Funzionamento di PM e ICD

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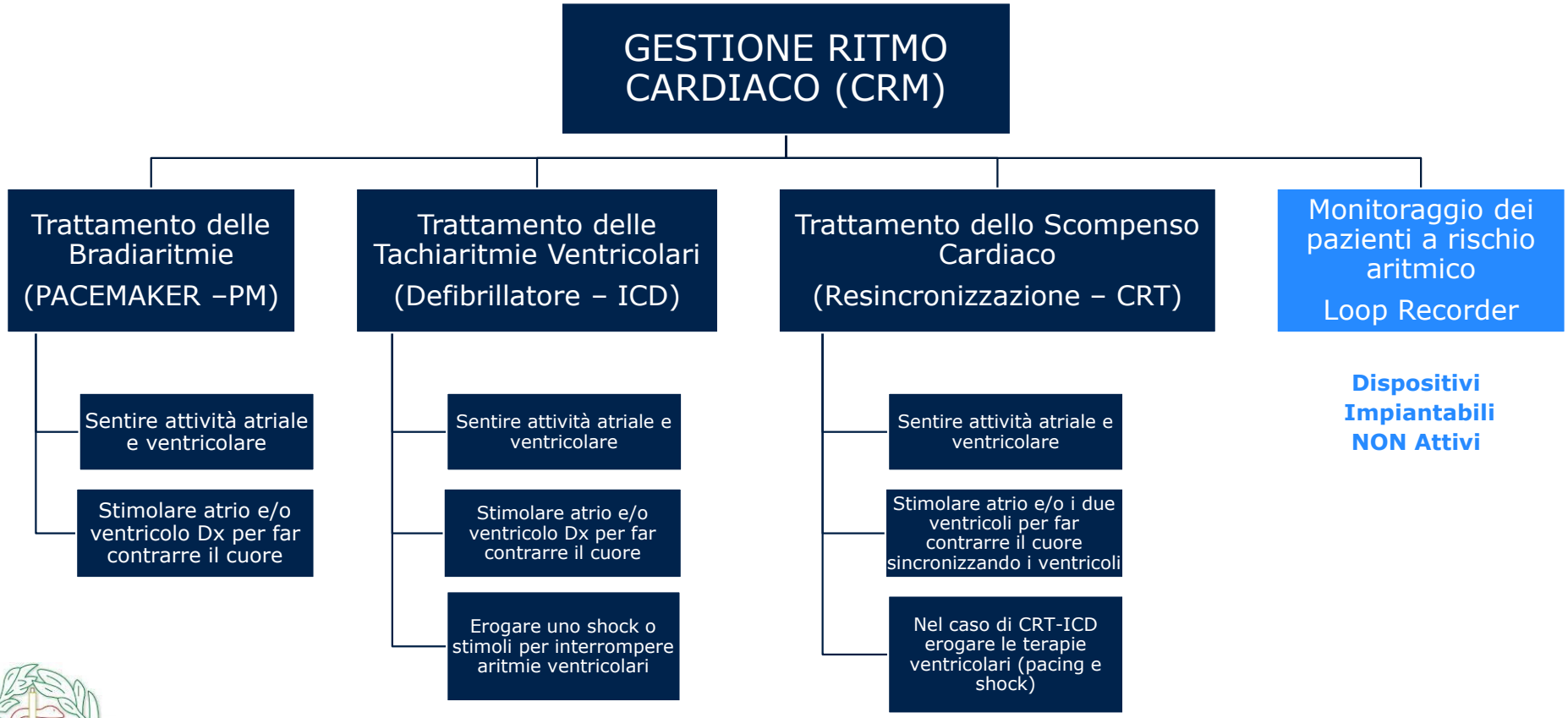
Elettrostimolazione (gestione del ritmo cardiaco)



Dispositivi Impiantabili NON Attivi

Dispositivi Impiantabili Attivi

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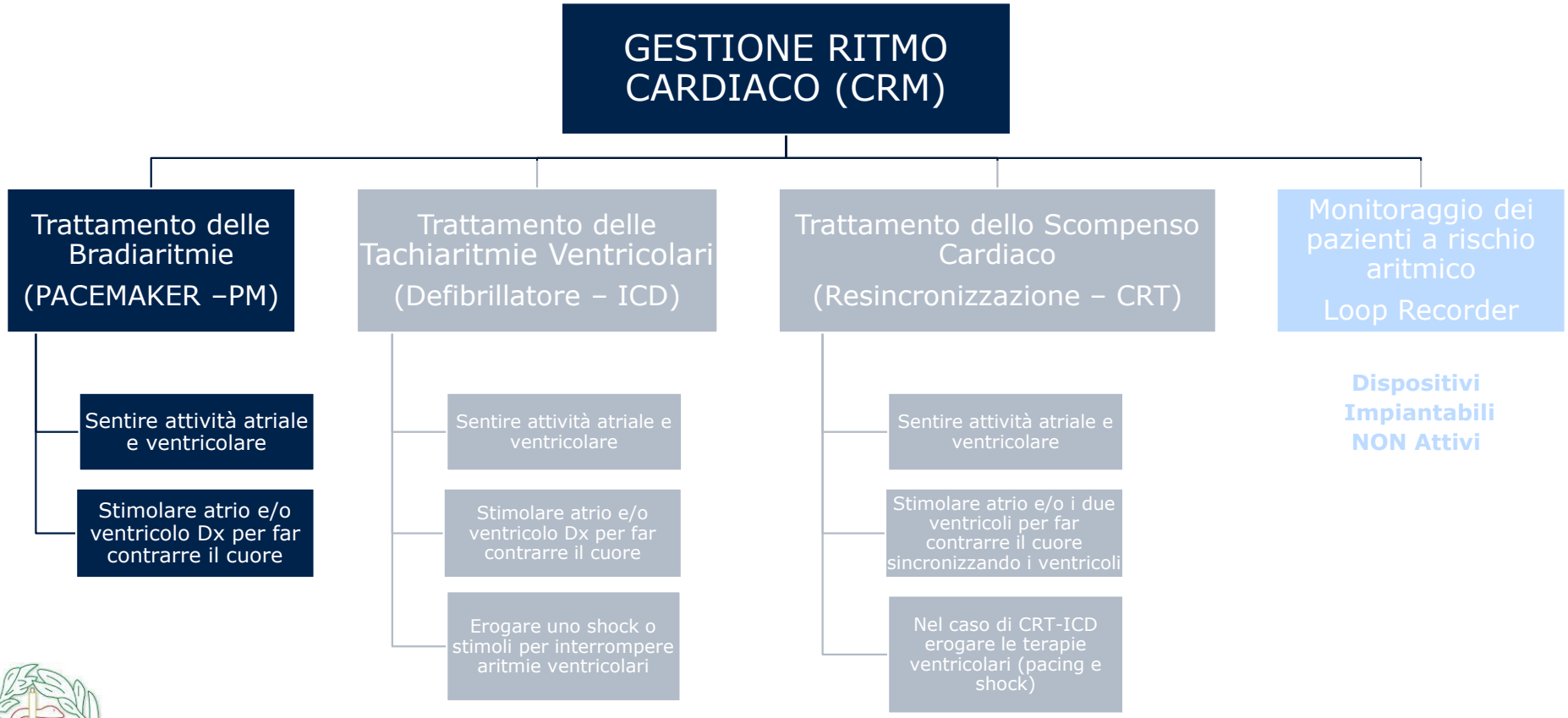

Dispositivi Impiantabili Attivi

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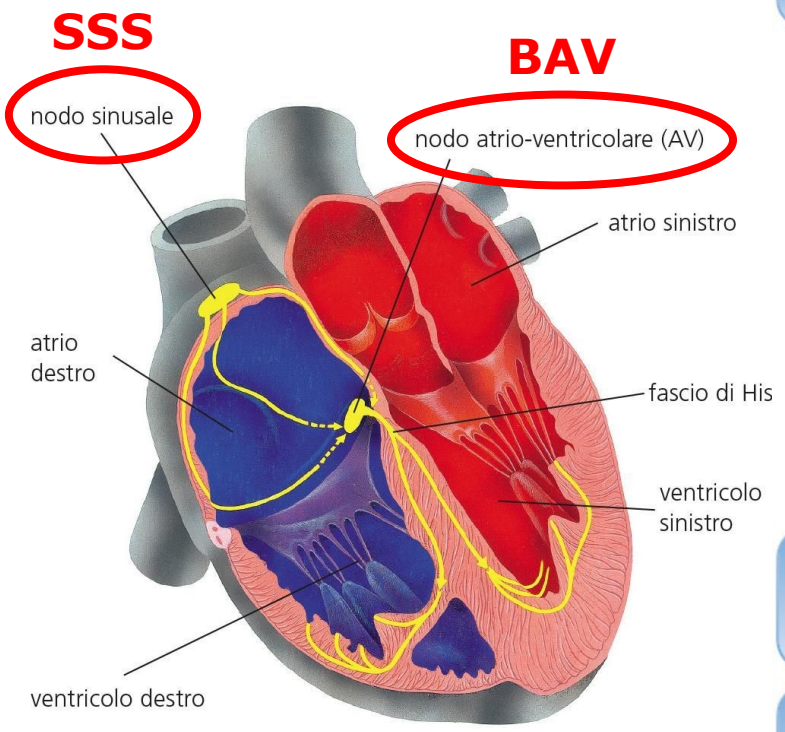
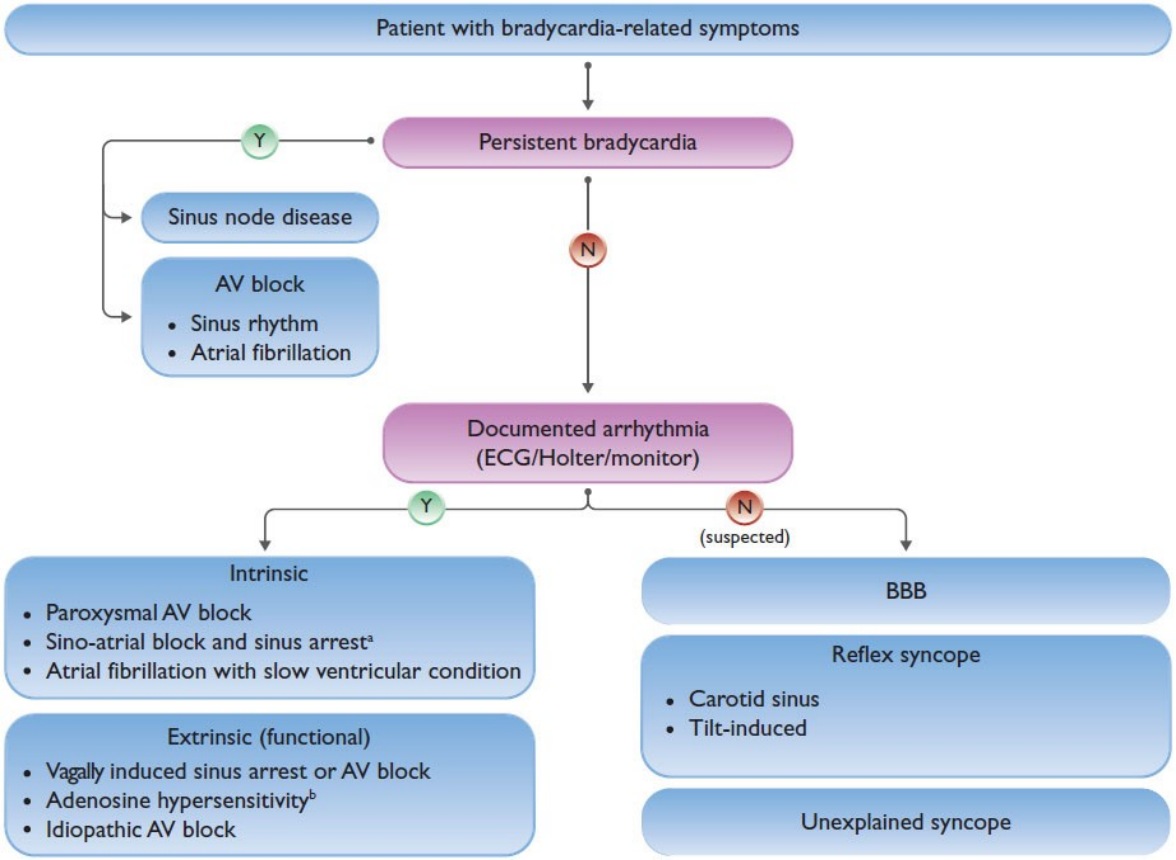
Sistema di conduzione cardiaco e bradiaritmie





Alterazioni del sistema di conduzione -> **bradiaritmie** -> **persistenti** o **parossistiche** -> **sintomatiche** o meno

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Funzionamento dei PM

Principi fondamentali, tipi di dispositivi, funzioni, elettrocateteri, connettori, parametri elettrici e soglie

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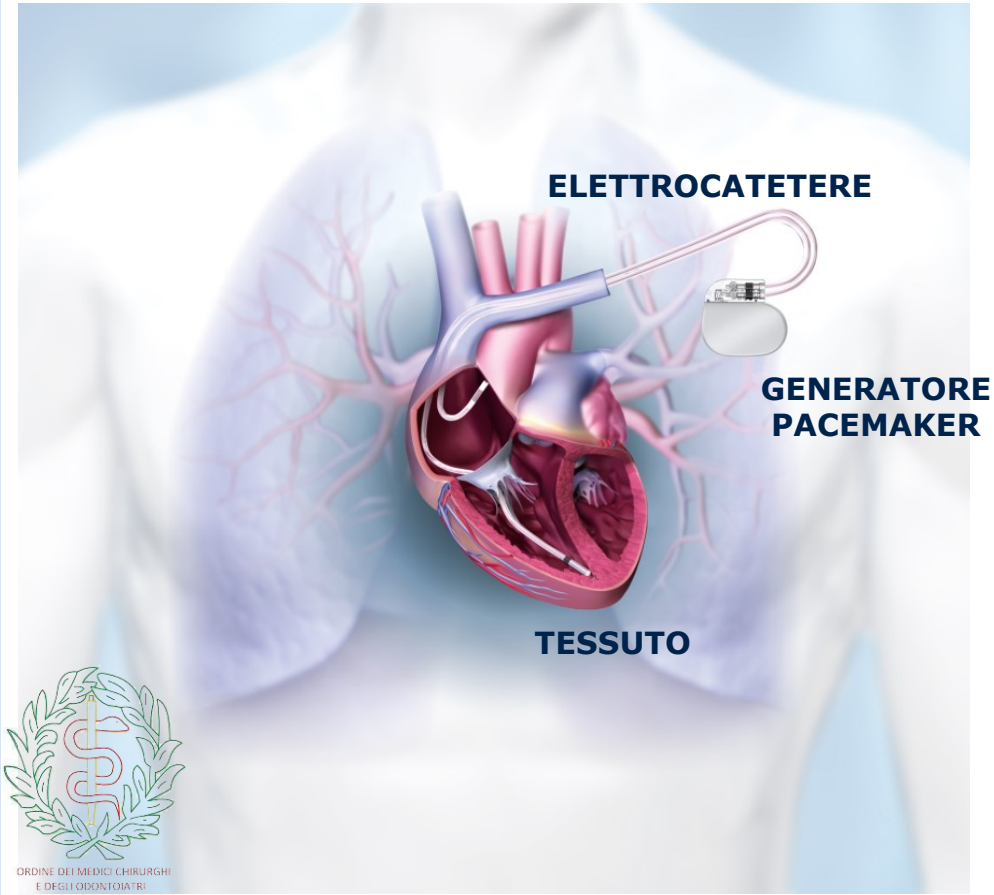
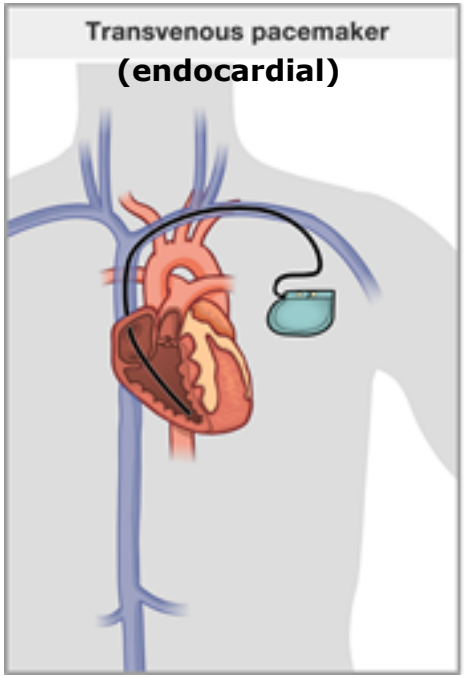
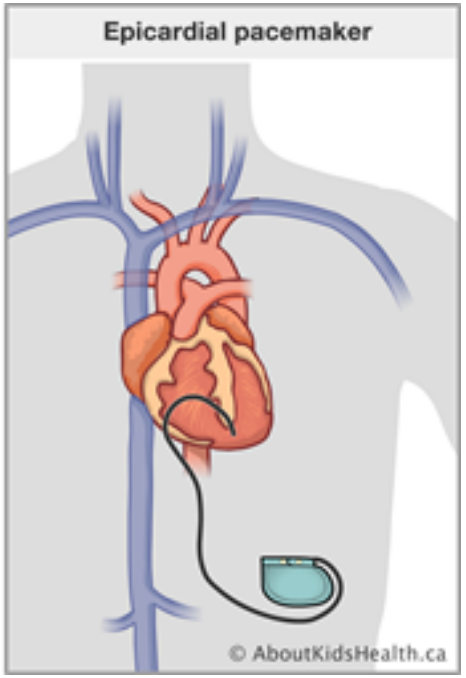
Basi della Stimolazione Cardiaca

- PRINCIPIO = **impulso elettrico -> depolarizzazione -> contrazione muscolare**
- **Elettrocatetere (EC)** posto all'interno (**TRANSVENOSO**) o all'esterno (**EPICARDICO**) della camera cardiaca, se collegato ad una **batteria (generatore di impulsi)**, può condurre l'impulso elettrico dalla batteria al cuore e generare una contrazione cardiaca.







