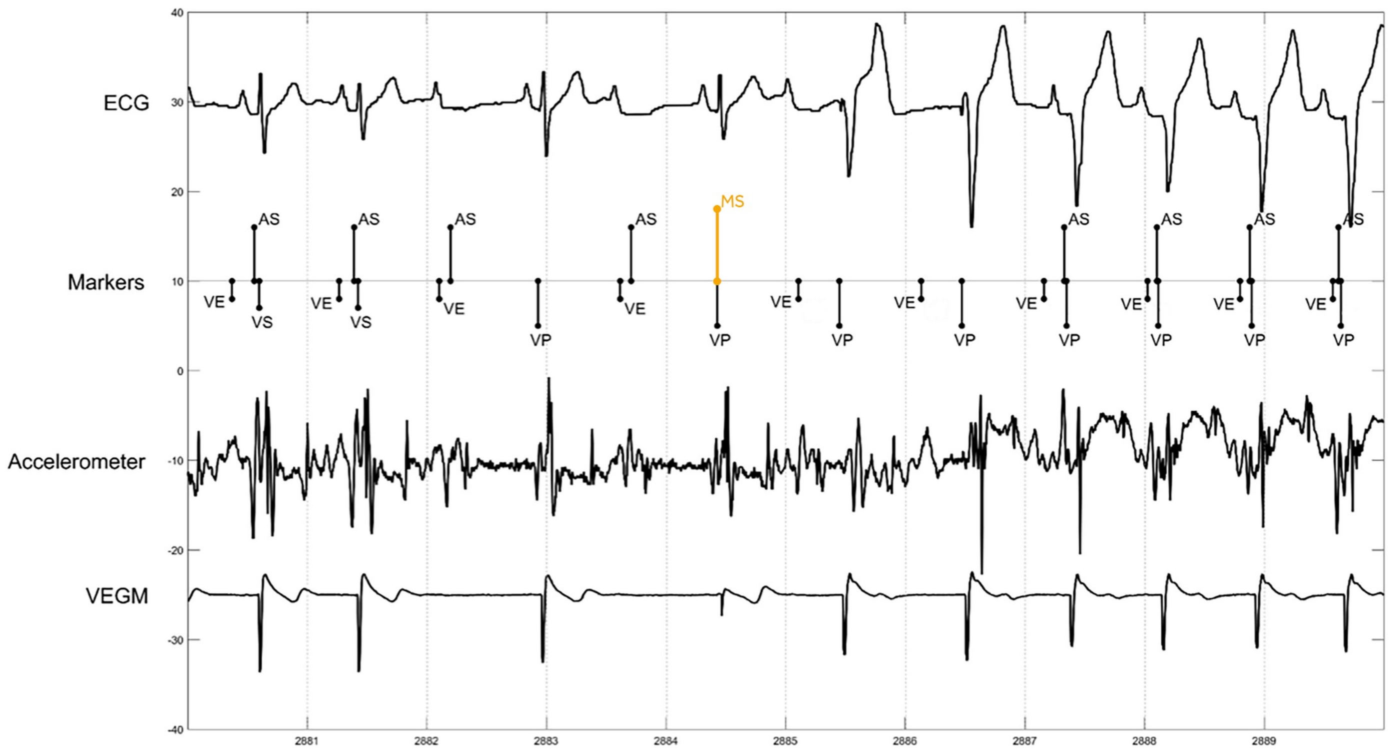
A1
Start of ventricular systole, mitral and tricuspid valves close.

A2
End of ventricular systole, aortic and pulmonic valves close.

A3
Diastole, passive blood flow from A to V, corresponds to E-wave on Doppler echo.

A4
Atrial systole, blood pushed into ventricles, 100 ms electromechanical delay, corresponds to A-wave on Doppler echo.

Mode switch to VDD in patient with intermittent AV block



cosa ci aspetta…

2022: first implantation of dual chamber leadless pacemaker system

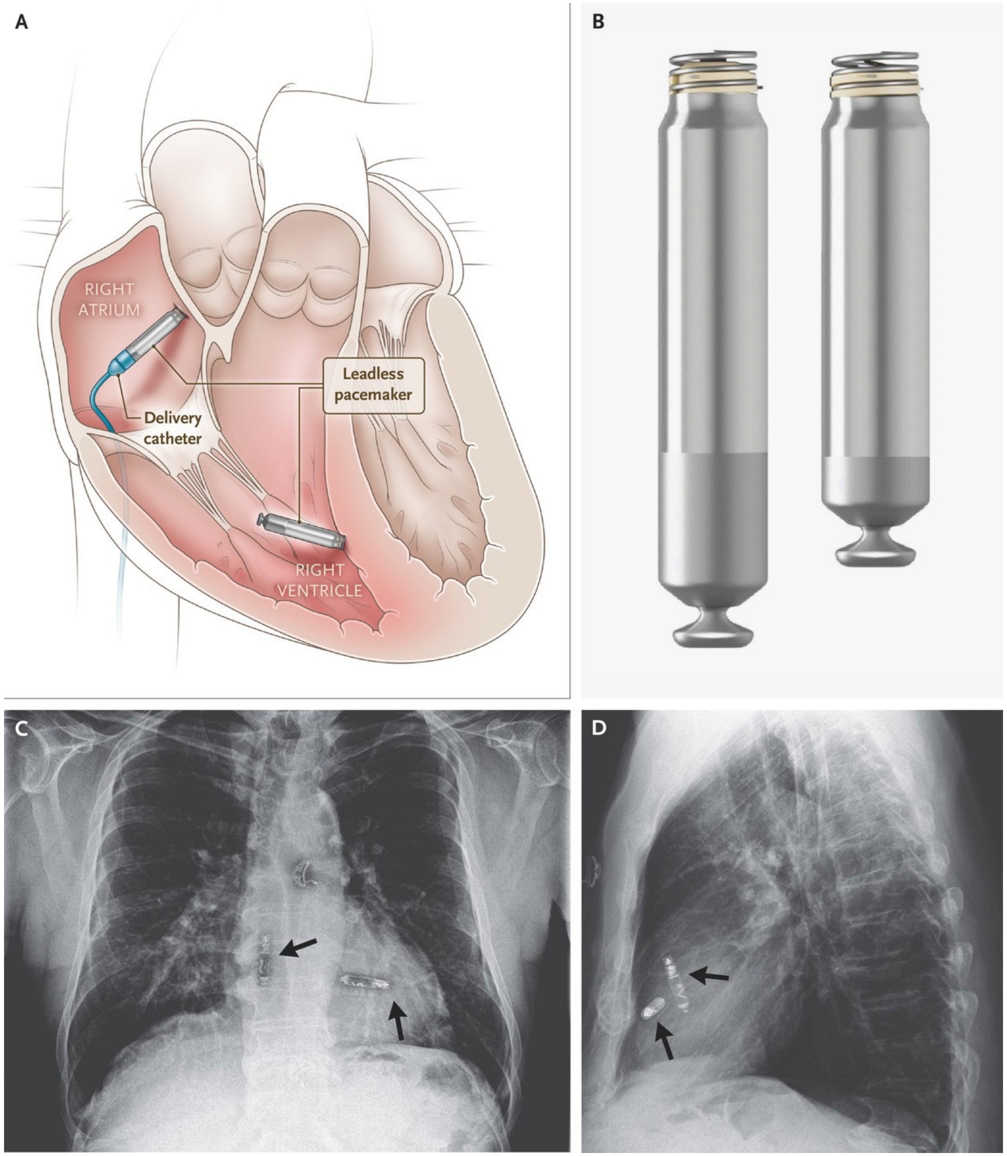
AVEIR™ DR Dual Chamber Leadless Pacemaker System