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Generatore di impulsi – Pacemaker (PM)

- Dispositivo elettronico ricoperto

  da **cassa in titanio**

- Può connettersi a **1-3 elettrocateteri**

- **Programmabile**

- **4 funzioni principali**

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Funzioni di un PM

STIMOLARE
Il cuore in modo efficace, garantendo la depolarizzazione cardiaca in ogni condizione fisiologica
(**PACING**)

RILEVARE
L'attività elettrica spontanea del cuore, evitando stimolazioni inutili o pericolose
(**SENSING**)

RISPONDERE
Ad ogni stress neurovegetativo aumentando o diminuendo la frequenza di stimolazione, quando il cuore non è in grado di modularla
(**RATE RESPONSE, –R**)

FORNIRE INFORMAZIONI
Sul funzionamento spontaneo del cuore e sull'attività svolta dal pacemaker, individuando eventuali aritmie presenti e anomalie del sistema
(**DIAGNOSTICA**)

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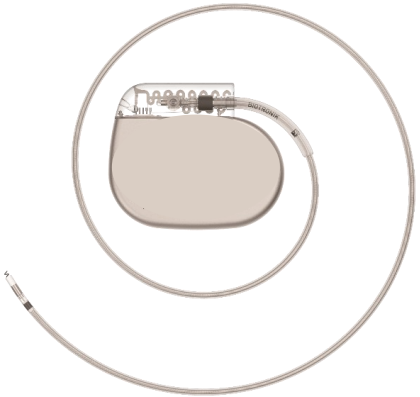
Tipi di PM

MONOCAMERALE

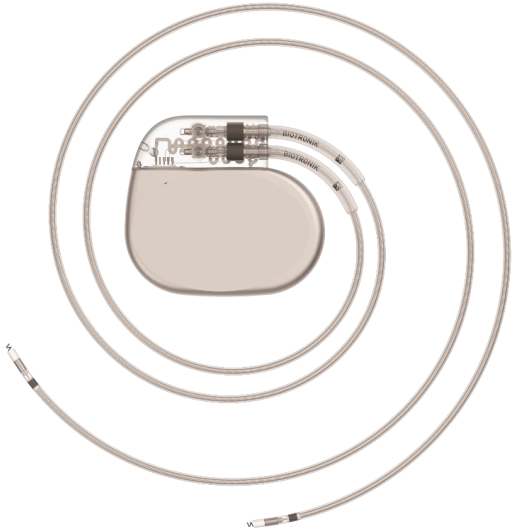
In grado di collegare 1 solo catetere e stimolare o sentire una sola camera cardiaca (atrio o ventricolo destro)



Nella pratica clinica:
Monocamerale **Ventricolare dx**
Se paziente in **fibrillazione atriale permanente**
VVI(R)

BICAMERALE

In grado di collegare 2 cateteri e stimolare o sentire sia la camera atriale che ventricolare destra



Nella pratica clinica:
Bicamerale (**atrio dx + ventricolo dx**)
Se paziente **NON** in fibrillazione atriale permanente
(quindi anche se FA parossistica)
DDD(R)

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Modalità di stimolazione

Codice Internazionale

D	D	D	R
D = Atrio e Ventricolo S = Atrio o Ventricolo A = Atrio V = Ventricolo 0 = Nessuna	D = Atrio e Ventricolo S = Atrio o Ventricolo A = Atrio V = Ventricolo 0 = Nessuna	D = Inibito e Triggherato I = Inibito T = Triggherato 0 = Nessuna	R = Risposta in Frequenza
Camere Stimolate	**Camere Sentite**	**Modalità di Risposta al Sensing**	**Capacità di Modulare la Frequenza di Stimolazione**

1. **DDD(R)** = bicamerale
2. **VVI(R)** = monocamerale ventricolare
3. **AAI(R)** = monocamerale atriale (in disuso)

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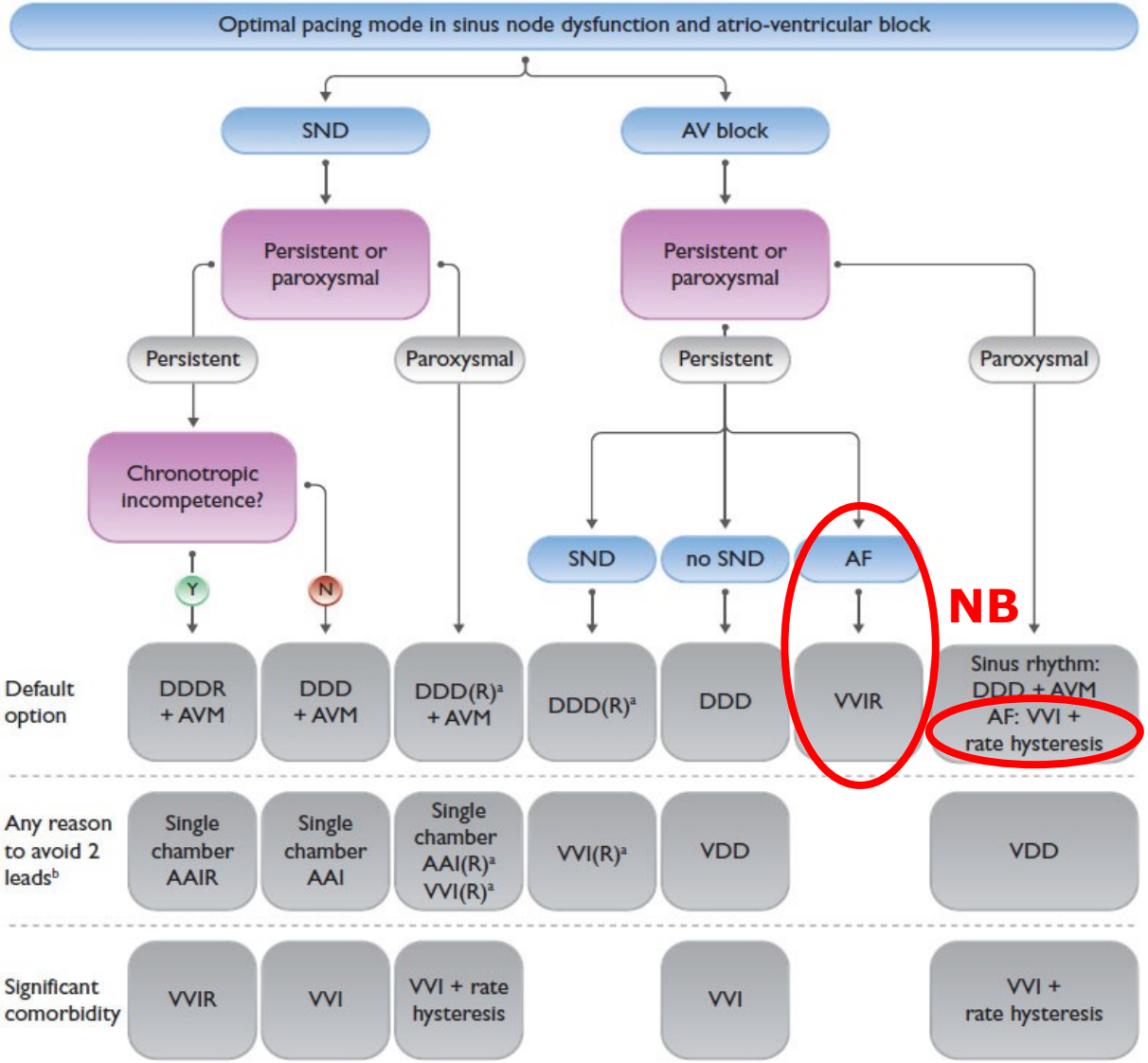
Modalità di pacing ottimale



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DDD vs VVI pacing

Outcome	Advantage with dual-chamber vs. ventricular pacing	Notes
All-cause death[18–23]	No advantage **NB**	-
Stroke, embolism[18–23]	Advantage in meta-analysis only, not in single trials	20% risk reduction Higher advantage in SND
Atrial fibrillation[18–23]	Advantage	Around 20% risk reduction Higher advantage in SND
HF, hospitalization for HF[18–22]	No advantage **NB**	-
Exercise capacity[18,19]	Advantage	Overall mean improvement of 35% Non-significant compared to VVIR
Pacemaker syndrome[18,19,22,23]	Advantage	May occur in up to 25% of patients with a VVI pacemaker
Functional status[18,19,21,22]	No advantage	-
Quality of life[18,19,21–23]	Variable	-
Complications[18-23]	More complications with dual-chamber	Higher rate of lead dislodgment (4.25% vs. 1.4%) and inadequate pacing (1.3% vs. 0.3%).

NB

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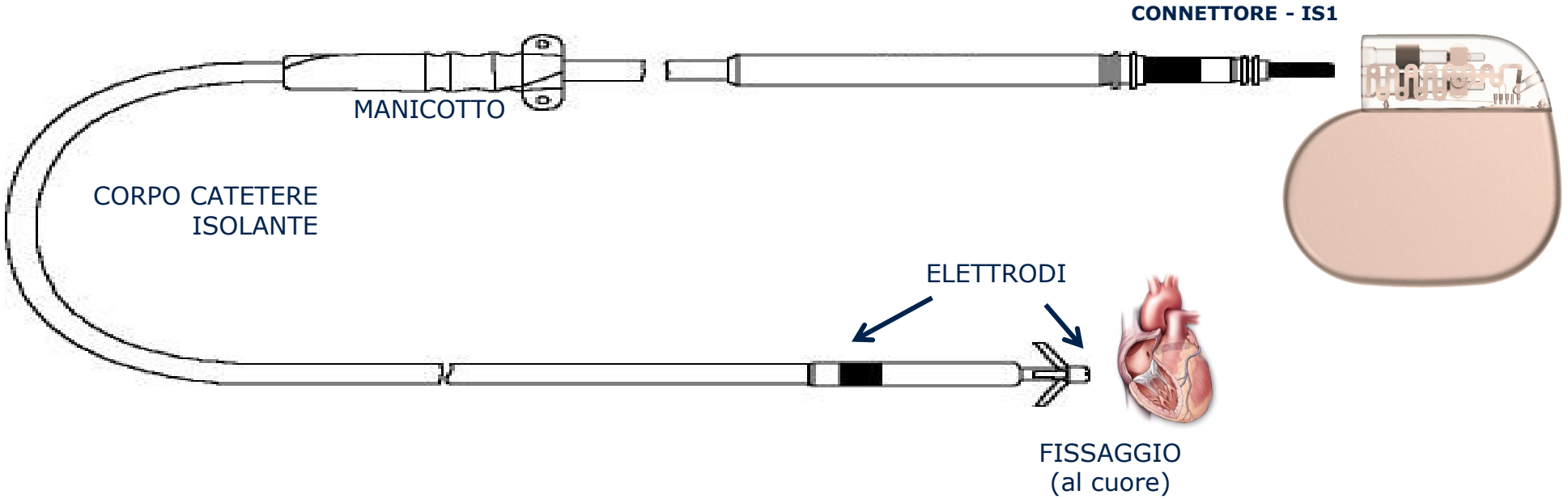
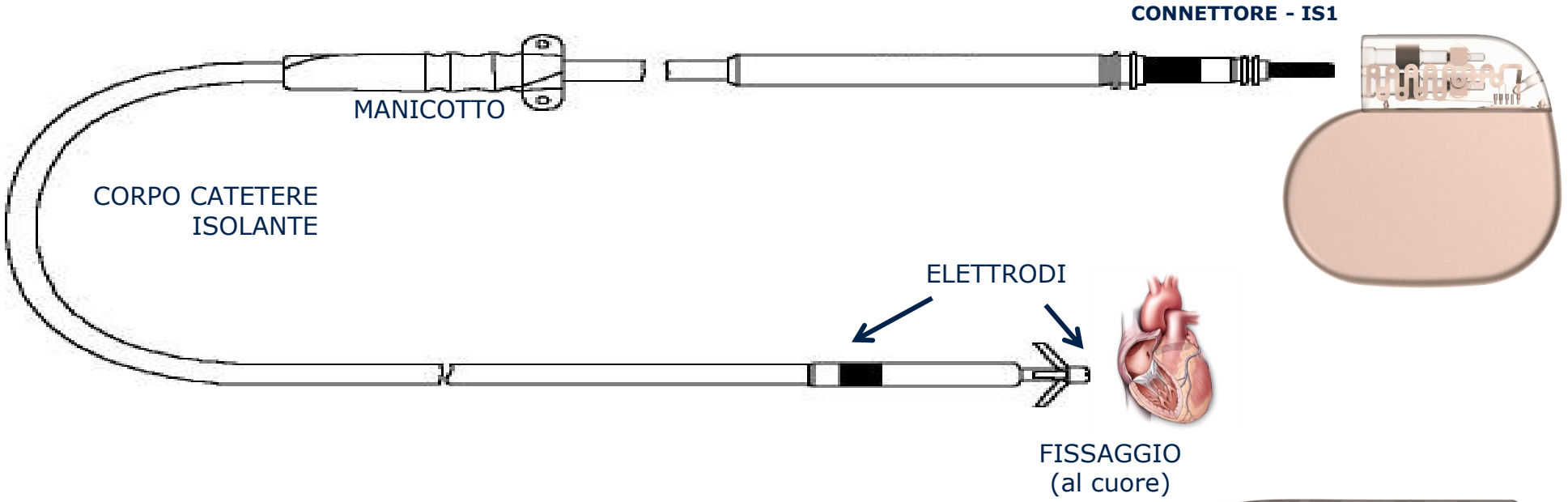
Caratteristiche elettrocateteri

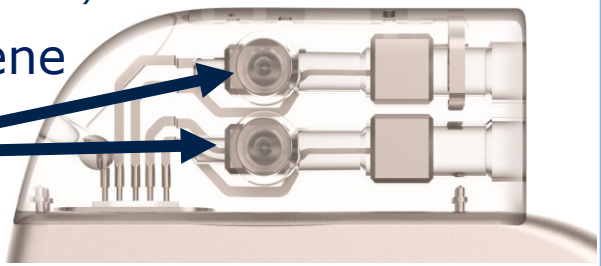


- **Sostituzione PM** = sostituzione del **solo generatore**
- **Estrazione elettrocateteri** = procedura **complessa**
- **Fondamentale impiantare elettrocateteri** nel **miglior modo possibile** (teoricamente restano in sede "a vita")

Connettore IS-1



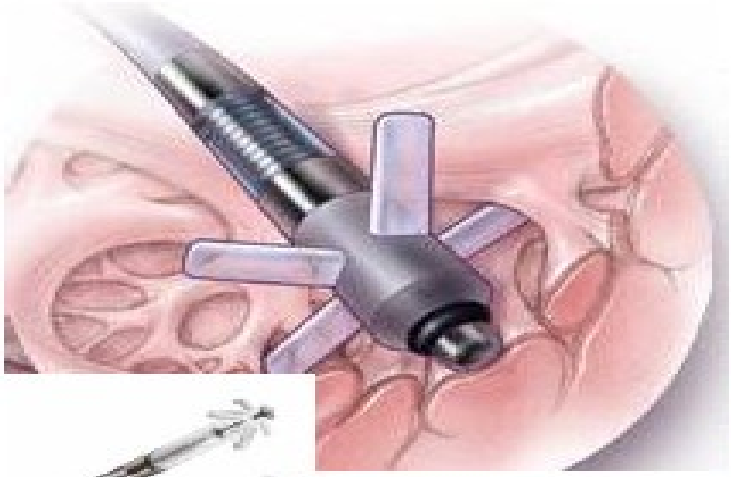
- **CONNETTORE** = "spinotto" prossimale che viene inserito dentro il PM e avvitato con **VITI**



- Ogni **elettrodo** -> un **contatto** sul connettore
- Elettrocateteri odierni = **BIPOLARI** (Standard **IS-1**)

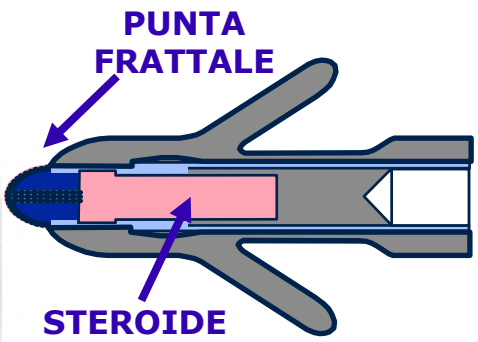
  2 elettrodi: uno in **punta** + un **anello** a circa 1 cm

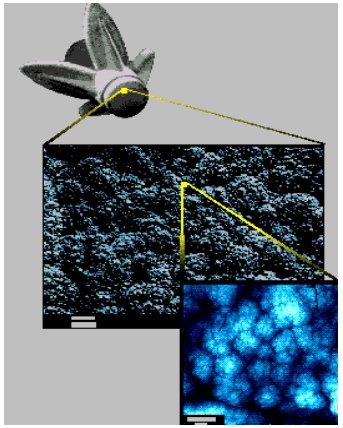
Elettrocatetere: fissaggio e forme



Fissaggio **PASSIVO = BARBE**

Fissaggio **ATTIVO = VITE**





Mandrini o stiletti

Dritto Ventricolare

Pre-Formato a J Atriale

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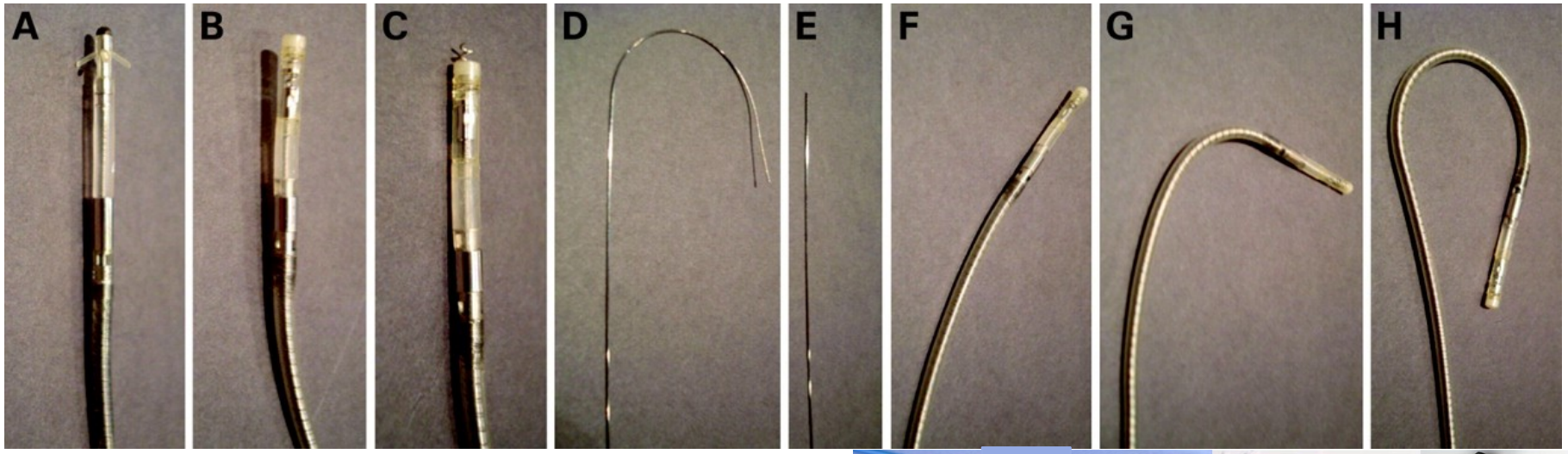
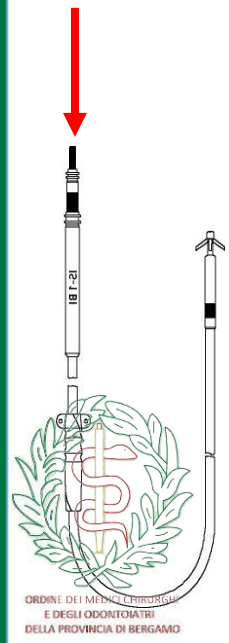
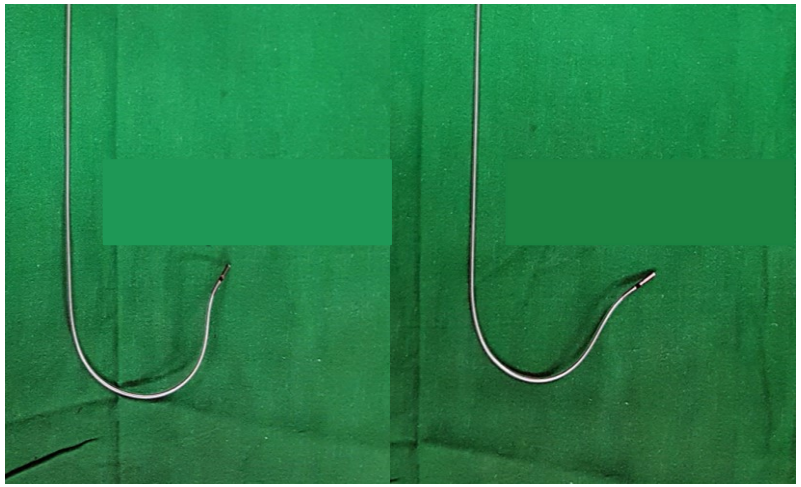
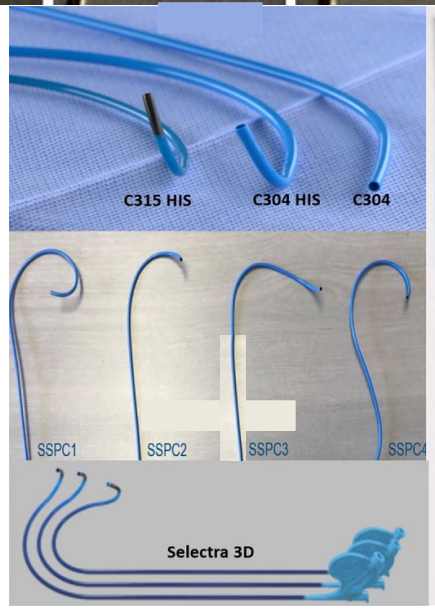
Elettrocatetere: stiletti e delivery









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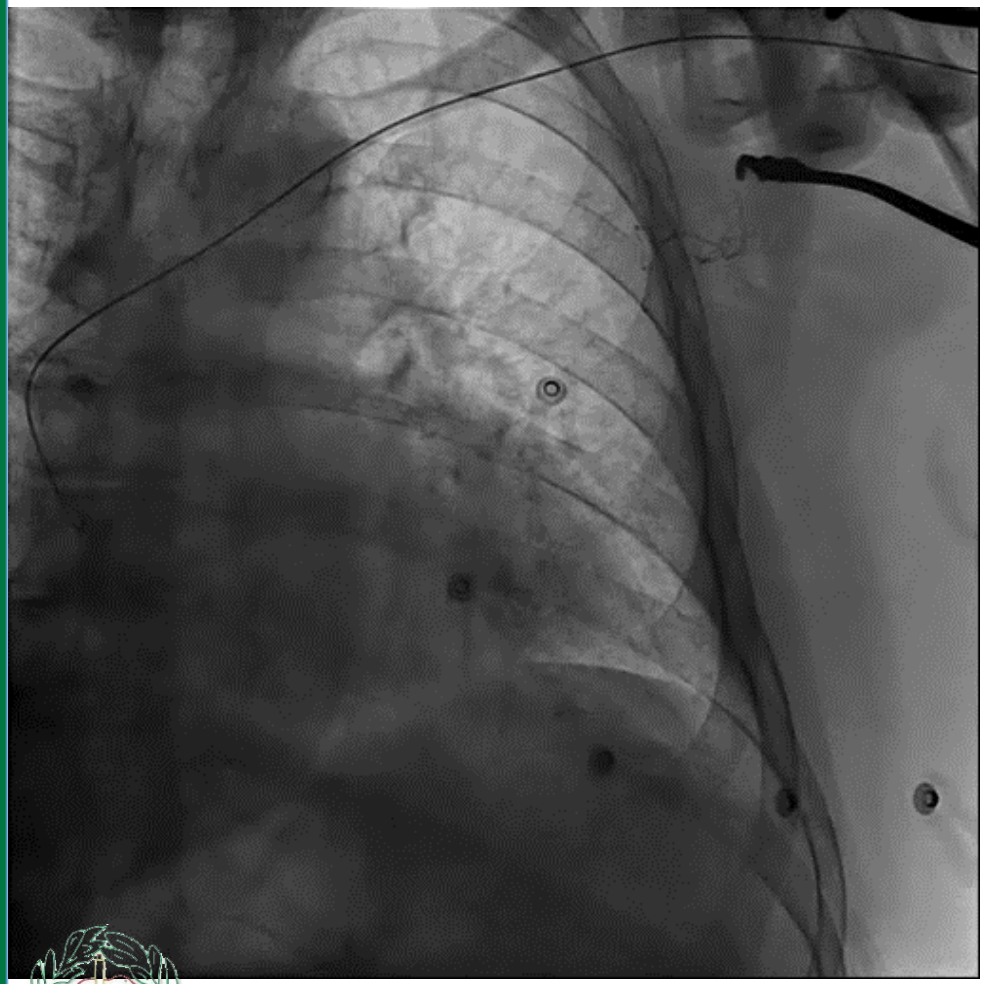
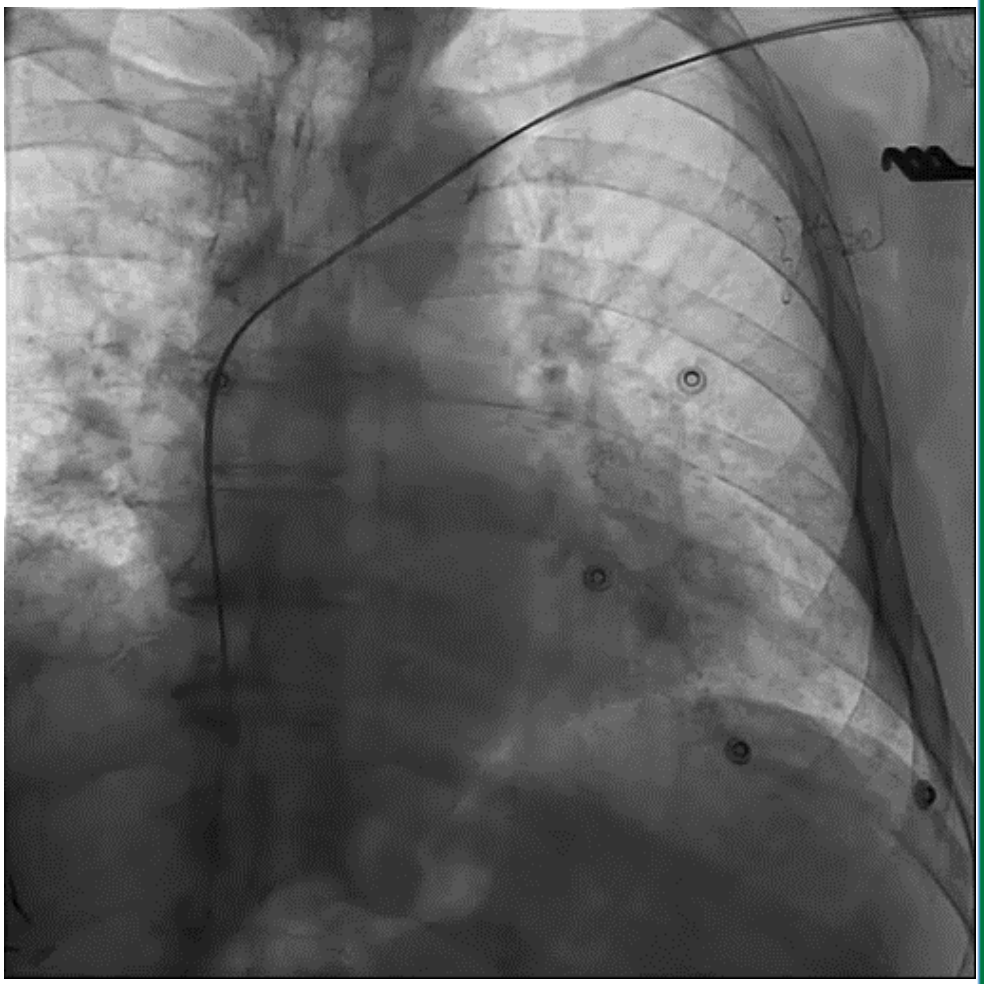
Rajappan K. Permanent pacemaker implantation technique: Part II. Heart. 2009;**95**(4):334-342.
Ravi V, et al. His bundle pacing: Tips and tricks. Pacing Clin. Electrophysiol. 2021;**44**, 26–34

howtopace.com

Accesso venoso: vena cefalica sx





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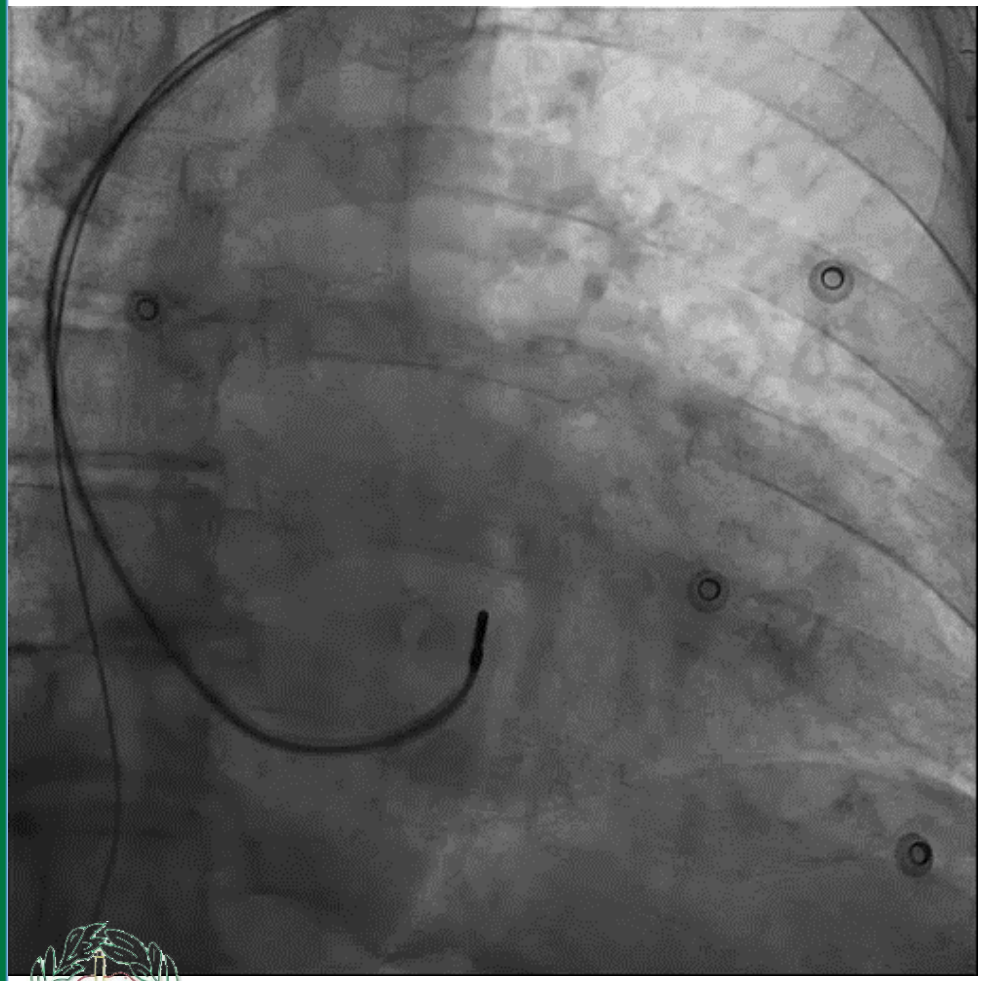
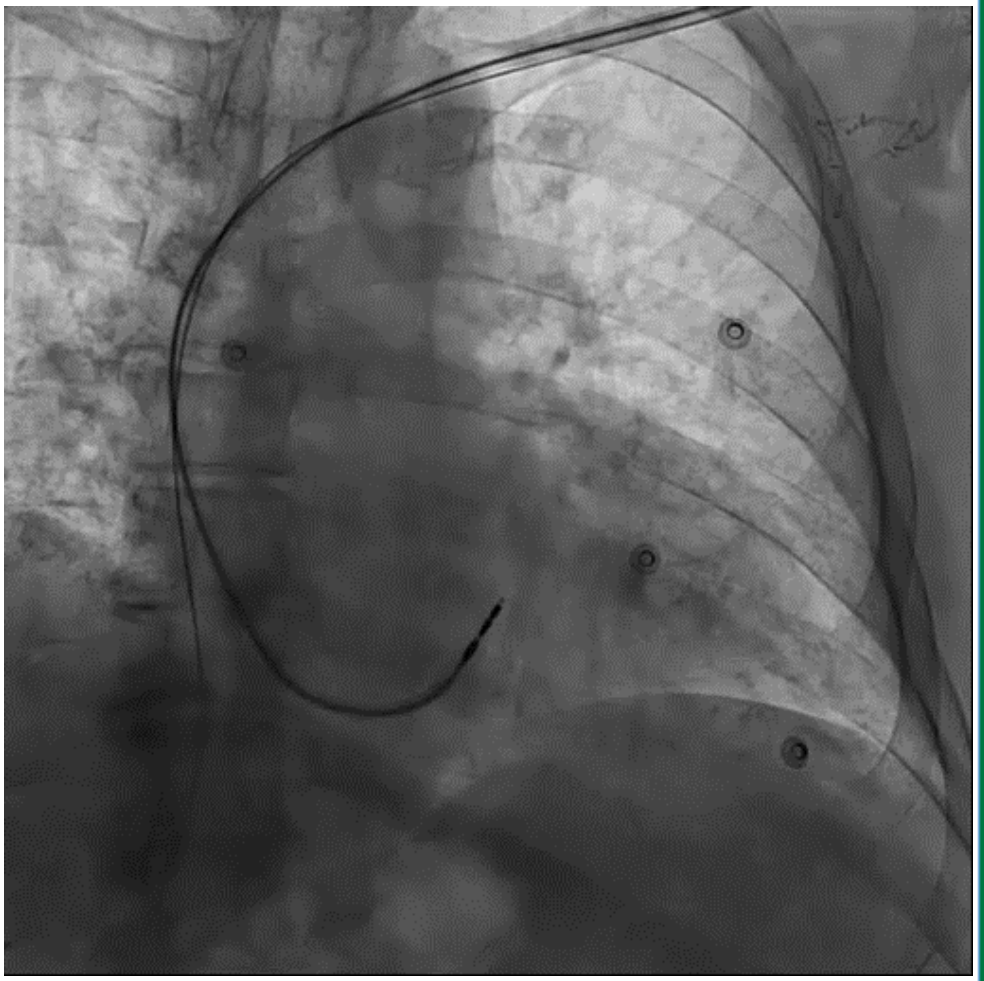
Posizionamento EC Hissiano





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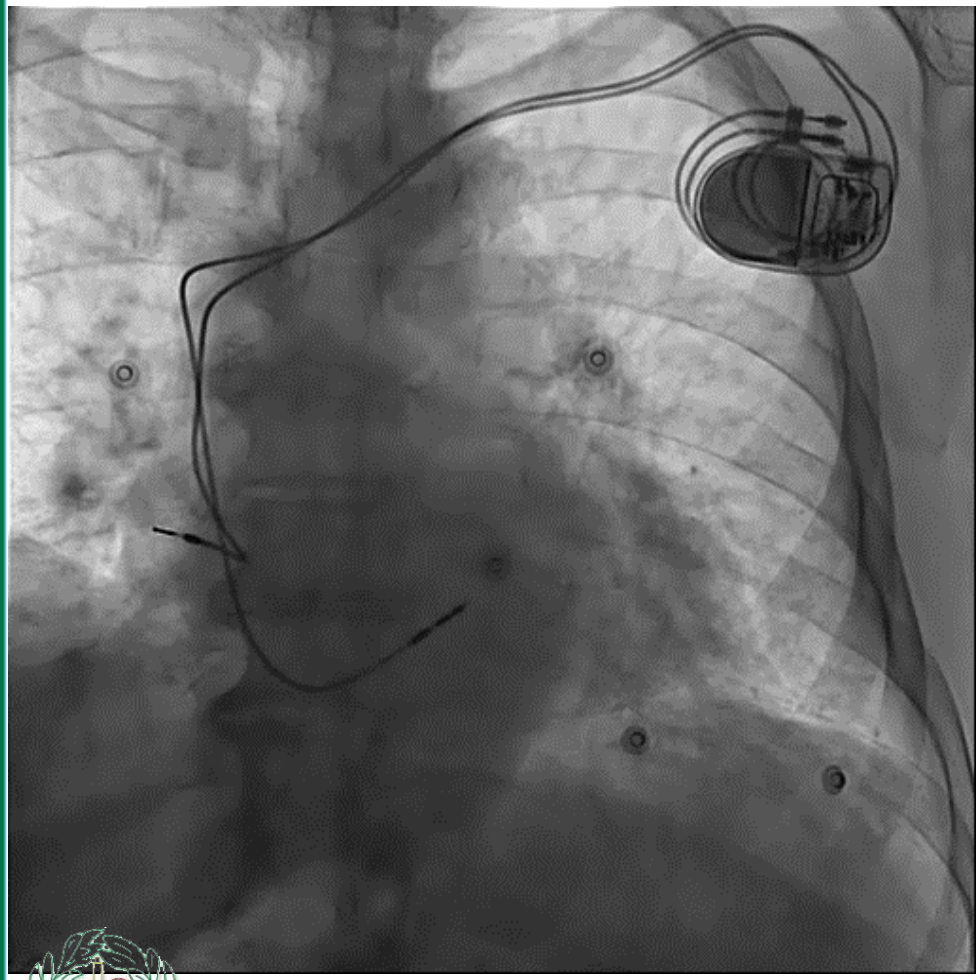
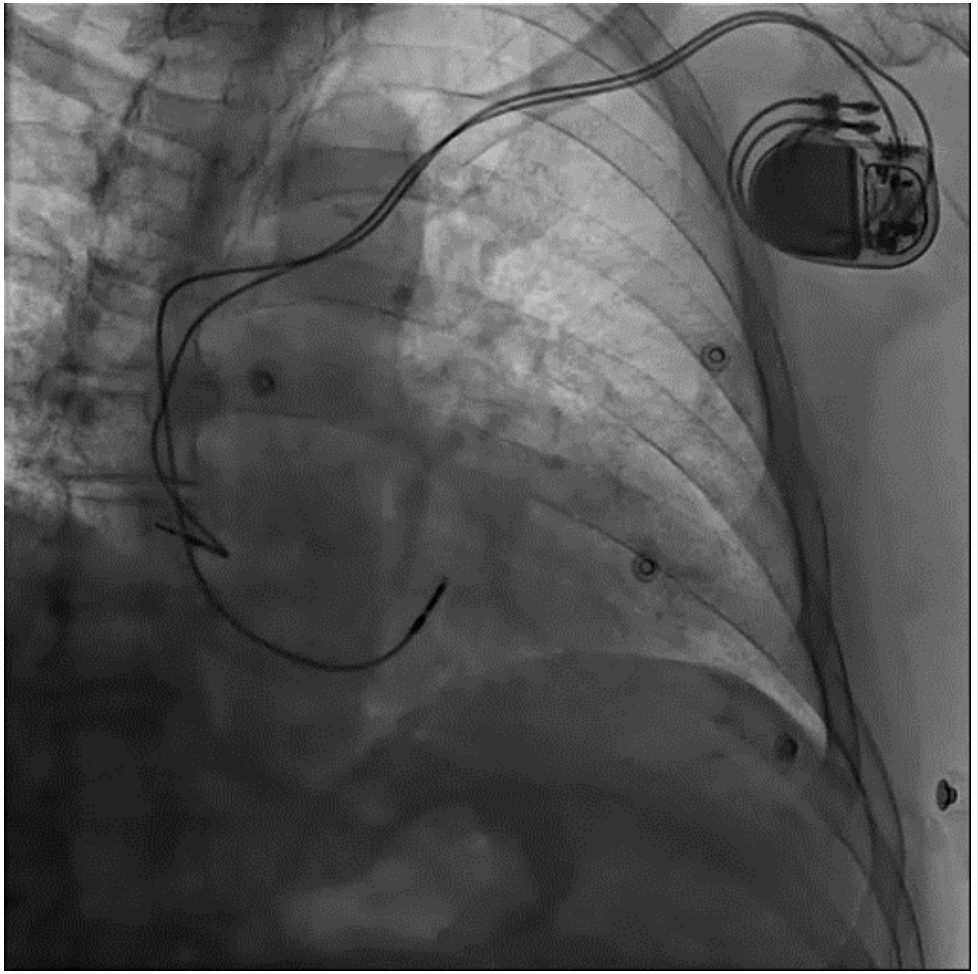
Posizione finale del PM





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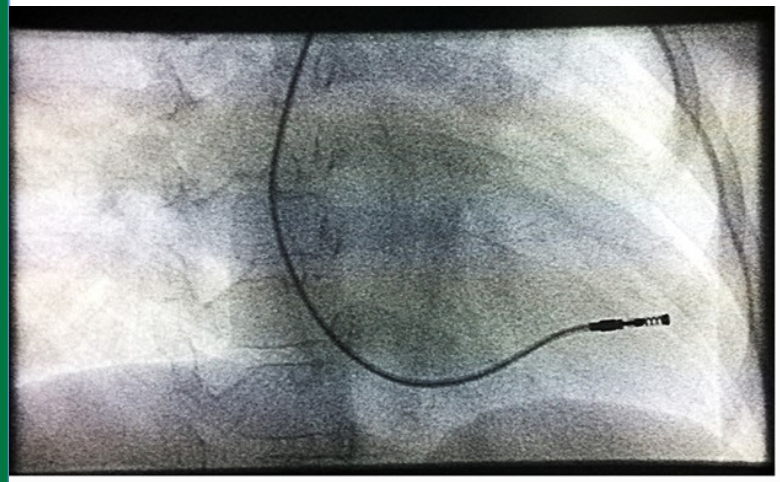
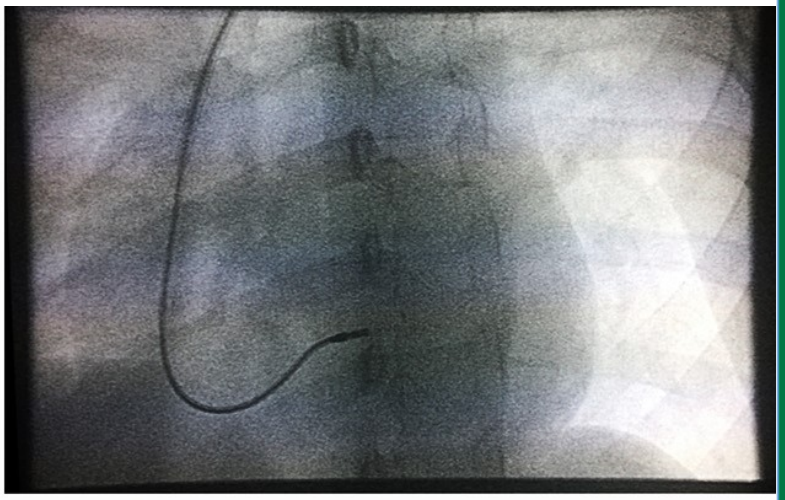
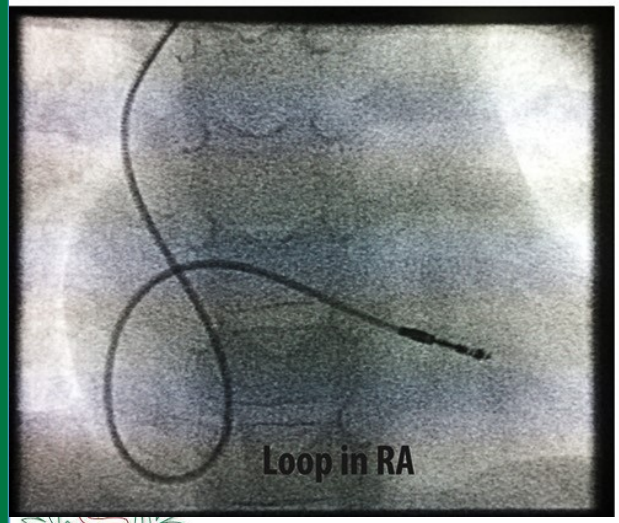
Posizionamento EC in pz pediatrici