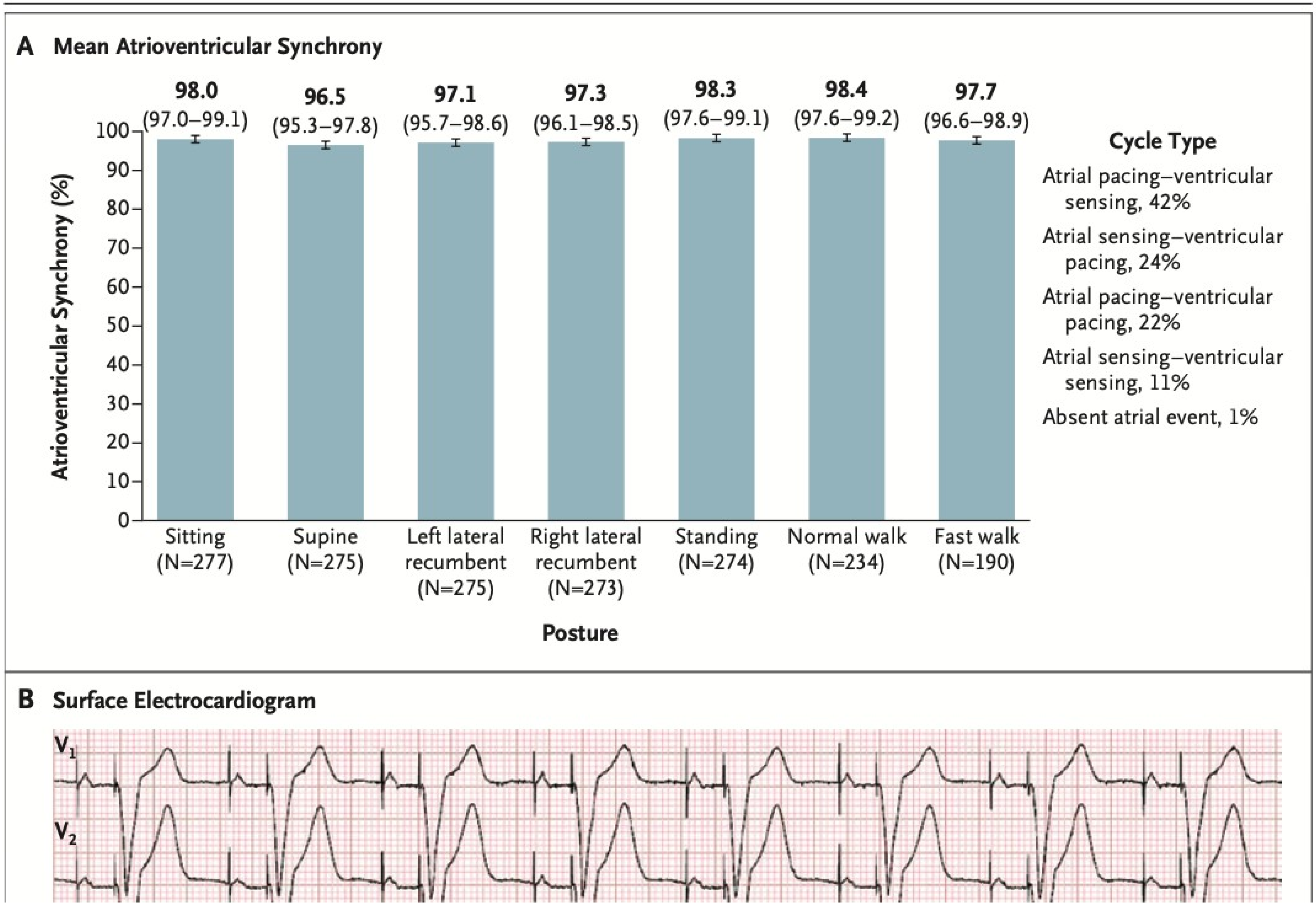
Setting the Pace with Dual Chamber Leadless Pacing

BEAT-TO-BEAT SYNCHRONY | UPGRADEABLE SYSTEM | LONG-TERM RETRIEVAL

NOW FDA APPROVED

NON ANCORA MARCHIO CE


A
RIGHT ATRIUM
Leadless pacemaker
Delivery catheter
RIGHT VENTRICLE
B
C
D



Knops RE, Reddy VY, Ip JE, Doshi R, Exner DV, Defaye P, Canby R, Bongiorni MG, Shoda M, Hindricks G, Neužil P, Rashtian M, Breeman KTN, Nevo JR, Ganz L, Hubbard C, Cantillon DJ; Aveir DR i2i Study Investigators. A Dual-Chamber Leadless Pacemaker. N Engl J Med. 2023 Jun 22;388(25):2360-2370. doi: 10.1056/NEJMoa2300080. Epub 2023 May 20. PMID: 37212442.

ESC
European Society of Cardiology

European Heart Journal (2022) **43**, 1216–1218
https://doi.org/10.1093/eurheartj/ehab769

EDITORIAL

Leadless pacing: is this the end of the road for transvenous pacemakers?