RAO 30

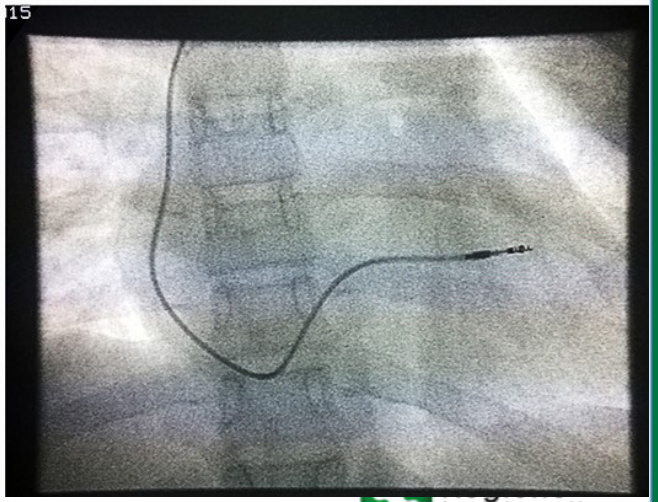
LAO 40





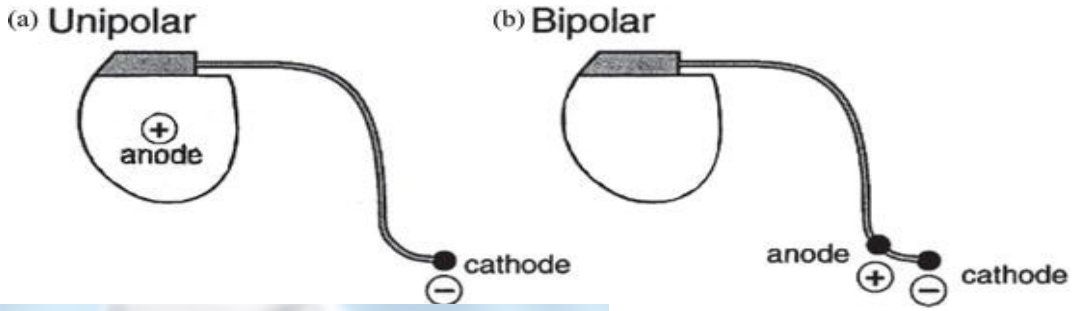
AP

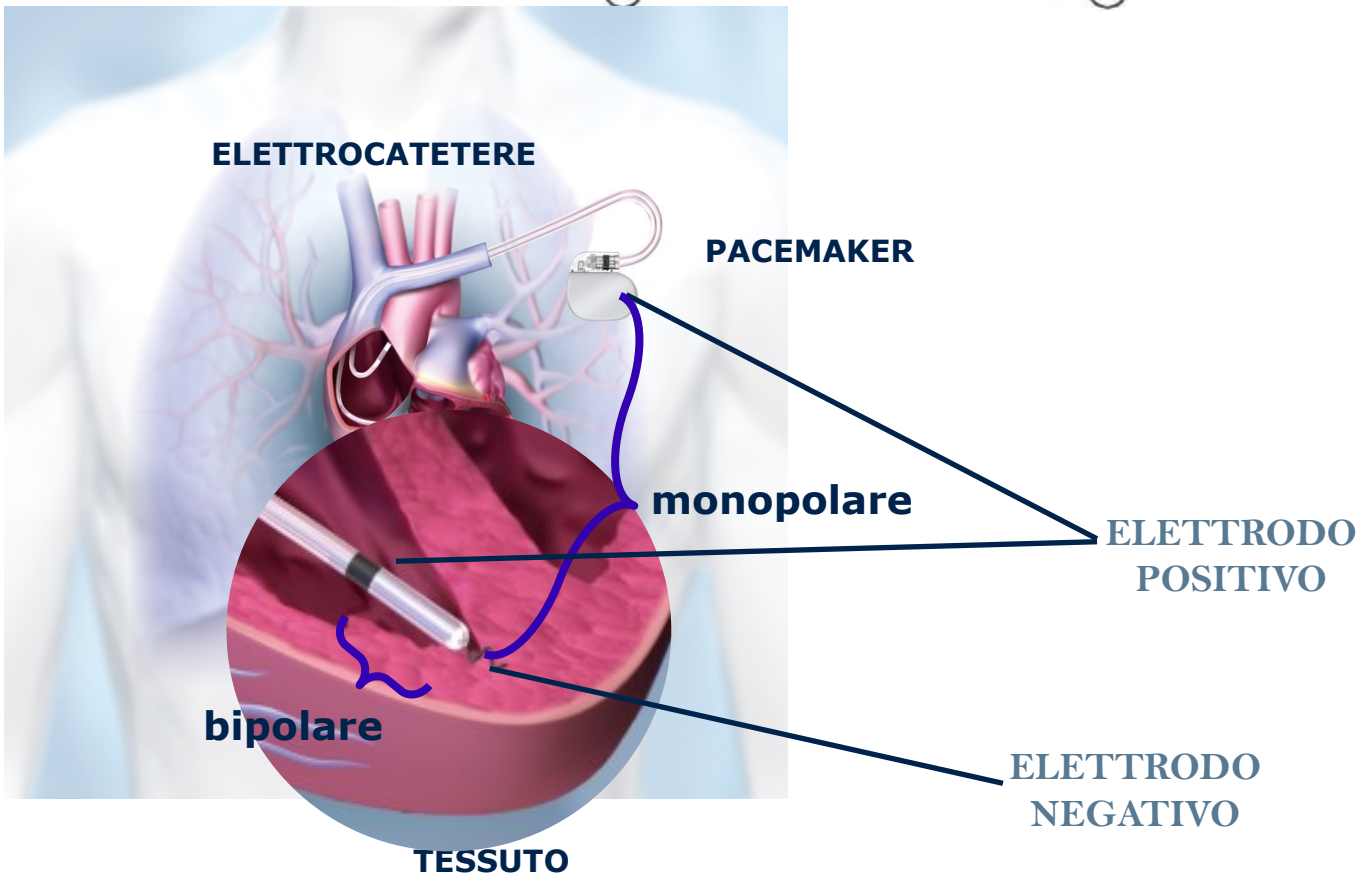
AP



Some examples in paediatric pacing

Elettrocatetere: polarità





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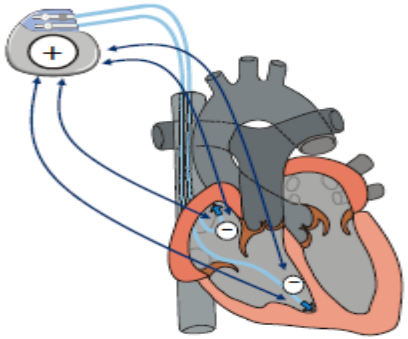
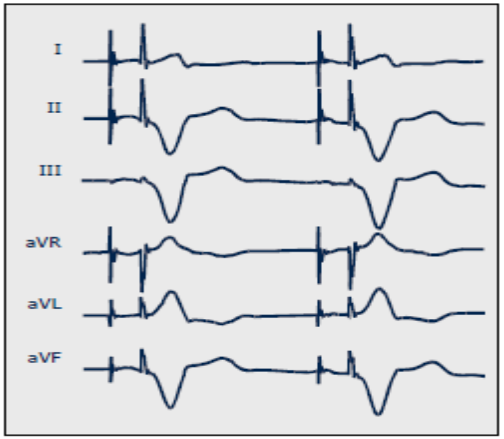
Elettrocatetere: bipolare vs unipolare



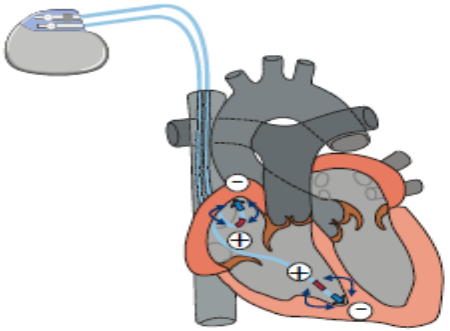


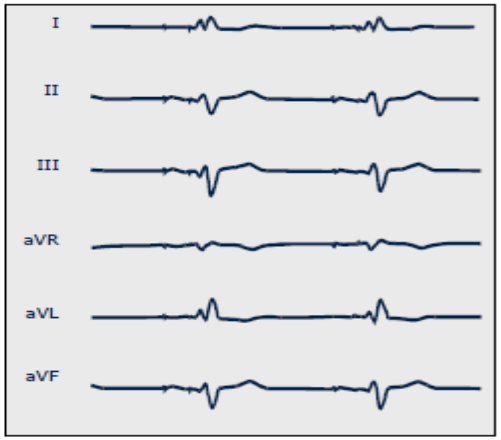
Unipolare

- **Pacing**: Facile da riconoscere lo **spike** di stimolazione
- **Sensing**: Rischio di sentire **rumore**

Bipolare

- **Pacing**: NON si vede spike stimolazione
- **Sensing**: ottima capacità di sentire con poco rischio di riconoscere rumore

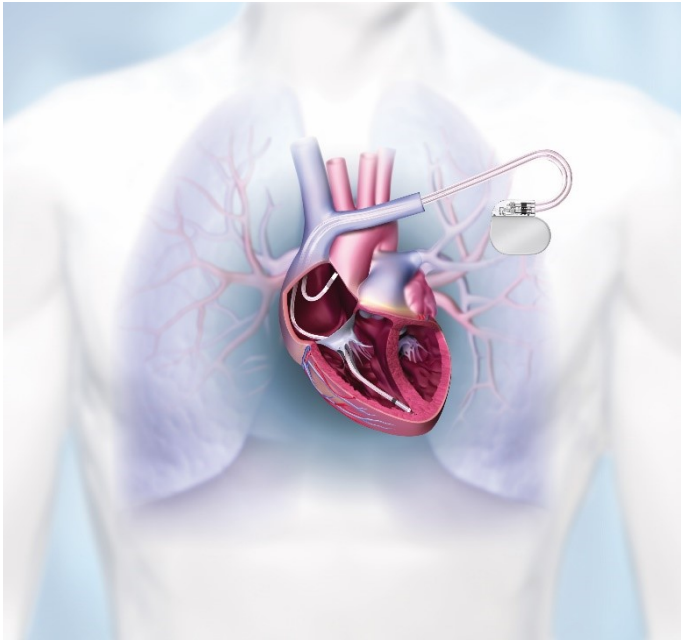




Soluzione Pratica

- **Sensing bipolare** per un ottimo riconoscimento
- **Pacing monopolare** per vedere spike su ECG

Elettrocatetere: parametri elettrici (1)



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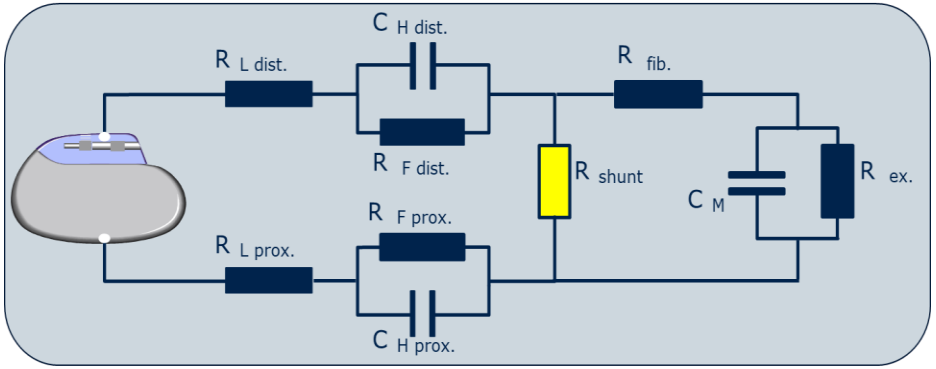

- **Sistema di stimolazione** PM-elettrodi-cuore = **circuito elettrico**
- **Misure elettriche** possono aiutarci a capire all'impianto e nel tempo se il **circuito** è ancora **stabile** e **ben funzionante**
- **Misure** eseguite **all'impianto** e **periodicamente** nel tempo

ORDINE DEI MEDICI CHIRURGHI E DEGLI ODONTOIATRI DELLA PROVINCIA DI BERGAMO

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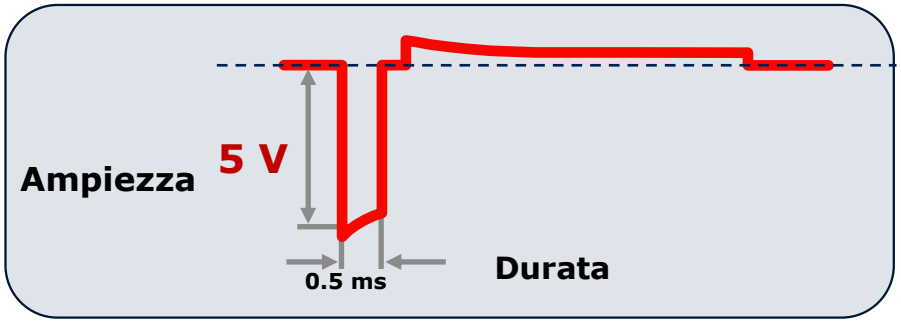
Regione Lombardia
ASST Bergamo Est

Elettrocatetere: parametri elettrici (2)

1. **Impedenza** del circuito = **resistenza** al passaggio di corrente, è **misura indiretta dello stato fisico e dell'integrità dei cateteri**
   200-2000 Ω (stimolazione); 20-200 Ω (defibrillazione)
2. **Sensing** = capacità dell'elettrocatetere di **riconoscere l'attività elettrica spontanea** delle camere cardiache
   Ottimale: Ventricolare ≥4 mV; Atriale ≥1 mV
3. **Soglia di stimolazione** = valore minimo dello stimolo elettrico in grado di "catturare" (depolarizzare) le camere cardiache
   NB: Ampiezza x durata
   Ottimale: endocardico ≤1 V @ 0.4 ms; epicardico ≤2 V @ 1.0 ms

NB: oltre che il **valore assoluto**, è importante il **TREND** nel tempo



Funzionamento degli ICD

Principi fondamentali, tipi di dispositivi, funzioni, cateteri, connettori

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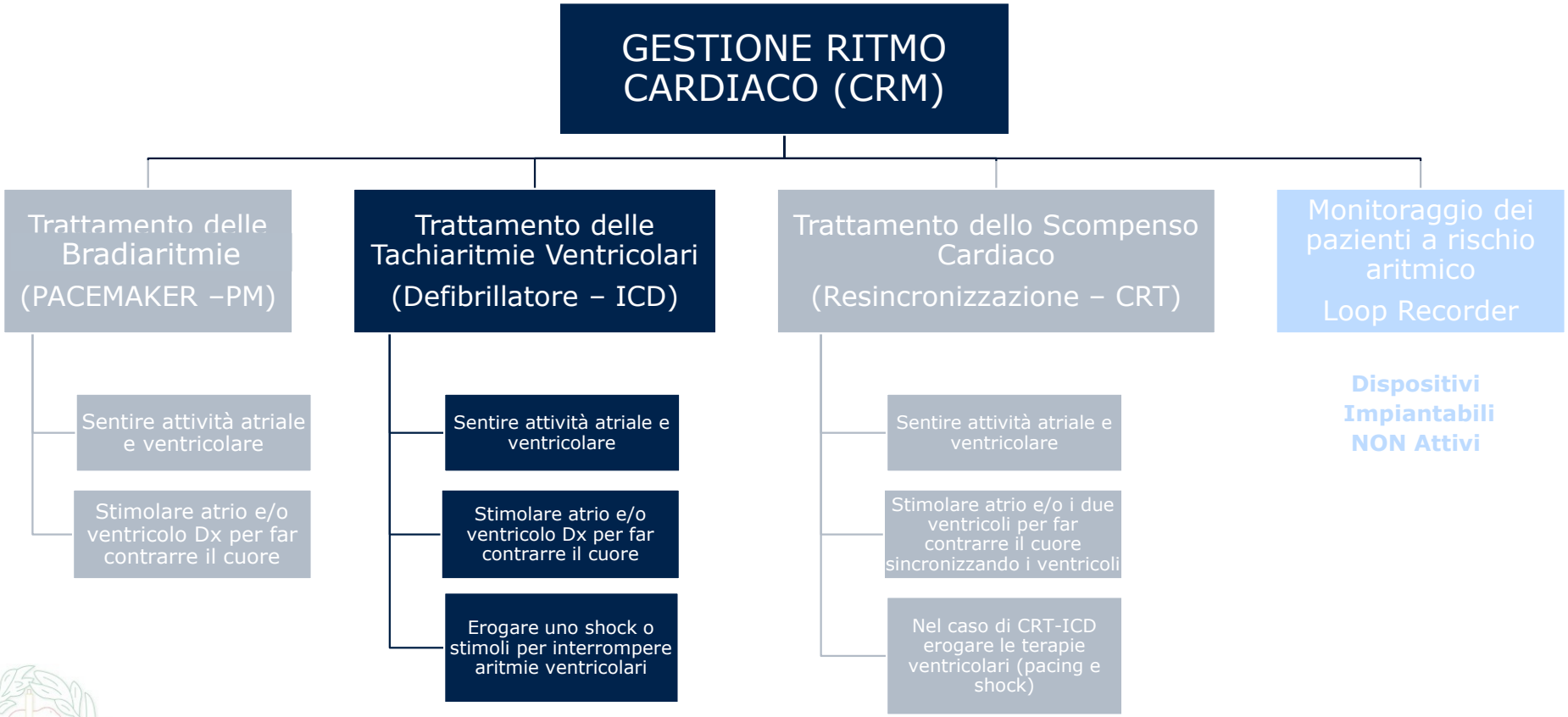
Elettrostimolazione (gestione del ritmo cardiaco)



Dispositivi Impiantabili Attivi

ORDINE DEI MEDICI CHIRURGHI E DEGLI ODONTOIATRI DELLA PROVINCIA DI BERGAMO

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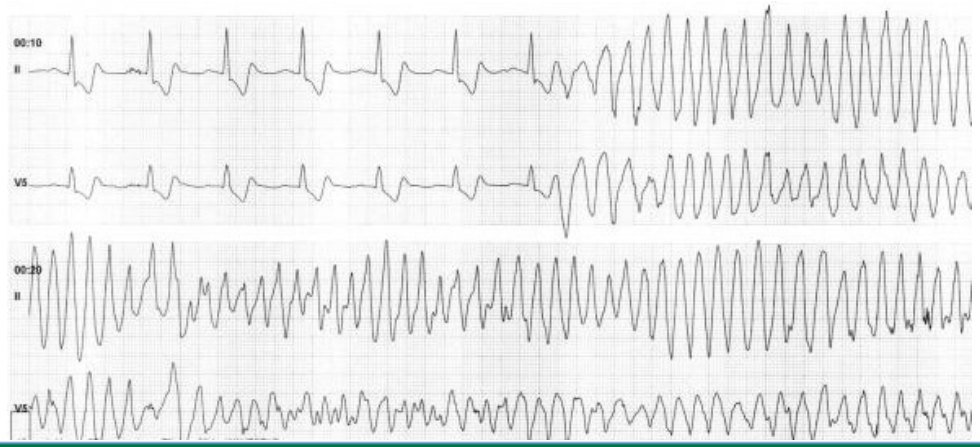
Indicazioni all'impianto di ICD

1. **PREVENZIONE PRIMARIA:** pazienti ad **elevato rischio di arresto cardiaco** o **tachiaritmie ventricolari emodinamicamente instabili**
    - **HFrEF**
    - **Cardiomiopatie** (ipertrofica, displasia aritmogena, ecc)
    - **Sindromi aritmogene** (S. di Brugada, S. del QT lungo, ecc)
2. **PREVENZIONE SECONDARIA**: pazienti **sopravvissuti** ad **arresto cardiaco** o a **tachiaritmie ventricolari emodinamicamente instabili**



ORDINE DEI MEDICI CHIRURGHI
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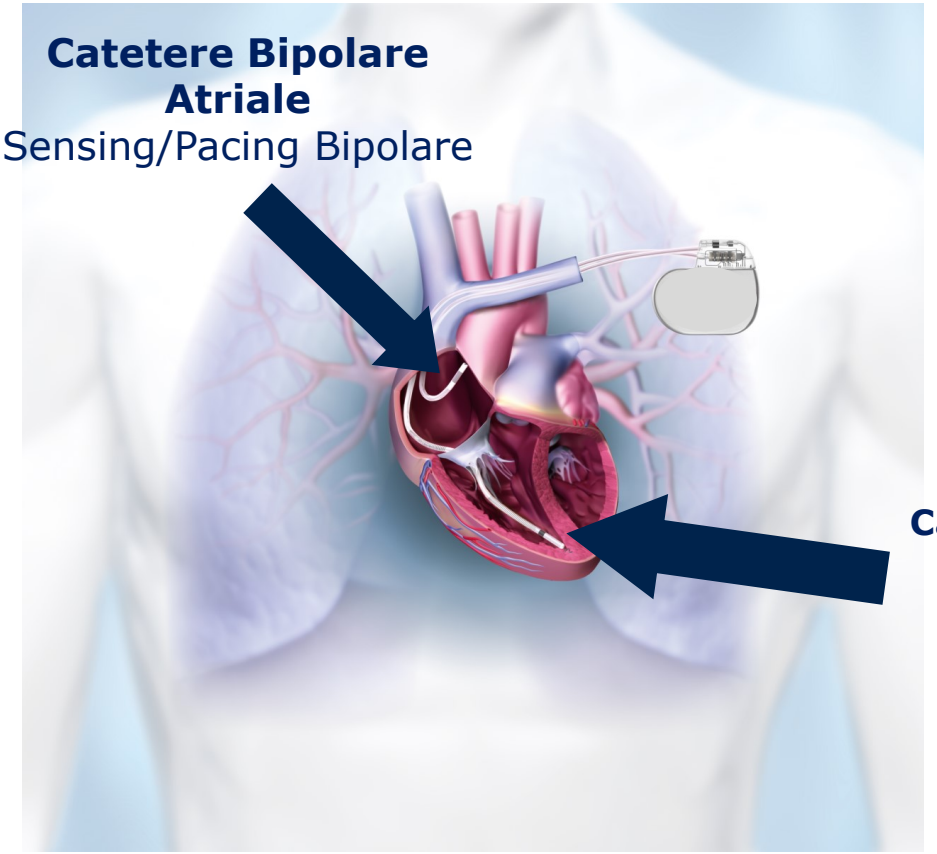
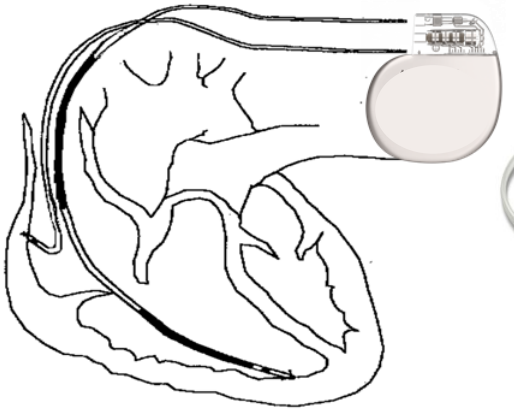
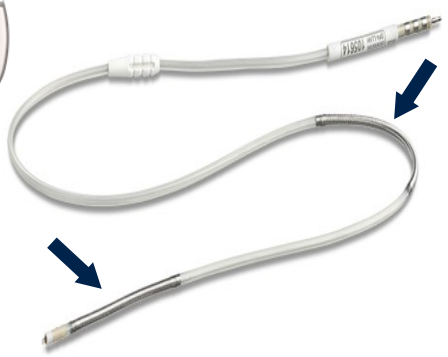
ICD: introduzione

Catetere Bipolare Atriale
Sensing/Pacing Bipolare







Double coil

Catetere Tri-/Quadripolare Ventricolare
Sensing/Pacing Bipolare **+**
1-2 Coil Defibrillazione (ventricolo dx ± VCS)

Single coil

Stesse funzioni del PM **+ riconoscimento** e **trattamento** delle **tachiaritmie ventricolari**

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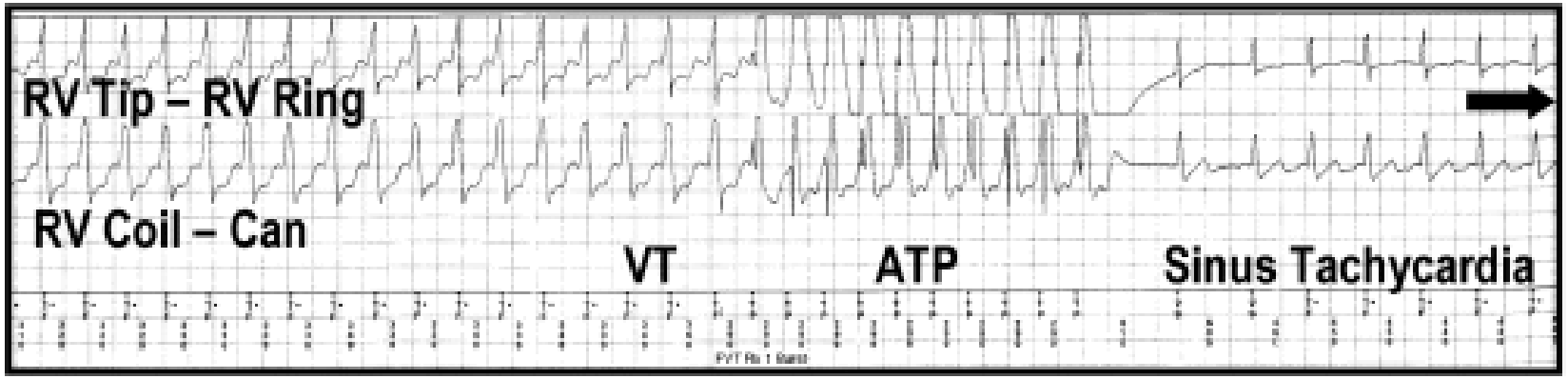
ICD: riconoscimento e terapie

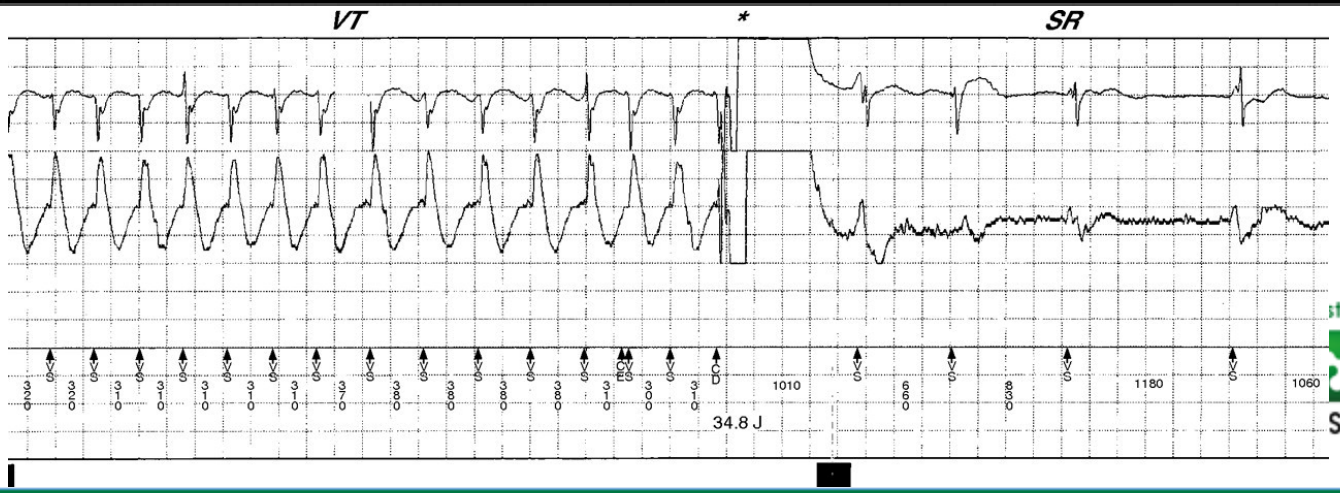
Principio fondamentale = riconoscimento e **discriminazione aritmie**

Erogazione terapie

1. Terapie **"indolori" = ATP** (anti-tachycardia pacing)



2. Shock



ORDINE DEI MEDICI CHIRURGHI E DEGLI ODONTOIATRI DELLA PROVINCIA DI BERGAMO

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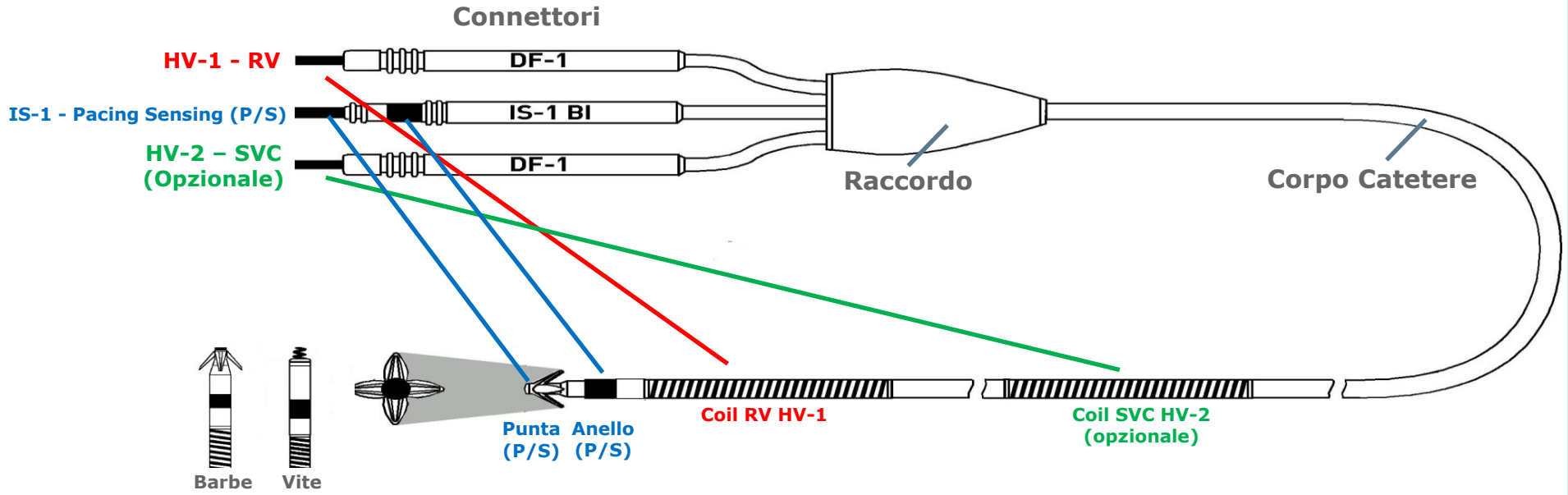
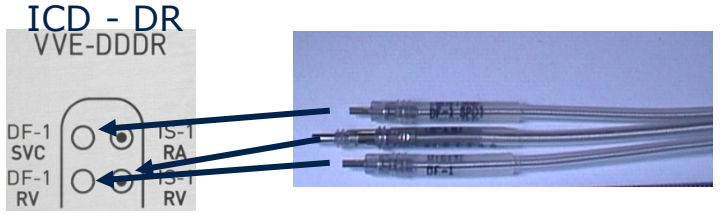
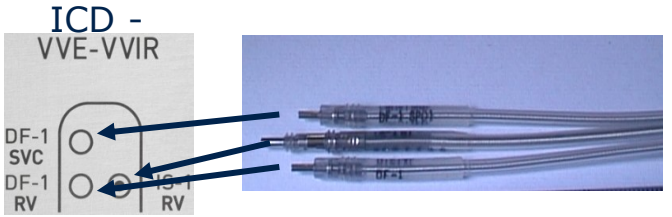
Elettrocatetere di ICD: DF-1



Catetere Double Coil





Catetere Single Coil

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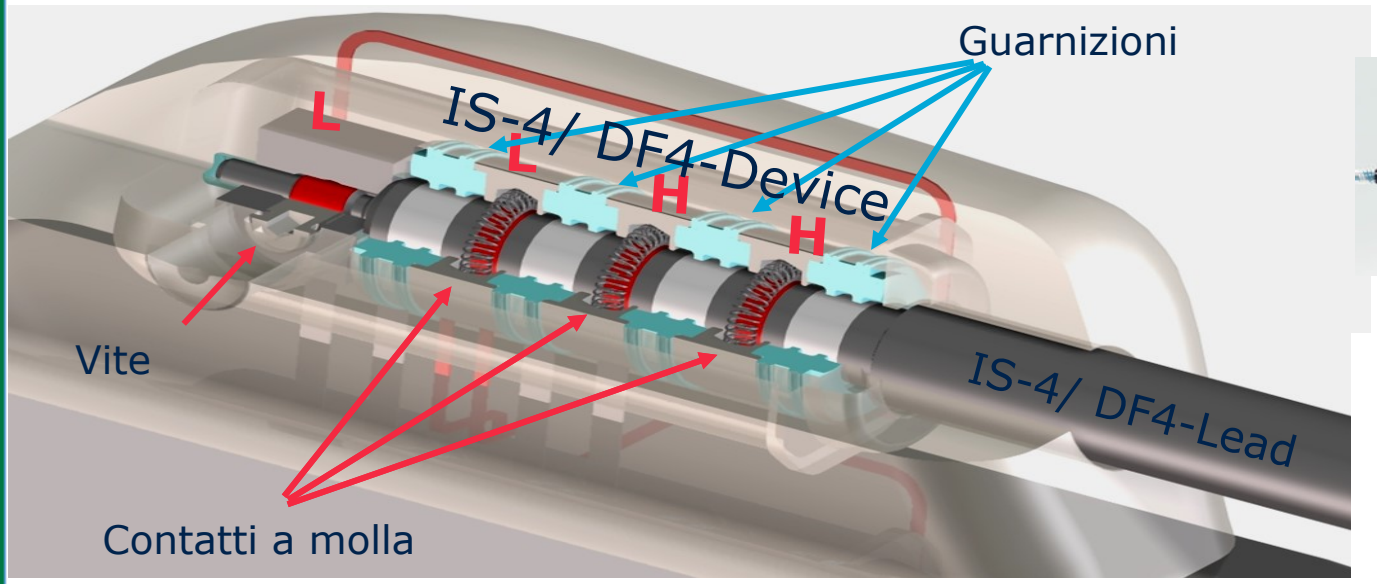
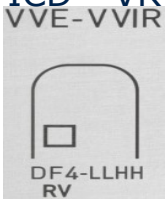
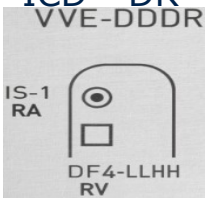
Connettore IS-4/DF-4



- EC **quadripolare** = **4 contatti** per 4 elettrodi
- Cateteri da stimolazione in **CRT** (**IS-4**) -> **4 poli per stimolazione/sensing**
- Cateteri da defibrillazione in **ICD** (**DF-4**) -> **2 poli** per **stimolazione/sensing +**
  1-2 poli per **defibrillazione** (**coil**)

ORDINE DEI MEDICI CHIRURGHI E DEGLI ODONTOIATRI DELLA PROVINCIA DI BERGAMO





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Funzionamento dei dispositive per CRT

Principi fondamentali, tipi di dispositivi, funzioni, cateteri, connettori

ORDINE DEI MEDICI CHIRURGHI
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DELLA PROVINCIA DI BERGAMO

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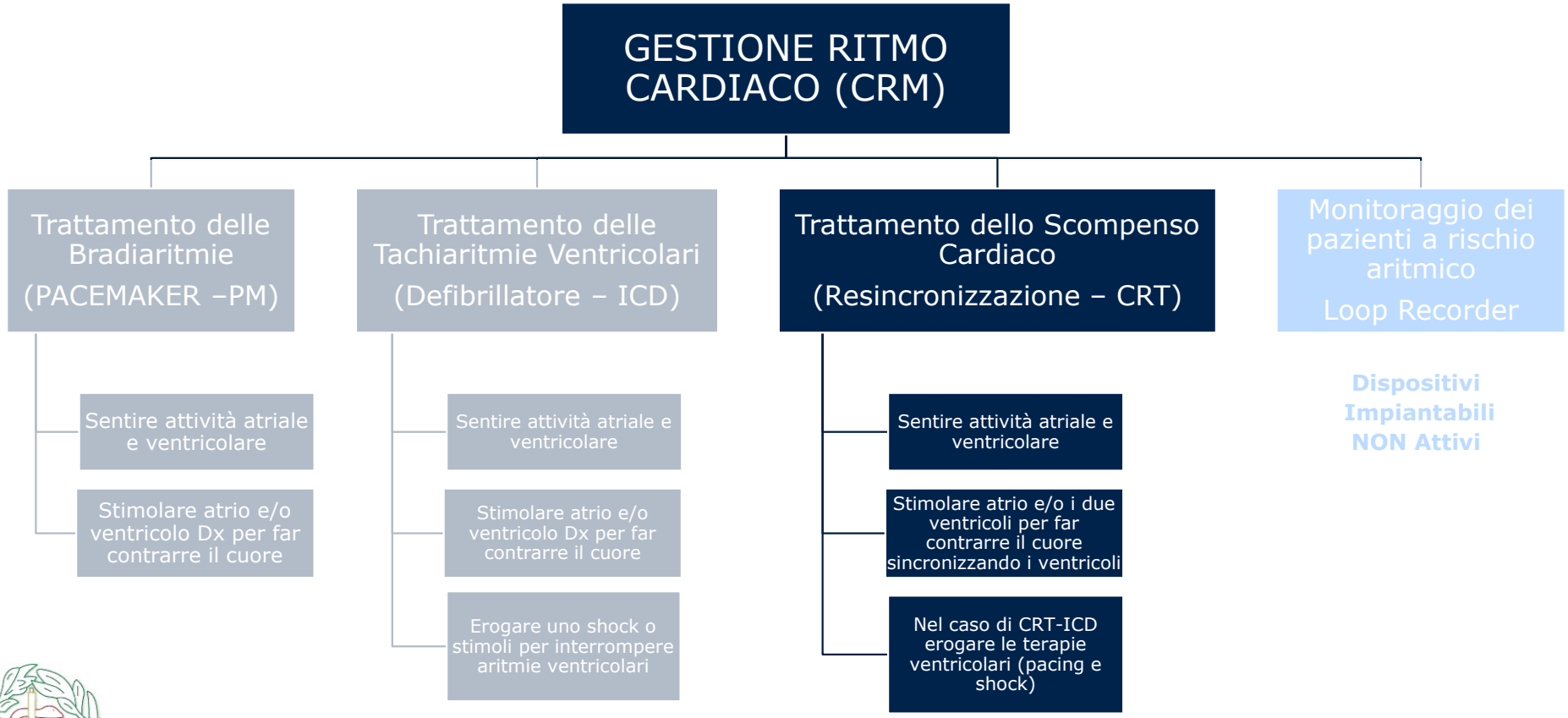
Elettrostimolazione (gestione del ritmo cardiaco)



Dispositivi Impiantabili Attivi

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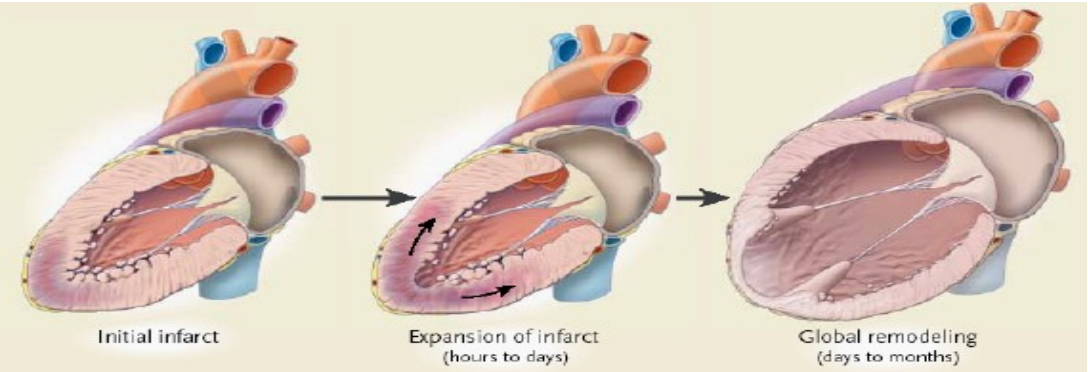
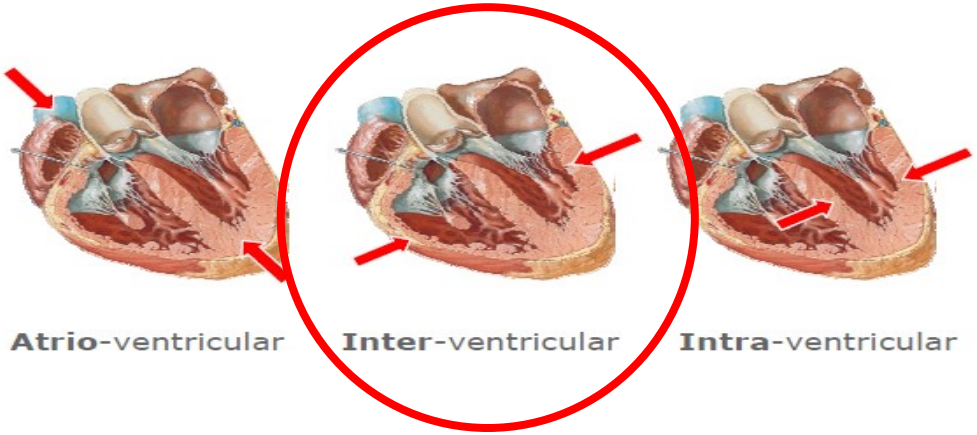
Scompenso cardiaco



Scompenso cardiaco -> **dilatazione** e **rimodellamento** delle camere cardiache

DiSSINCRONIE, ovvero ritardi nella conduzione:

- Atrio-Ventricolari
- **Inter-Ventricolari**
- Intra-Ventricolari



Obiettivo della **CRT** = **correzione dissincronia** fra **ventricolo destro** e **sinistro**