Haran Burri *

Cardiac Pacing Unit, Department of Cardiology, University Hospital of Geneva, Geneva, Switzerland

Online publish-ahead-of-print 13 November 2021

Deleterious effect of RV chronic pacing

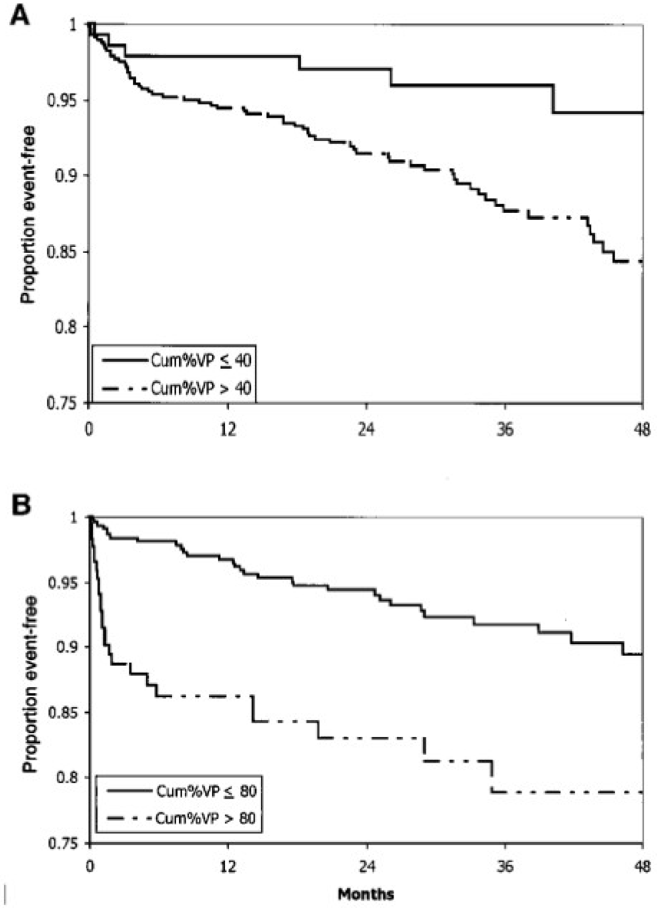


Figure 2. Kaplan-Meier rates for freedom from first HFH by percent ventricular paced during the first 30 days. a, DDDR mode; b, VVIR mode.

Our study suggests that ventricular desynchronization imposed by right ventricular apical pacing even when AV synchrony is preserved increases the risk of heart failure and AF in patients with SND and normal baseline QRS duration.

Sweeney MO, Hellkamp AS, Ellenbogen KA, Greenspon AJ, Freedman RA, Lee KL, Lamas GA; MOde Selection Trial Investigators. Adverse effect of ventricular pacing on heart failure and atrial fibrillation among patients with normal baseline QRS duration in a clinical trial of pacemaker therapy for sinus node dysfunction. Circulation. 2003 Jun 17;107(23):2932-7. doi: 10.1161/01.CIR.0000072769.17295.B1. Epub 2003 Jun 2. PMID: 12782566.

Cardiac-resynchronization therapy in patients with systolic heart failure and QRS interval ≤130 ms: insights from a meta-analysis

Rachit M. Shah[1], Dhavalkumar Patel[1], Janos Molnar[2], Kenneth A. Ellenbogen[1], and Jayanthi N. Koneru[1]*

[1]Cardiac Electrophysiology, Department of Cardiology, Virginia Commonwealth University Hospital, Gateway Building, 3rdFl, PO Box 980053, Richmond, VA 23298-0053, USA; and [2]Department of Cardiology, Rosalind Franklin University, North Chicago, IL, USA

Received 15 June 2014; accepted after revision 3 July 2014; online publish-ahead-of-print 27 August 2014

Aims Cardiac-resynchronization therapy (CRT) reduces morbidity and mortality in patients with chronic systolic heart failure (SHF) and a wide QRS complex. It is unclear whether the same benefit extends to patients with QRS duration (QRSd) <130 ms.

Methods and results Our aim was to perform a meta-analysis of all randomized controlled trial (RCTs) and to evaluate the effect of implantable CRT defibrillator(CRTD) on all-cause mortality, HF mortality, and HF hospitalization in patients with QRSd <130 ms. We performed a systematic literature search to identify all RCTs, comparing CRTD therapy with implantable cardiac defibrillator (ICD) therapy in patients with SHF (ejection fraction <35%) and QRS ≤130 ms, published in Pubmed, Medline, EMBASE, Cochrane library, and Google scholar from June 1980 through June 2013. The search terms included CRT, QRS duration, narrow QRS, clinical trial, RCT, biventricular pacing, heart failure, systolic dysfunction, dyssynchrony, left ventricular remodelling, readmission, mortality, survival, and various combinations of these terms. We studied the trends of overall mortality, SHF mortality, and hospitalizations due to SHF between the two groups. Heterogeneity of the studies was analysed by Q statistic. A fixed-effect model was used to compute the relative risk (RR) of mortality due to SHF, while a random-effects model was used to compare hospitalization due to SHF. Out of a total of 12 100 citations, four RCTs comparing CRTD vs. ICD therapy in patients with SHF and QRS ≤130 ms fulfilled the inclusion criteria. The median follow-up was 12 months and the cumulative number of patients was 1177. Relative Risk for all-cause mortality in patients treated with CRTD was 1.66 with a 95% CI of 1.096–2.515 ($P = 0.017$) while for SHF mortality was 1.29 with 95% CI of 0.68–2.45 ($P = 0.42$). Relative risk for HF hospitalization in patients treated with CRTD was 0.94 with 95% CI of 0.50–1.74 ($P = 0.84$) in comparison to the ICD group.

Conclusion Cardiac-resynchronization therapy defibrillator has no impact on SHF mortality and SHF hospitalization in patients with systolic HF with QRS duration ≤130 ms and is associated with higher all-cause mortality in comparison with ICD therapy.