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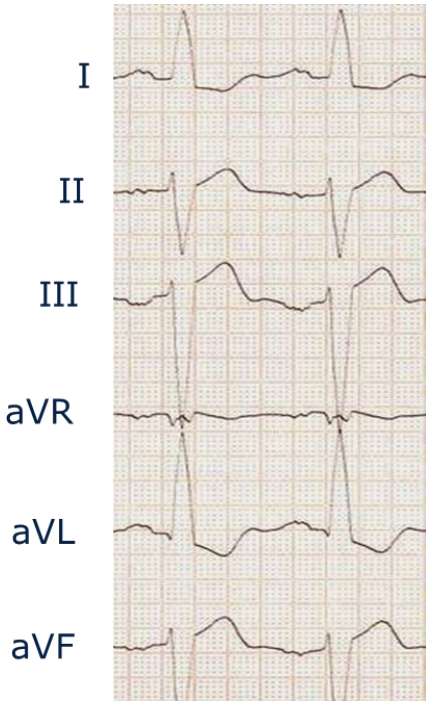
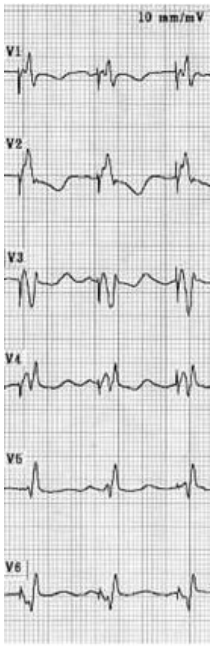
Dissincronia elettrica e CRT



Dilatazione ventricolare e **dissincronia** -> **QRS slargato** (≥130 msec)



Stimolazione BiV ->

↓durata QRS ->

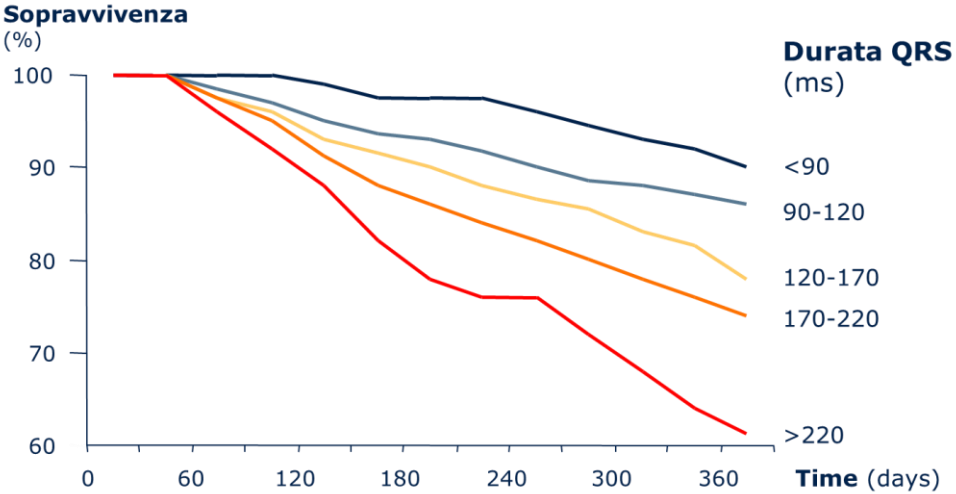
↓mortalità e **morbilità** +

miglioramento

sintomatologico (sia CRT-D che CRT-P)

↑durata QRS =

↓sopravvivenza



ORDINE DEI MEDICI CHIRURGHI E DEGLI ODONTOIATRI DELLA PROVINCIA DI BERGAMO

Glikson, M. et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur. Heart J. **42**, 3427–3520 (2021).

CRT: trials clinici

1. **Miglioramento** della **sintomatologia**

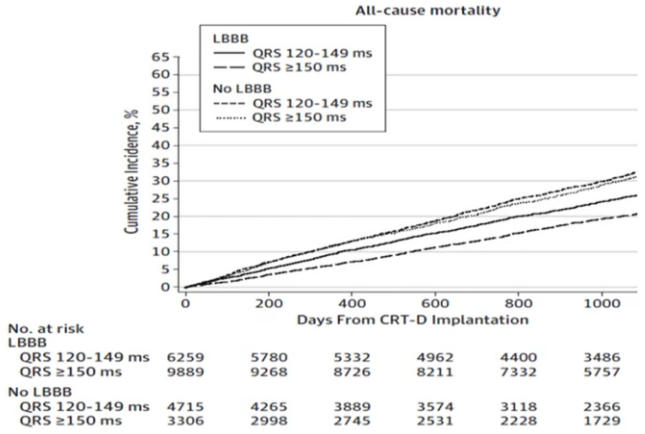
Trial (ref)	No.	Design	NYHA	LVEF	QRS	Primary endpoints	Secondary endpoints	Main Findings
MUSTIC-SR[52]	58	Single-blinded, crossover, randomized CRT vs. OMT, 6 months	III	<35%	≥150	6MWD	NYHA class, QoL, peak VO_2 LV volumes, MR hospitalizations, mortality	CRT-P improved 6MWD, NYHA class, QoL, peak VO_2, reduced LV volumes and MR and reduced hospitalizations
PATH-CHF[53]	41	Single-blinded, crossover, randomized RV vs. LV vs. BiV, 12 months	III–IV	NA	≥150	Peak VO_2, 6MWD	NYHA class, QoL hospitalizations	CRT-P improved NYHA class, QoL and 6MWD and reduced hospitalizations
MIRACLE[49]	453	Double-blinded, randomized CRT vs. OMT, 6 months	III–IV	≤35%	≥130	NYHA class, 6MWD , QoL	Peak VO_2 LVEDD, LVEF, MR clinical composite response	CRT-P improved NYHA class, QoL and 6MWD and reduced LVEDD, MR and increased LVEF
MIRACLE-ICD[54]	369	Double-blinded, randomized CRT-D vs. ICD, 6 months	III–IV	≤35%	≥130	NYHA class, 6MWD , QoL	Peak VO_2 LVEDD, LVEF, MR clinical composite response	CRT-D improved NYHA class, QoL, peak VO_2
CONTAK-CD[53]	490	Double-blinded randomized CRT-D vs. ICD, 6 months	II–III–IV	≤35%	≥120	NYHA class, 6MWD , QoL	LV volume, LVEF composite of mortality, VT/VF, hospitalizations	CRT-D improved 6MWD, NYHA class, QoL, reduced LV volume and increased LVEF
MIRACLE-ICD II[60]	186	Double-blinded, randomized CRT-D vs. ICD, 6 months	II	≤35%	≥130	Peak VO_2	VE/VCO_2, NYHA, QoL, 6MWD, LV volumes and EF, composite clinical endpoint	CRT-D improved NYHA, VE/CO_2 and reduced LV volumes and improved LVEF

2. **Riduzione** della **mortalità** e della **morbilità**

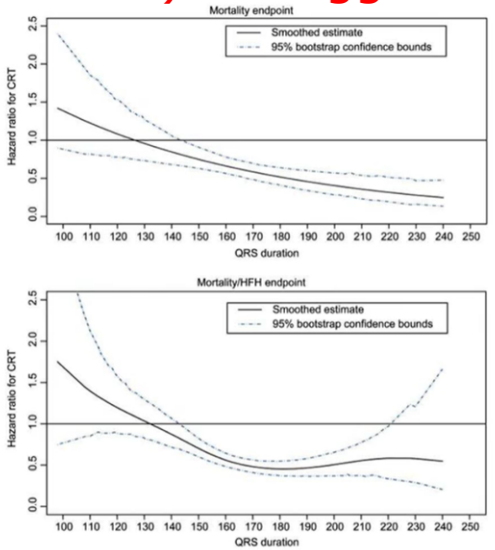
Trial (ref)	No.	Design	NYHA	LVEF	QRS	Primary endpoints	Secondary endpoints	Main Findings
COMPANION[55]	1520	Double-blinded randomized OMT vs. CRT-P / or vs. CRT-D, 15 months	III–IV	≤35%	≥120	All-cause mortality or hospitalization	All-cause mortality, cardiac mortality	CRT-P and CRT-D reduced all-cause mortality or hospitalization
CARE-HF[56]	813	Double-blinded randomized OMT vs. CRT-P 29.4 months	III–IV	≤35%	≥120	All-cause mortality or hospitalization	All-cause mortality, NYHA class, QoL	CRT-P reduced all-cause mortality and hospitalization and improved NYHA class and QoL
REVERSE[61]	610	Double-blinded, randomized CRT-ON vs. CRT-OFF, 12 months	I–II	≤40%	≥120	% worsened by clinical composite endpoint	LVESV index, heart failure hospitalizations and all-cause mortality	CRT-P/CRT-D did not change the primary endpoint and did not reduce all-cause mortality but reduced LVESV index and heart failure hospitalizations.
MADIT-CRT[50]	1820	Single-blinded, randomized CRT-D vs. ICD, 12 months	I–II	≤30%	≥130	All-cause mortality or heart failure hospitalizations	All-cause mortality and LVESV	CRT-D reduced the endpoint heart failure hospitalizations or all-cause mortality and LVESV. CRT-D did not reduced all-cause mortality
RAFT[62]	1798	Double-blinded, randomized CRT-D vs. ICD 40 months	II–III	≤30%	≥120	All-cause mortality or heart failure hospitalizations	All-cause mortality and cardiovascular death	CRT-D reduced the endpoint all-cause mortality or heart failure hospitalizations. In NYHA III, CRT-D only reduced significantly all-cause mortality

Brignole M, et al. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur Heart J. 2013;**34**(29):2281-2329.

Maggiore durata del QRS (**variabile continua**) = Maggior beneficio clinico



JAMA. 2013;310(6):617-626



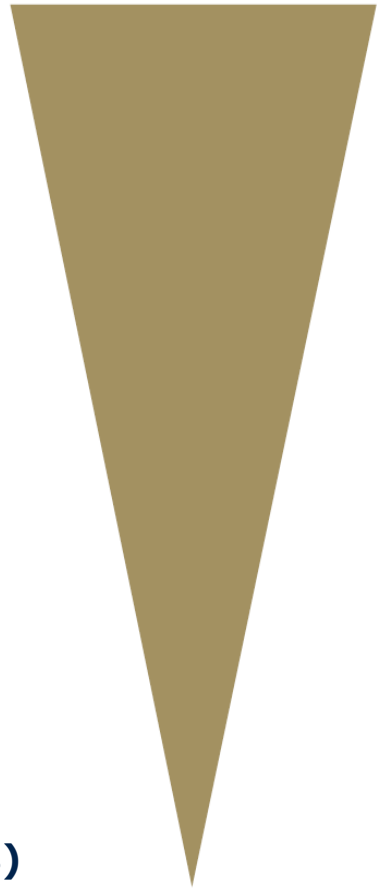
Eur Heart J. 2013 Dec;34(46):3547-56

ORDINE DEI MEDICI CHIRURGHI E DEGLI ODONTOIATRI DELLA PROVINCIA DI BERGAMO

Sistema Socio Sanitario Regione Lombardia ASST Bergamo Est

Predittori di risposta alla CRT

Elevata risposta (responders)



QRS largo, BBSx, femmine, cardiopatia non ischemica

Maschi, cardiopatia ischemica

Bassa risposta (non-responders)

QRS più stretto, blocco di branca con morfologia non-BBSx

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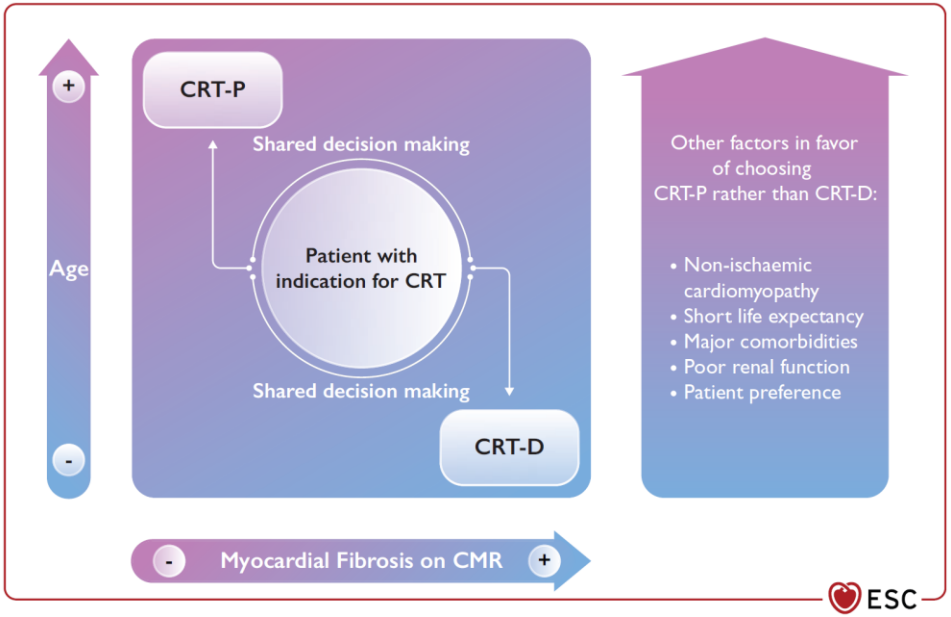
Glikson, M. et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur. Heart J. 42, 3427–3520 (2021).

CRT: dispositivi e indicazioni principali

Factors favouring CRT-P	Factors favouring CRT-D
Advanced heart failure	Life expectancy >1 year
Severe renal insufficiency or dialysis	Stable heart failure, NYHA II
Other major co-morbidities	Ischaemic heart disease (low and intermediate MADIT risk score)
Frailty	Lack of comorbidities
Cachexia	

NB: tutte necessarie

1. **HF sintomatico** (NYHA ≥2)
2. **LVEF ≤35%**
3. **QRS ≥130 msec**



Glikson, M. et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur. Heart J. 42, 3427–3520 (2021).
Brignole M, et al. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur Heart J. 2013;**34**(29):2281-2329.

CRT: indicazioni particolari

- In **HF** -> **maggiore** indicazione se **RS** (vs. FA) e **BBSx** (vs. morfologia non-BBSx)
- **Upgrading a CRT: PM o ICD** con **elevata percentuale di pacing ventricolare (≥20%)** che sviluppano **HFrEF** indipendentemente dalla durata del QRS intrinseco
- **"BAV e BiV": bradiaritmie** con **aspettata elevata percentuale di pacing ventricolare + HFrEF, CRT** (vs. PM/ICD) anche se **asintomatici**, includendo **FA a bassa RV**
- **Ablate and pace:** in **ablazione del nodo AV CRT** (vs. PM/ICD) anche se **LVEF lievemente ridotta (≤50%)** o **normale**

Recommendations for cardiac resynchronization therapy in patients in sinus rhythm

Recommendations	Class[a]	Level[b]
LBBB QRS morphology		
CRT is recommended for symptomatic patients with HF in SR with LVEF ≤35%, QRS duration ≥150 ms, and LBBB QRS morphology despite OMT, in order to improve symptoms and reduce morbidity and mortality.[37,39,40,254–266,283,284]	I	A
CRT should be considered for symptomatic patients with HF in SR with LVEF ≤35%, QRS duration 130–149 ms, and LBBB QRS morphology despite OMT, in order to improve symptoms and reduce morbidity and mortality.[37,39,40,254–266,283,284]	IIa	B
Non-LBBB QRS morphology		
CRT should be considered for symptomatic patients with HF in SR with LVEF ≤35%, QRS duration ≥150 ms, and non-LBBB QRS morphology despite OMT, in order to improve symptoms and reduce morbidity.[37,39,40,254–266,283,284]	IIa	B
CRT may be considered for symptomatic patients with HF in SR with LVEF ≤35%, QRS duration 130–149 ms, and non-LBBB QRS morphology despite OMT, in order to improve symptoms and reduce morbidity.[273–278,281]	IIb	B
QRS duration		
CRT is not indicated in patients with HF and QRS duration <130 ms without an indication for RV pacing.[264,282]	III	A

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CRT = cardiac resynchronization therapy; HF = heart failure; LBBB = left bundle branch block; LVEF = left ventricular ejection fraction; OMT = optimal medical therapy; SR = sinus rhythm.
[a]Class of recommendation.
[b]Level of evidence.

Recommendation for upgrade from right ventricular pacing to cardiac resynchronization therapy

Recommendation	Class[a]	Level[b]
Patients who have received a conventional pacemaker or an ICD and who subsequently develop symptomatic HF with LVEF ≤35% despite OMT, and who have a significant[c] proportion of RV pacing, should be considered for upgrade to CRT.[37,148,185,190,324–352]	IIa	B

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CRT = cardiac resynchronization therapy; HF = heart failure; ICD = implantable cardioverter-defibrillator; LVEF = left ventricular ejection fraction; OMT = optimal medical therapy; RV = right ventricular.
[a]Class of recommendation.
[b]Level of evidence.
[c]A limit of 20% RV pacing for considering interventions for pacing-induced HF is supported by observational data. However, there are no data to support that any percentage of RV pacing can be considered as defining a true limit below which RV pacing is safe and beyond which RV pacing is harmful.

Recommendations for cardiac resynchronization therapy in patients with persistent or permanent atrial fibrillation

Recommendations	Class[a]	Level[b]
1) In patients with HF with permanent AF who are candidates for CRT:		
1A) CRT should be considered for patients with HF and LVEF ≤35% in NYHA class III or IV despite OMT if they are in AF and have intrinsic QRS ≥130 ms, provided a strategy to ensure biventricular capture is in place, in order to improve symptoms and reduce morbidity and mortality.[302,306,307,322]	IIa	C
1B) AVJ ablation should be added in the case of incomplete biventricular pacing (<90–95%) due to conducted AF.[297–302]	IIa	B
2) In patients with symptomatic AF and an uncontrolled heart rate who are candidates for AVJ ablation (irrespective of QRS duration):		
2A) CRT is recommended in patients with HFrEF.[196,197,306,308]	I	B
2B) CRT rather than standard RV pacing should be considered in patients with HFmrEF.	IIa	C
2C) RV pacing should be considered in patients with HFpEF.[188,196,323]	IIa	B
2D) CRT may be considered in patients with HFpEF.	IIb	C

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AF = atrial fibrillation; AVJ = atrioventricular junction; CRT = cardiac resynchronization therapy; EF = ejection fraction; HF = heart failure; HFrEF = heart failure with reduced ejection fraction (<40%); HFmrEF = heart failure with mildly reduced ejection fraction (40–49%); HFpEF = heart failure with preserved ejection fraction (≥50%) according to the 2021 ESC HF Guidelines;[242] LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; RV = right ventricular.
[a]Class of recommendation.
[b]Level of evidence.

Recommendation for patients with heart failure and atrioventricular block

Recommendation	Class[a]	Level[b]
CRT rather than RV pacing is recommended for patients with HFrEF (<40%) regardless of NYHA class who have an indication for ventricular pacing and high-degree AVB in order to reduce morbidity. This includes patients with AF.[183,190,196,268,313,323,357–359,361,362]	I	A

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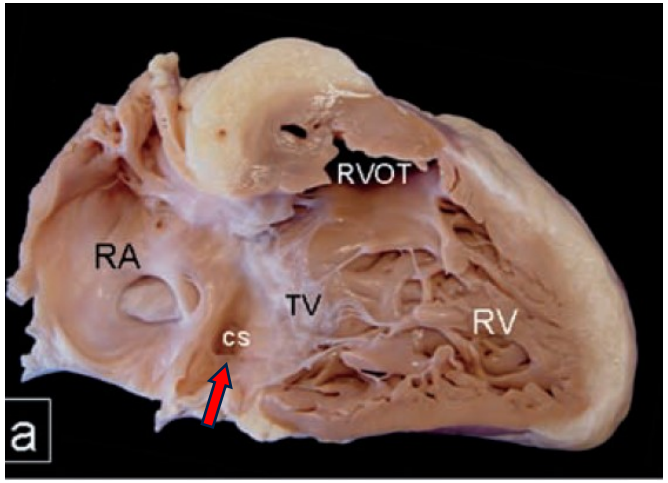
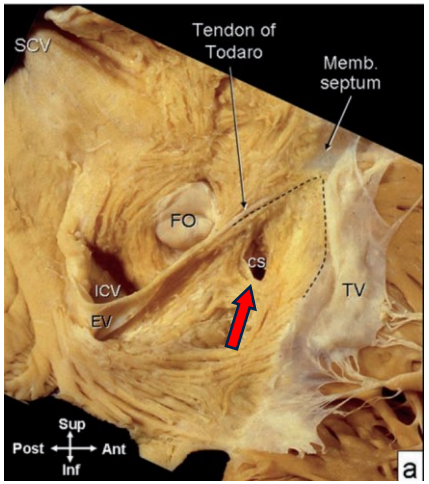
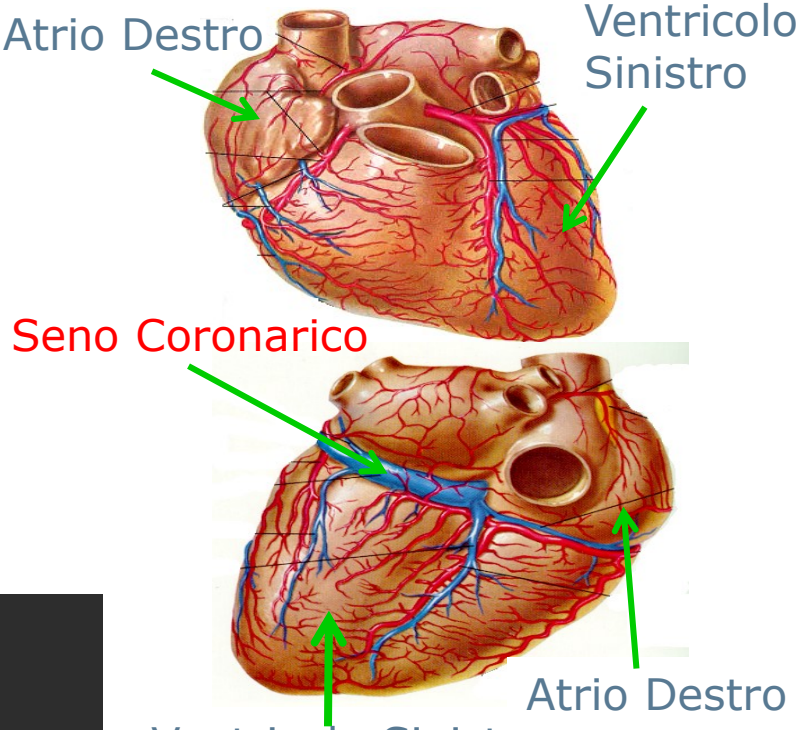
AF = atrial fibrillation; AVB = atrioventricular block; CRT = cardiac resynchronization therapy; HF = heart failure; HFrEF = heart failure with reduced ejection fraction (<40%) according to the 2021 ESC HF Guidelines;[242] NYHA = New York Heart Association; RV = right ventricular.
[a]Class of recommendation.
[b]Level of evidence.

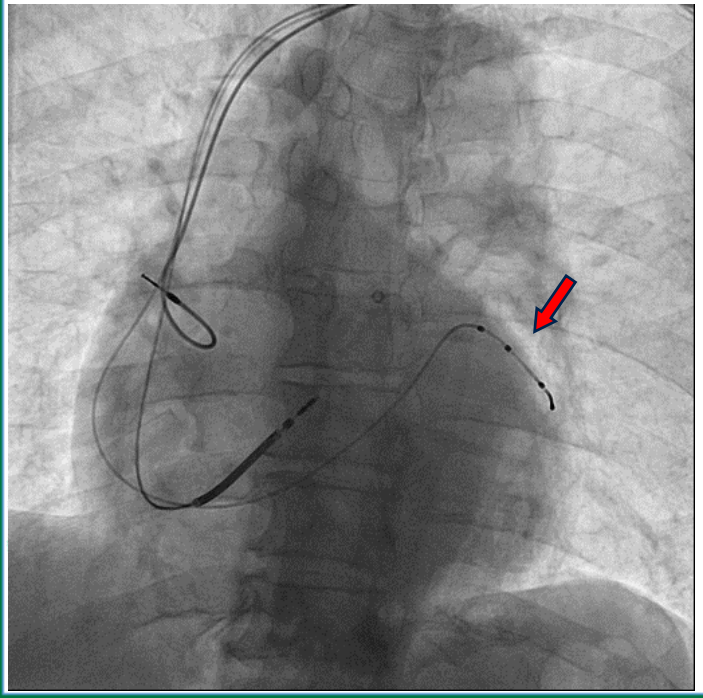
Glikson, M. et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur. Heart J. **42**, 3427–3520 (2021).

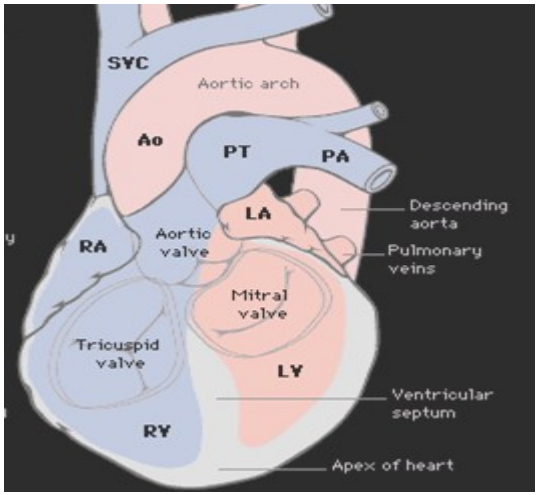
CRT: stimolazione epicardica del ventricolo sx

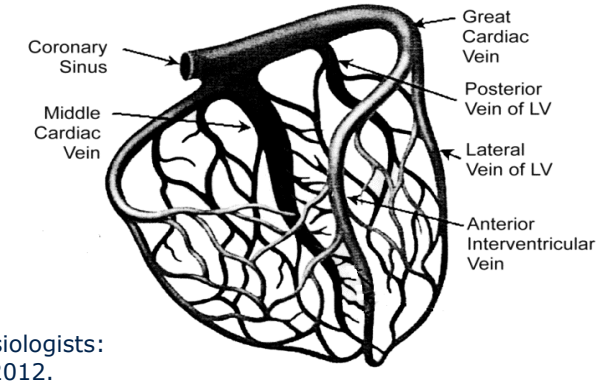








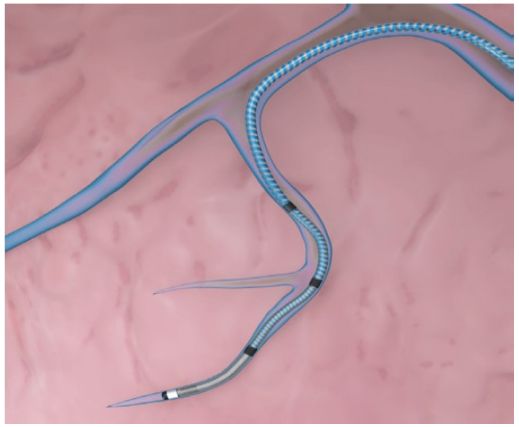




Yen Ho S, Ernst S. Anatomy for Cardiac Electrophysiologists: A Practical Handbook. Cardiotext Publishing; 2012.

CRT: elettrocateteri per ventricolo sx

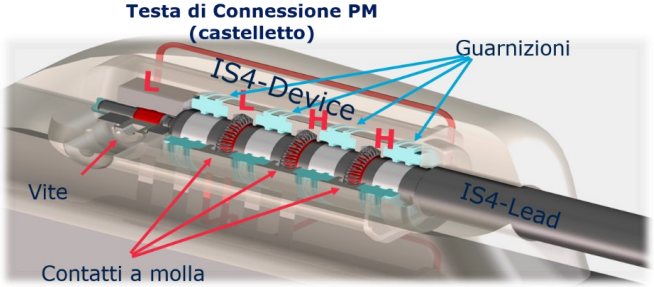
Flessibili



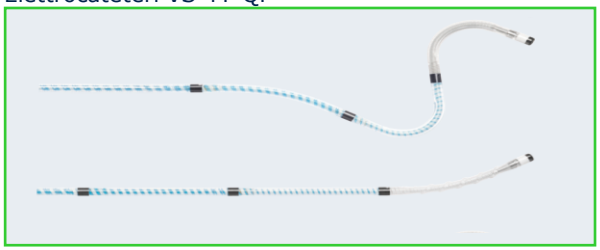
Sottili

Fissaggio passivo

Fissaggio attivo

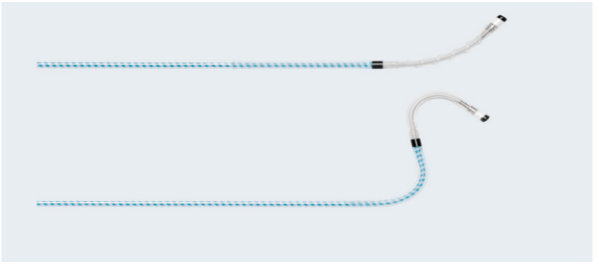


Elettrocateteri VS 4 F QP



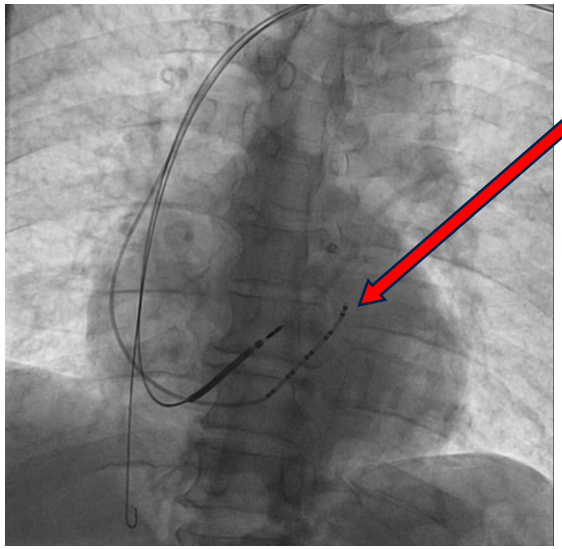
Connettore quadripolare IS4

Elettrocateteri VS 4 F BP

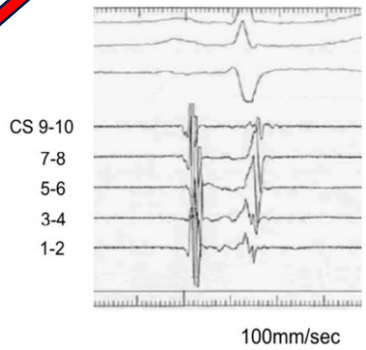


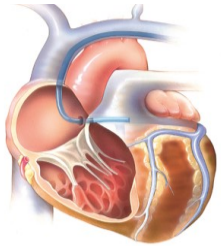
Connettore bipolare

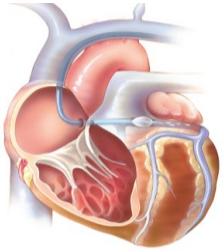
CRT: cannulazione del CS



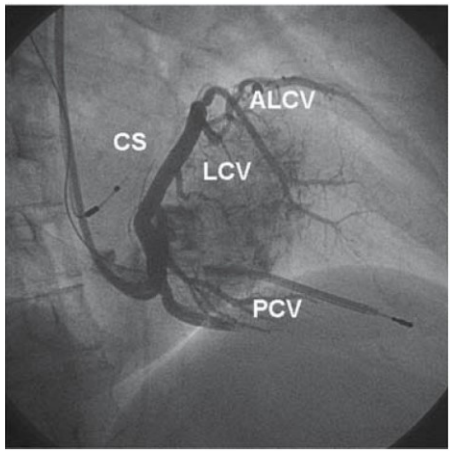
Catetere da elettrofisiologia a J all'interno del CS

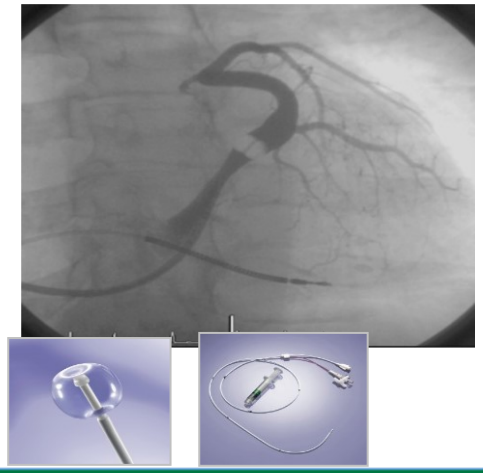


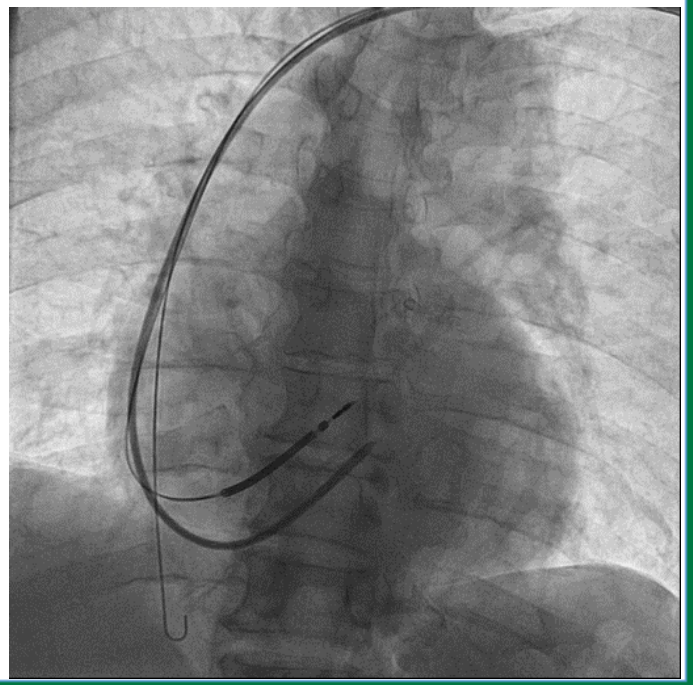




Venografia con o senza catetere di Swan-Ganz



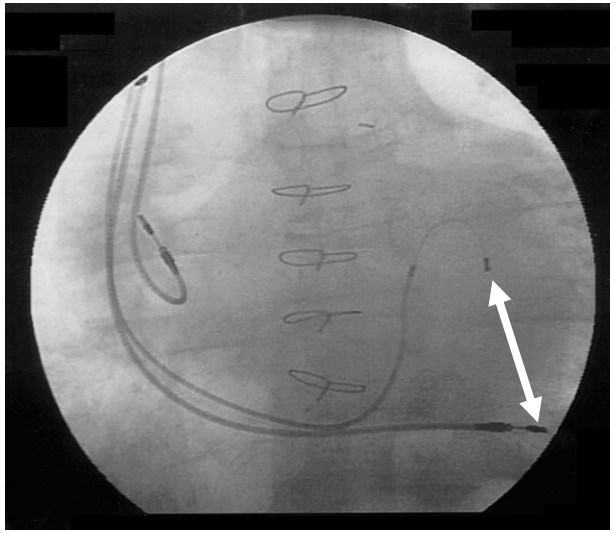




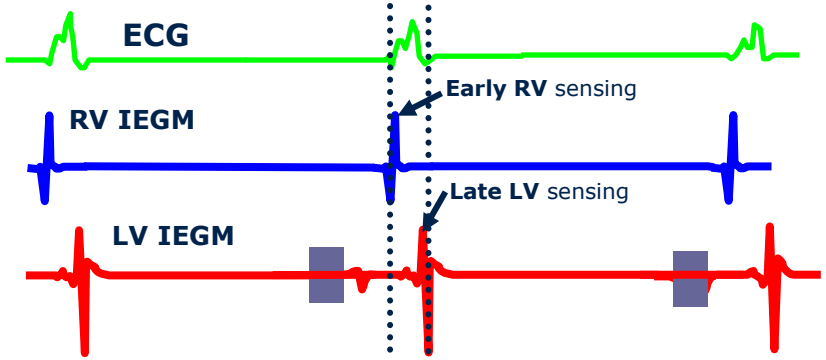
CRT: posizionamento dell'elettrocatetere

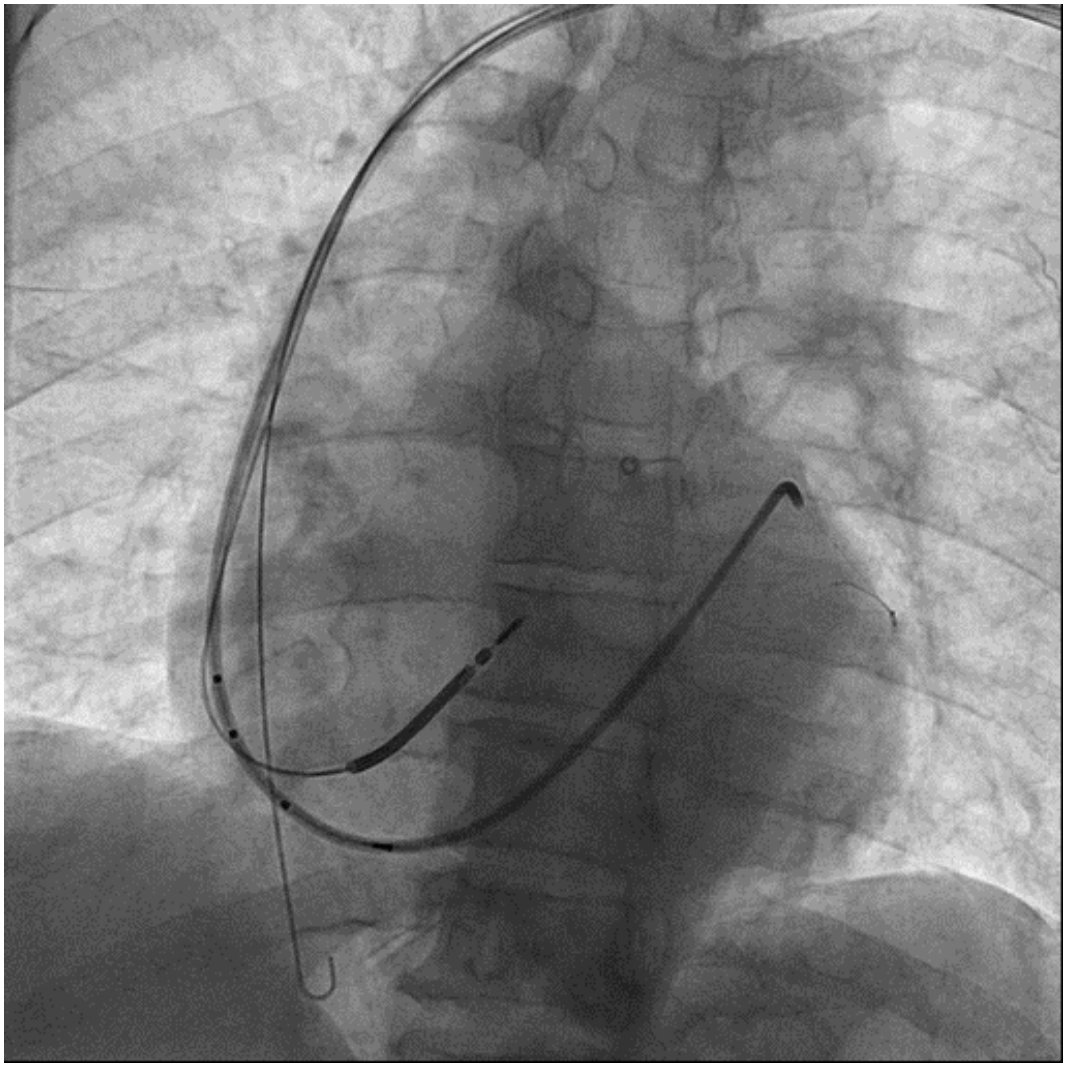
Corretto posizionamento valutabile con:

- distanza **anatomica**



- distanza **elettrica**



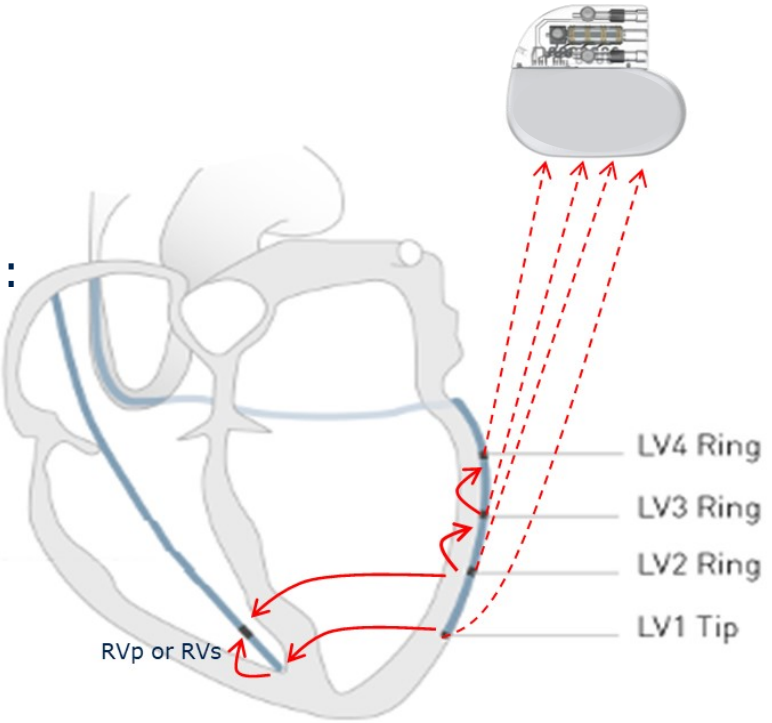


CRT: parametri elettrici dell'elettrocatetere

- Stimolazione **epicardica** = **soglie più elevate**
- Soglie di stimolazione del catetere sinistro

  (generalmente @ 0.4 msec oppure @ 1.0 msec):