Keywords CRT • QRS duration • LV dyssynchrony • HF mortality • All-cause mortality • HF hospitalization

La stimolazione del sistema di conduzione

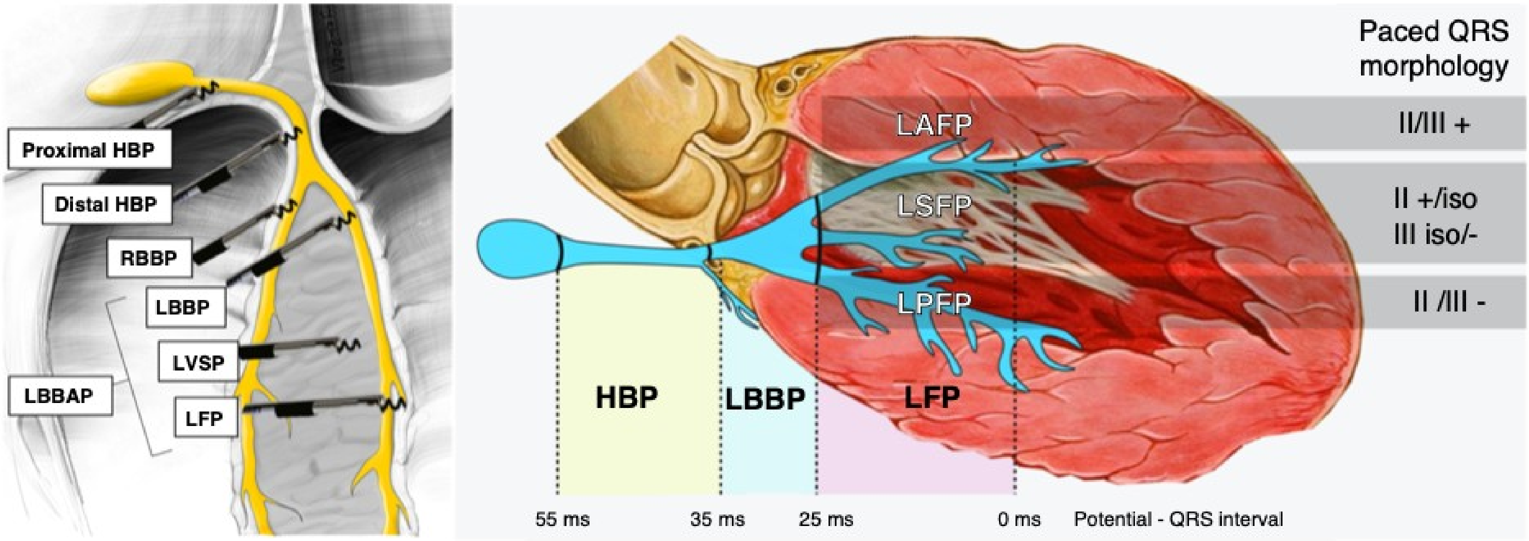


Figure 1 Categories of conduction system pacing. Anatomical position of the pacing lead, potential to QRS interval (if visualized), and paced QRS morphology in leads II and III are used to determine the level of CSP. RBBP and LVSP are not shown on the right panel. HBP = His bundle pacing; iso = isoelectric; LAFP = left anterior fascicle pacing; LBBAP = left bundle branch area pacing; LBBP = left bundle branch pacing; LFP = left fascicular pacing; LPFP = left posterior fascicle pacing; LSFP = left septal fascicle pacing; LVSP = left ventricular septal pacing; RBBP = right bundle branch pacing. Modified with permission from Filip Plesinger and from Jastrzebski *et al.*[7]

ESC European Society of Cardiology

Europace (2023) **25**, 1208–1236
https://doi.org/10.1093/europace/euad043

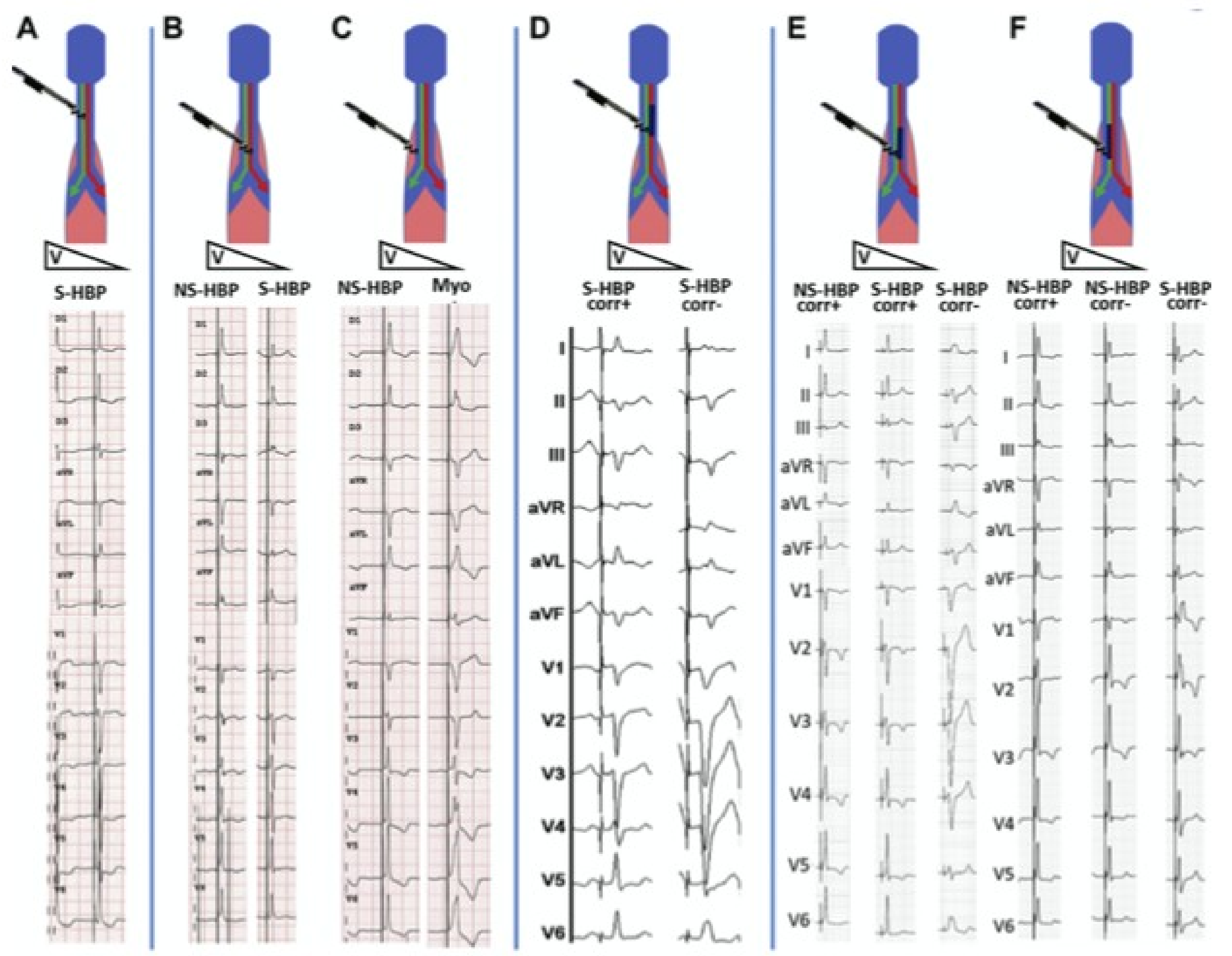
EHRA DOCUMENT

EHRA clinical consensus statement on conduction system pacing implantation: endorsed by the Asia Pacific Heart Rhythm Society (APHRS), Canadian Heart Rhythm Society (CHRS), and Latin American Heart Rhythm Society (LAHRS)