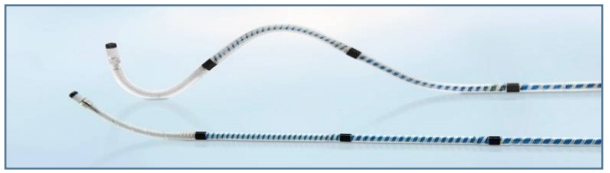
  - <1.0 V = eccellente
  - 1 – 2.5 V = accettabile
  - 2.5 – 4.5 V = subottimale



- **Elettrocateteri quadripolari** (sfruttando anche cassa

o elettrodi del catetere destro) -> a disposizione **20**

combinazioni diverse per il pacing ventricolare sinistro



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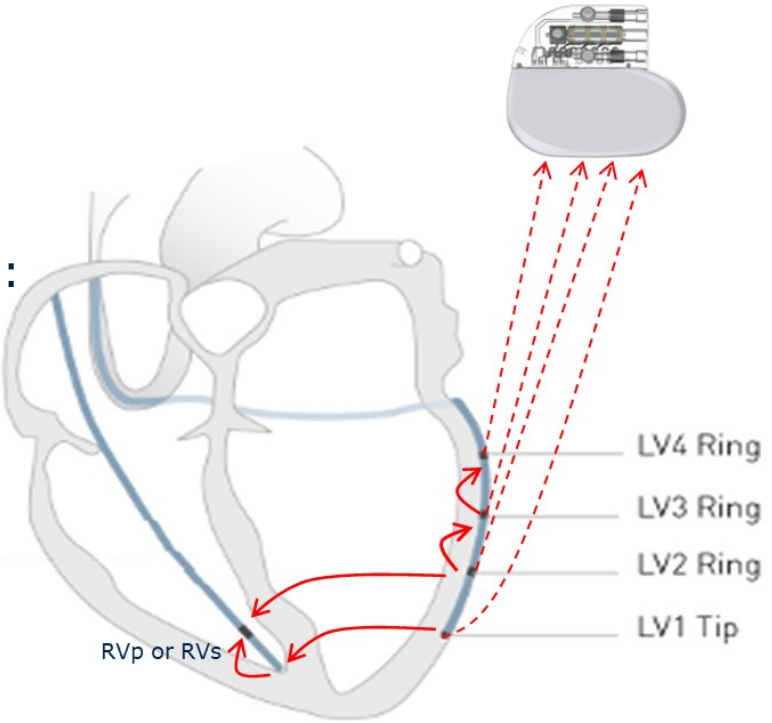

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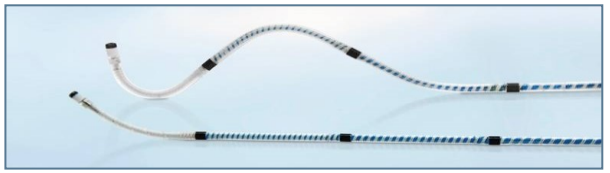
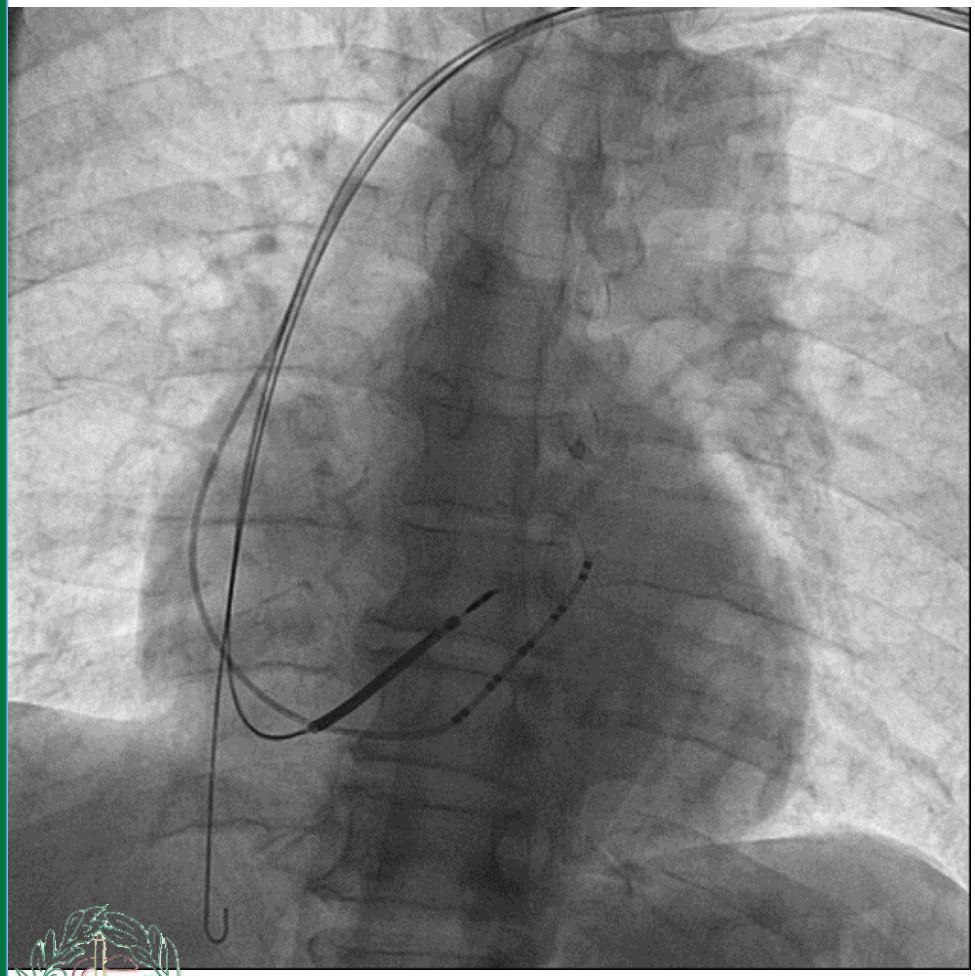
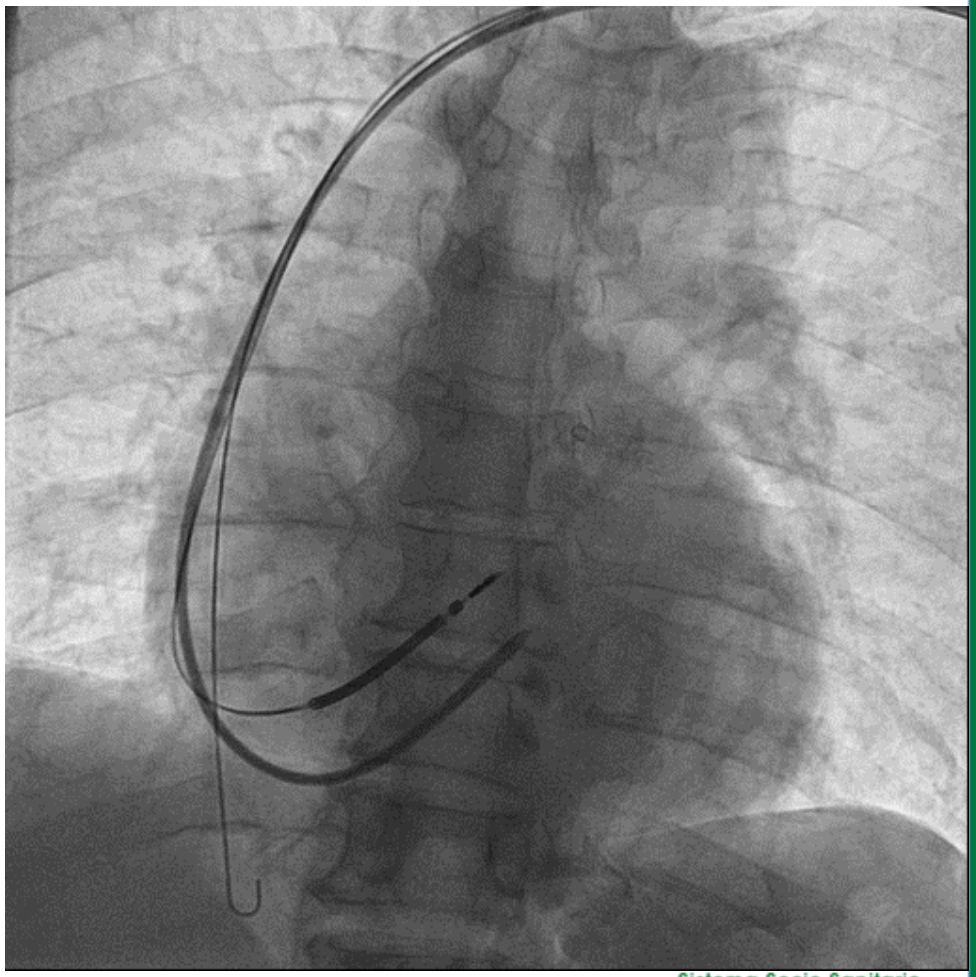
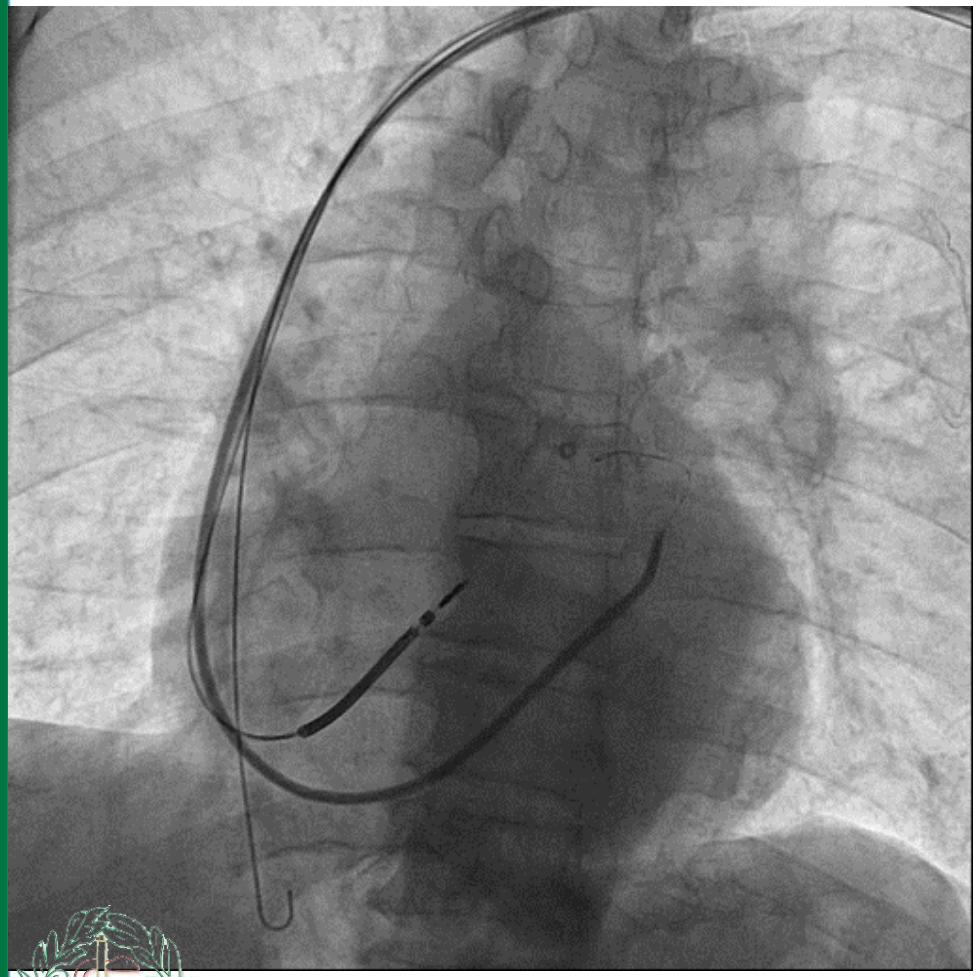


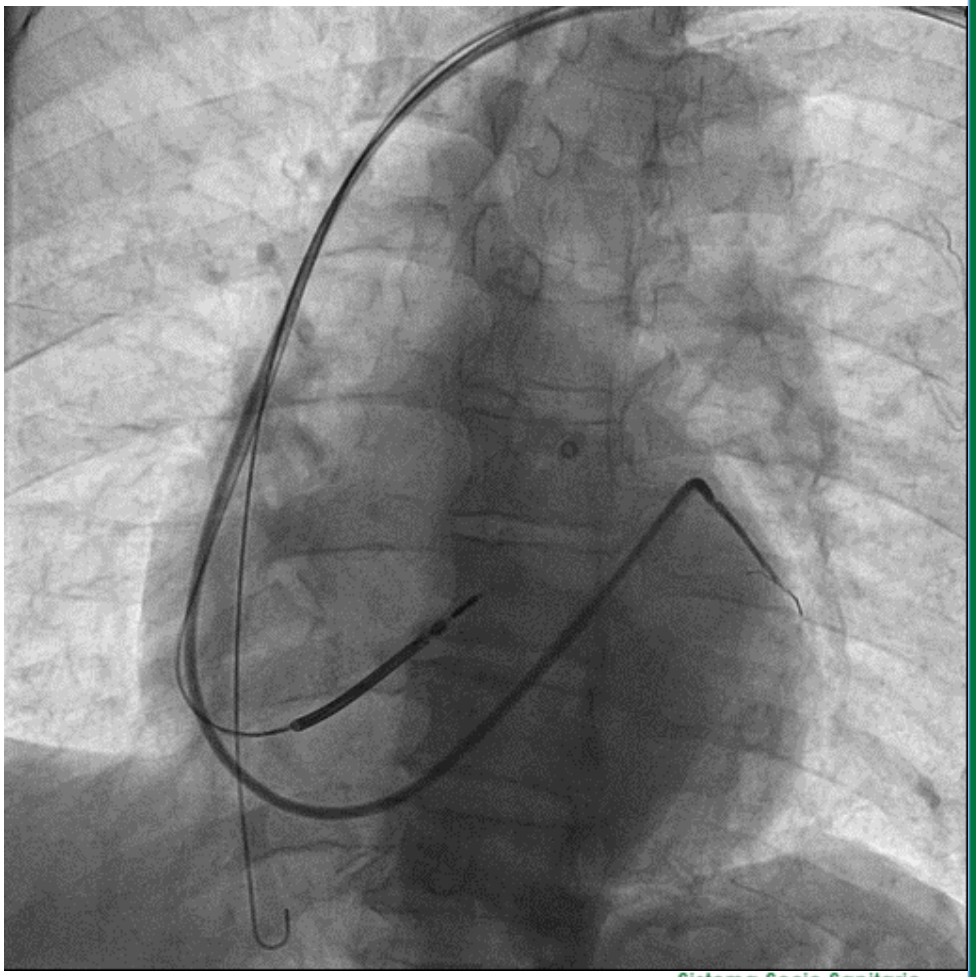
Cannulazione CS e venografia



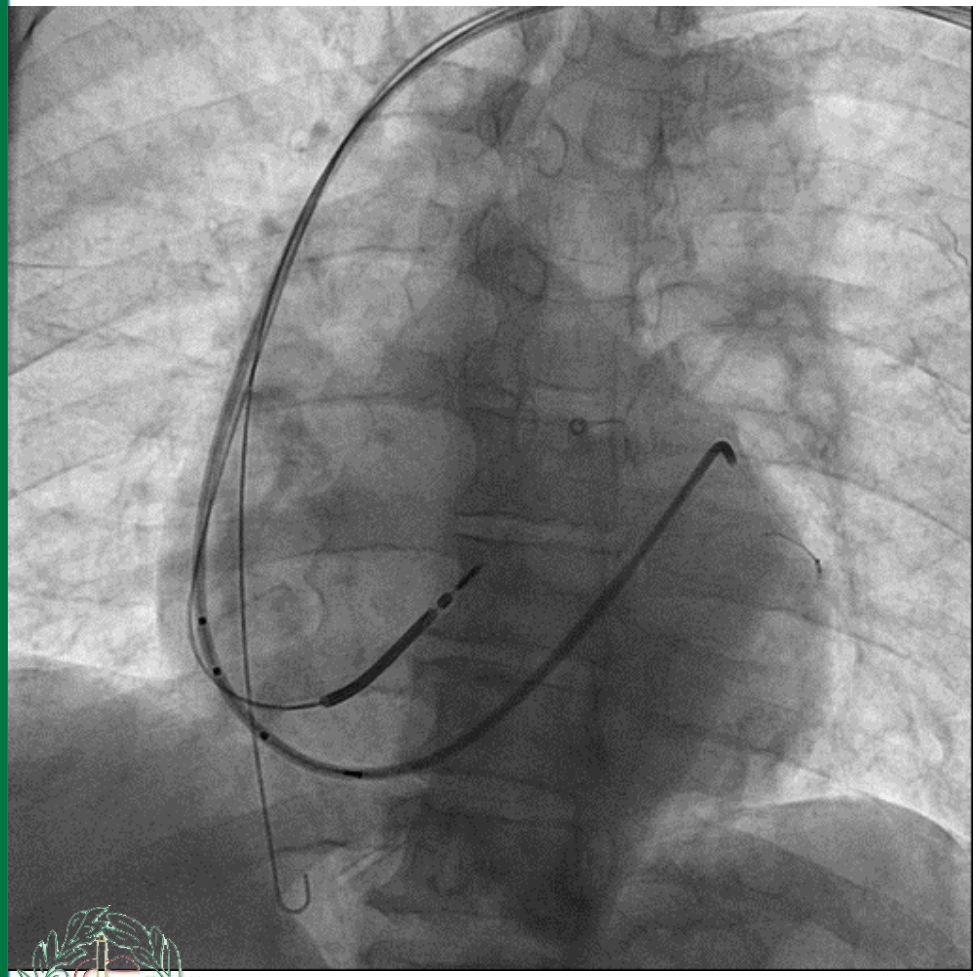


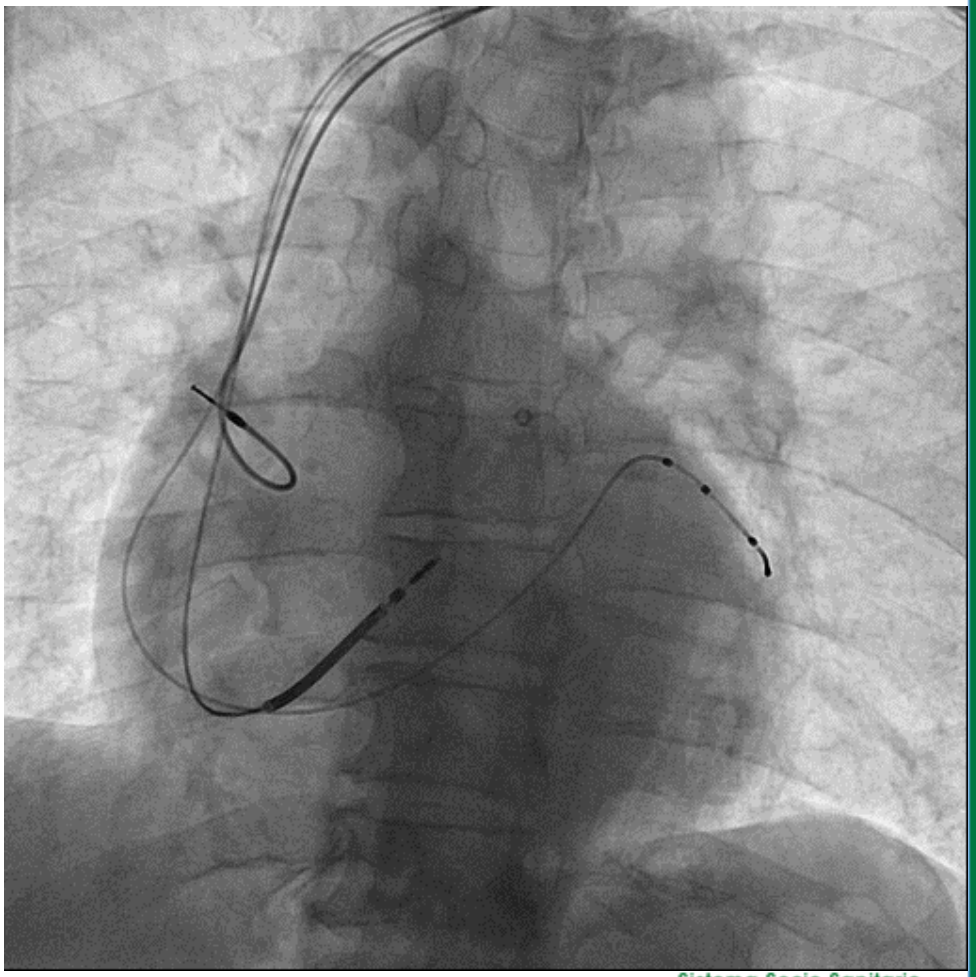
Selezione del ramo target





Posizionamento dell'EC da CS





ORDINE DEI MEDICI CHIRURGHI
E DEGLI ODONTOIATRI
DELLA PROVINCIA DI BERGAMO

Sistema Socio Sanitario
Regione Lombardia
ASST Bergamo Est

Funzionamento di PM e ICD

Dr. Andrea Dell'Aquila

UOS Elettrofisiologia ed Elettrostimolazione
UOC Cardiologia
ASST Bergamo Est
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Regione Lombardia
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