Haran Burri [1]*, Marek Jastrzebski[2], Óscar Cano[3,4], Karol Čurila[5], Jan de Pooter[6], Weijian Huang[7], Carsten Israel[8], Jacqueline Joza[9], Jorge Romero[10], Kevin Vernooy[11], Pugazhendhi Vijayaraman[12], Zachary Whinnett[13], and Francesco Zanon[14]

STIMOLAZIONE HISIANA

FIGURE 1 His Lead Position and Examples of Different Types of His Capture and Transitions in QRS Morphology With Decrementing Voltage Output



STIMOLAZIONE HISIANA

Outcomes of His-bundle pacing upgrade after long-term right ventricular pacing and/or pacing-induced cardiomyopathy: Insights into disease progression

Pugazhendhi Vijayaraman, MD, FHRS,* Bengt Herweg, MD, FHRS,†
Gopi Dandamudi, MD, FHRS,‡ Suneet Mittal, MD, FHRS,§ Advay G. Bhatt, MD,§
Lina Marcantoni, MD,¶ Angela Naperkowski, RN, CCDS, CEPS, FHRS,*
Parikshit S. Sharma, MD, MPH, FHRS,|| Francesco Zanon, MD, FESC¶

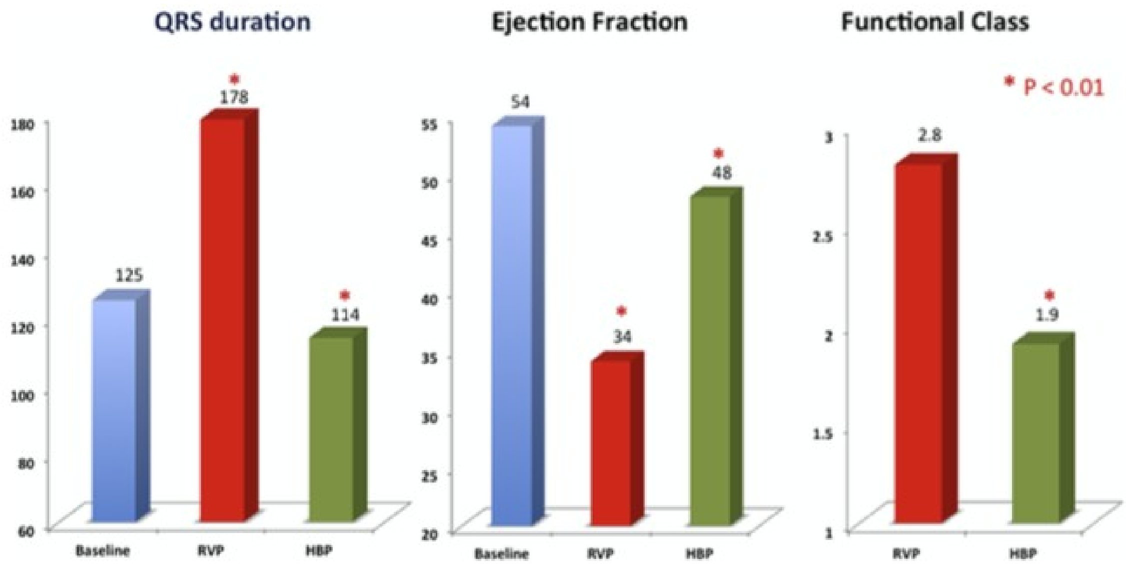
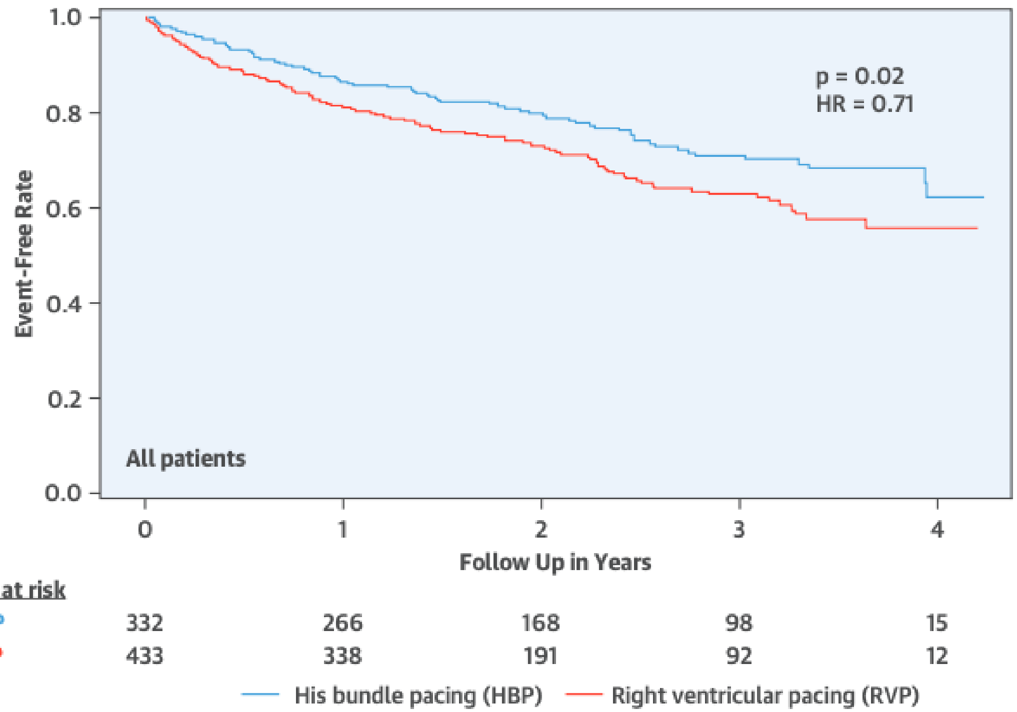


Figure 5 Pacing-induced cardiomyopathy. Changes in QRS duration, left ventricular ejection fraction, and New York Heart Association functional class after right ventricular pacing (RVP) and His-bundle pacing (HBP) in patients with pacing-induced cardiomyopathy are shown.

STIMOLAZIONE HISIANA

CENTRAL ILLUSTRATION **His Bundle Pacing and Outcomes: Kaplan-Meier Survival Curves and Analysis of the Primary Endpoint in All Patients**

Primary Outcome
(Death, Heart Failure Hospitalization, or Upgrade to Biventricular Pacing)



Abdelrahman, M. et al. J Am Coll Cardiol. 2018;71(20):2319-30.

Figure and analysis shows a statistically significant reduction in the primary endpoint (composite endpoint of all cause death, heart failure hospitalization, or upgrade to biventricular pacing) associated with HBP compared to RVP. HBP = His bundle pacing; HR = hazard ratio; RVP = Right ventricular pacing.

Abdelrahman M, Subzposh FA, Beer D, Durr B, Naperkowski A, Sun H, Oren JW, Dandamudi G, Vijayaraman P. Clinical Outcomes of His Bundle Pacing Compared to Right Ventricular Pacing. J Am Coll Cardiol. 2018 May 22;71(20):2319-2330. doi: 10.1016/j.jacc.2018.02.048. Epub 2018 Mar 10. PMID: 29535066.

STRATEGIES TO ADDRESS THE CHALLENGE OF NON-RESPONSIVENESS

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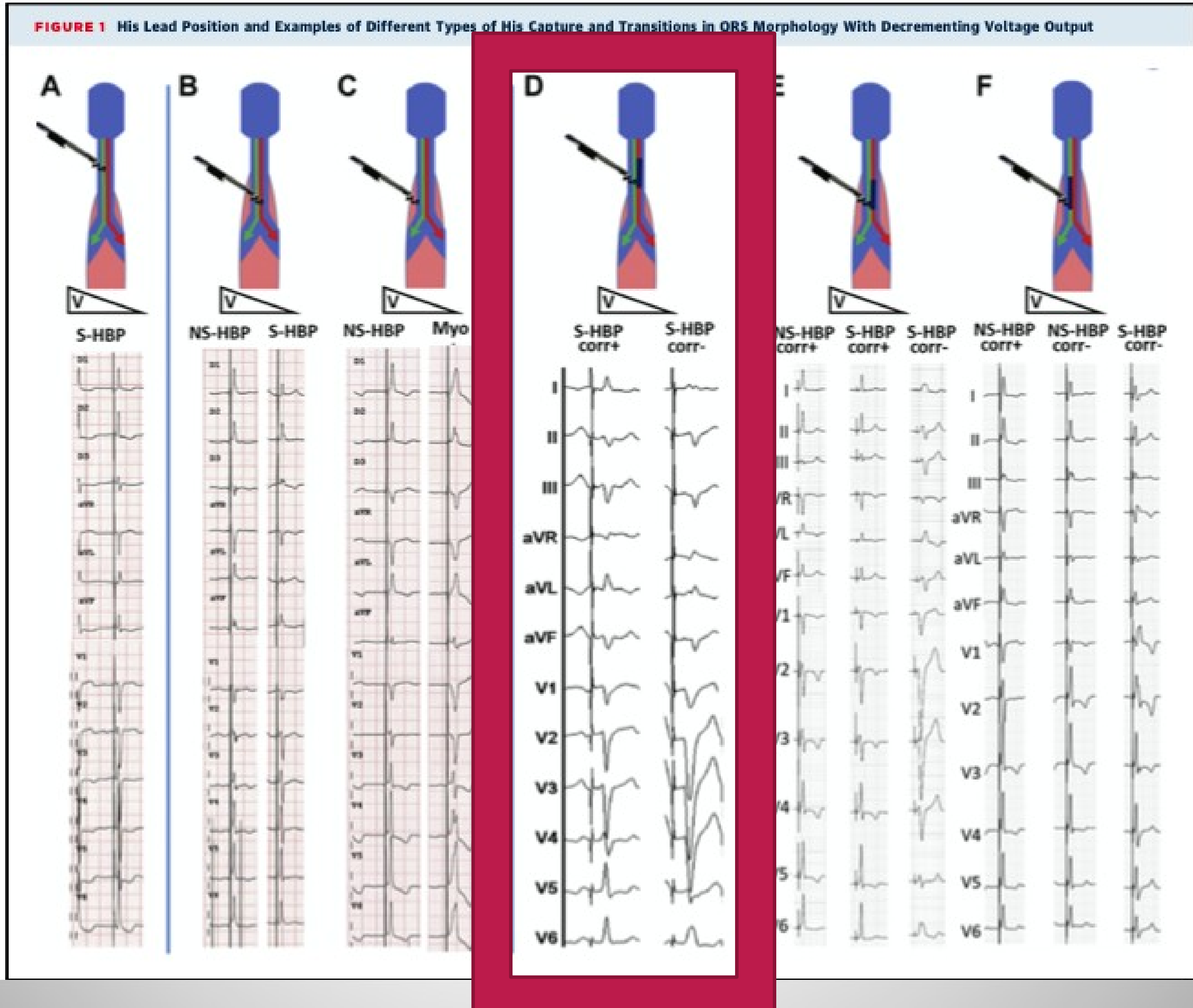
STIMOLAZIONE HISIANA



Circulation: Arrhythmia and Electrophysiology

ORIGINAL ARTICLE

His-Optimized Cardiac Resynchronization Therapy to Maximize Electrical Resynchronization

A Feasibility Study

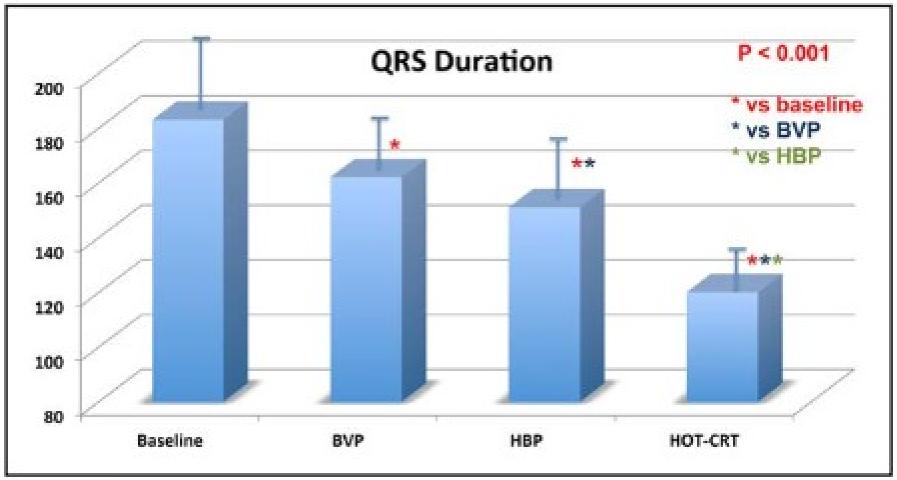


Figure 3. Electrical resynchronization and QRS duration with His-optimized cardiac resynchronization therapy (HOT-CRT).
The QRS duration incrementally decreased significantly during HOT-CRT compared with baseline, biventricular pacing, or HBP (*P*<0.001).

PROBLEMI DELLA STIMOLAZIONE HISIANA

- SOGLIA ELEVATA / INCREMENTO NEL TEMPO
- BASSA AMPIEZZA DELL'ONDA R (NON UTILIZZABILE COME CANALE DI SENSING VENTRICOLARE IN UN HOT-CRTD)
- PERSISTENZA DI DISTURBI DI CONDUZIONE DISTALI
- PACIND DI BACK UP IN VENTRICOLO DESTRO NEI PAZIENTI PM DIPENDENTI (AVANZAMENTO DEI DISTURBI DI CONDUZIONE DISTALI)

LEFT BUNDLE BRANCH AREA PACING

- Tecnicamente più semplice
- Sensing onda R
- No back up lead

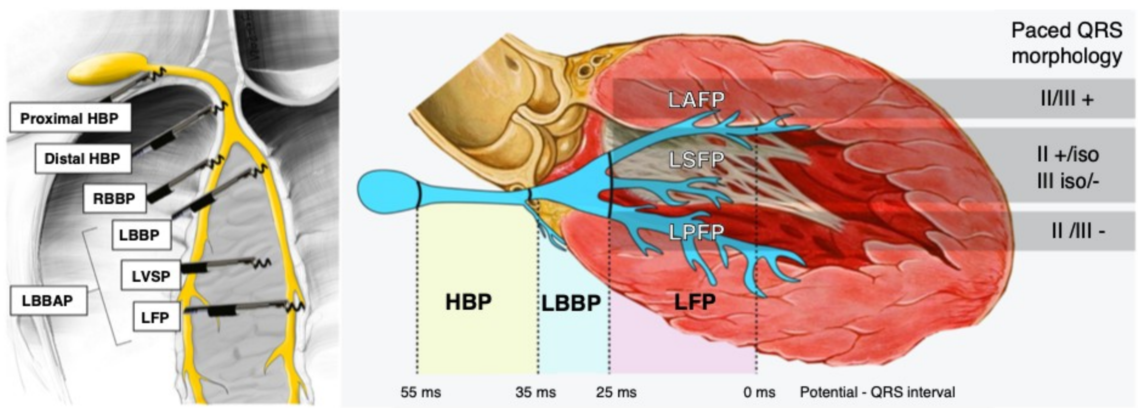


Figure 1 Categories of conduction system pacing. Anatomical position of the pacing lead, potential to QRS interval (if visualized), and paced QRS morphology in leads II and III are used to determine the level of CSP. RBBP and LVSP are not shown on the right panel. HBP = His bundle pacing; iso = isoelectric; LAFP = left anterior fascicle pacing; LBBAP = left bundle branch area pacing; LBBP = left bundle branch pacing; LFP = left fascicular pacing; LPFP = left posterior fascicle pacing; LSFP = left septal fascicle pacing; LVSP = left ventricular septal pacing; RBBP = right bundle branch pacing. Modified with permission from Filip Plesinger and from Jastrzebski *et al.*[7]

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European Heart Journal (2022) **43**, 4161–4173
https://doi.org/10.1093/eurheartj/ehac445

CLINICAL RESEARCH
Arrhythmias

Left bundle branch area pacing outcomes: the multicentre European MELOS study

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Complications attributed to the transseptal route of the pacing lead	
Intraprocedural perforation into the LV cavity	93 (3.67%)
Delayed perforation into the LV cavity	2 (0.08%)
Acute chest pain	25 (0.98%)
Acute ST-segment elevation in multiple leads	6 (0.24%)
Acute coronary syndrome [c]	11 (0.43%)
Coronary vein fistula	7 (0.28%)
Coronary artery fistula	2 (0.08%)
Painful pacing/chest pain	4 (0.16%)
LBBAP lead unscrewable/trapped/damaged helix	11 (0.43%)
LBBAP lead dislodgement	38 (1.5%)
Threshold rise to an absolute value > 2 V	17 (0.67%)
Threshold rise > 1 V from baseline	18 (0.71%)
Threshold rise leading to re-intervention	4 (0.16%)
Stroke/TIA	0 (0)
Summary	209 (8.25%)

Cardiac resynchronization therapy via left bundle branch pacing vs. optimized biventricular pacing with adaptive algorithm in heart failure with left bundle branch block: a prospective, multi-centre, observational study

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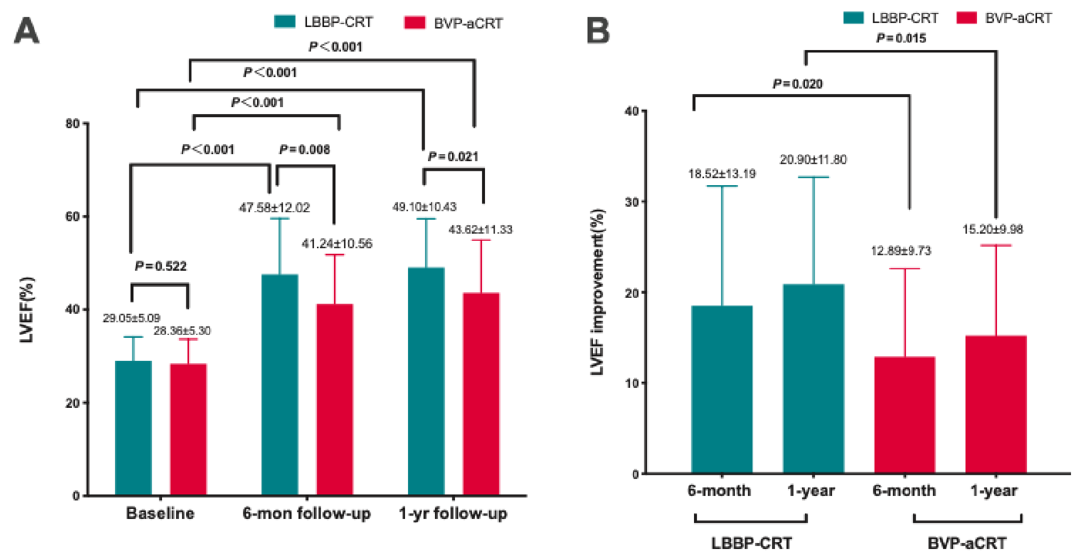


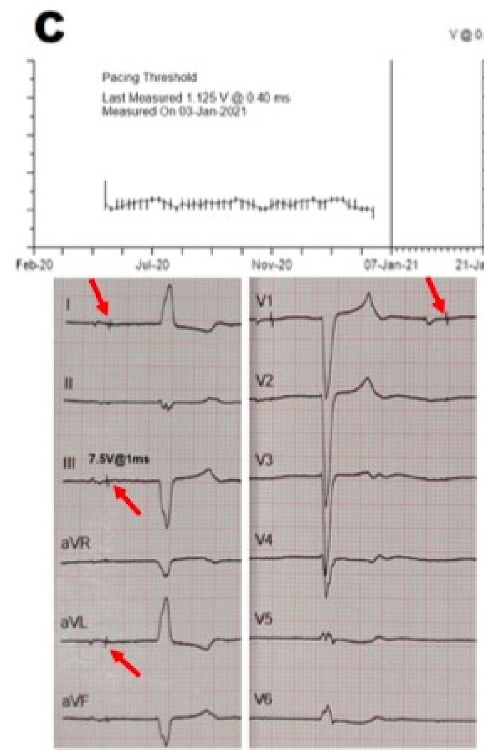
Table 5 Advantages and limitations of HBP and of LBBAP

HBP	LBBAP
Advantages	*Advantages*
Maximum electrical synchrony	Large target area
Endpoints well-defined for successful His capture	Correction of more distal conduction disease
Extractability has been demonstrated	Low capture thresholds
Relatively good mid-term evidence for safety and efficacy	Good sensing parameters
Avoids crossing the tricuspid valve when implanted on the atrial aspect of the annulus)	Consistent back-up myocardial capture (in addition by anodal capture by the ring electrode)
Some evidence of medium and long-term lead extraction[115,116]	No requirement for back-up pacing leads
	AV nodal ablation without risk of compromising lead function
Disadvantages/limitations	*Disadvantages/limitations*
Small target area	Conduction tissue capture may be difficult to demonstrate in some cases
Capture thresholds may be high	Requirement of digital callipers (i.e. electrophysiology recording system) for measuring parameters of conduction system capture
Sensing issues (atrial and His oversensing, ventricular undersensing)	Less electrical synchrony compared to HBP, especially in patients with normal baseline QRS
Limited to correction of proximal conduction block only	Complications specific to transseptal route (septal perforation, lesions to coronary vessels, septal hematoma, etc.)
Risk if distal conduction block develops over follow-up	Tricuspid regurgitation[53,62,63]
High (up to 11%[97]) requirement for lead revision	May be challenging in patients with septal scar
Back-up ventricular leads may be indicated in specific situations	Limited (but growing) evidence for safety and efficacy
Complex programming in case of back-up leads	Long-term extractability needs to be demonstrated
Risk of compromising lead function with AV node ablation[32,33,117]	

Figure 29 Micro-perforation of a 3830 lead in the LBB position with intact electrical parameters. No re-positioning was attempted, and there were no clinical sequelae.

LBBAP: PERFORATION IN LV CAVITY

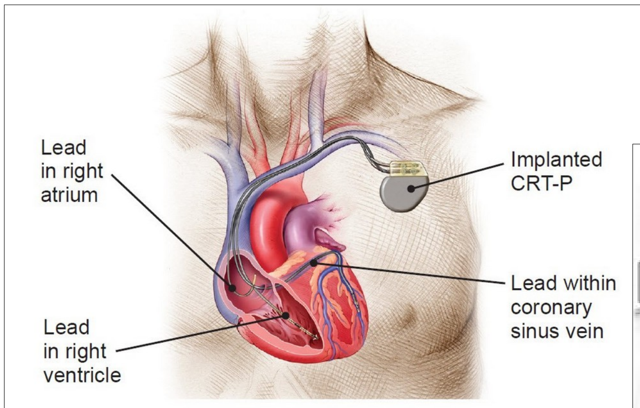
HIS PACING: LOSS OF CAPTURE AT FU

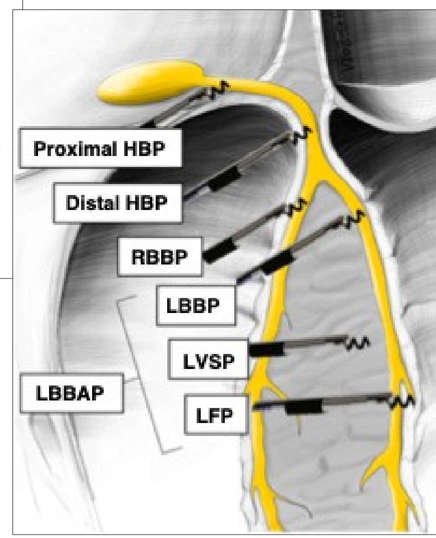


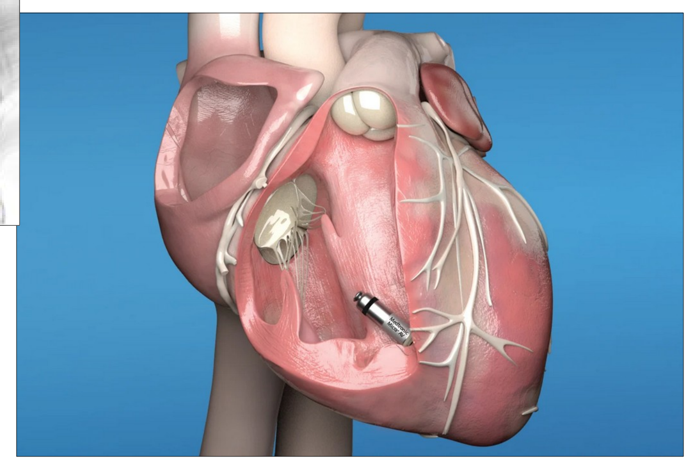
Piemontese GP, Toniolo S, Biffi M, Capobianco C, Bartoli L, Sorrentino S, Minguzzi A, Angeletti A, Statuto G, Ziacchi M, Martignani C, Massaro G, Diemberger I, Spadotto A. Bridging the future of cardiac stimulation: physiologic or leadless pacing? Rev Cardiovasc Med. 2022 Mar 17;23(3):107. doi: 10.31083/j.rcm2303107. PMID: 35345274.

CONCLUSIONE

AVENDO BISOGNO DI UN PACEMAKER, VOI COSA SCEGLIERESTE?







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