Pacemaker Mode Selection

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Introduction…

- Therapeutic cardiac stimulation has been in practice for many decades.
- Lately devices have shrunk in size, increased longevity and complexity.
- Increased interest in physiological or atrial based pacing.

Choice of appropriate pacing mode…

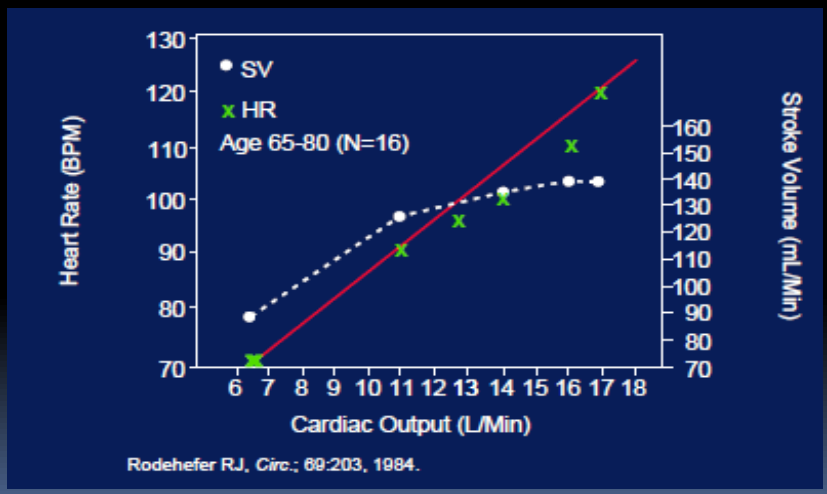
- Understanding the underlying pathology.
- Influence of pacing on this morbidity.
- Evidence base that reports the efficacy and safety of the pacing mode.

NBG code

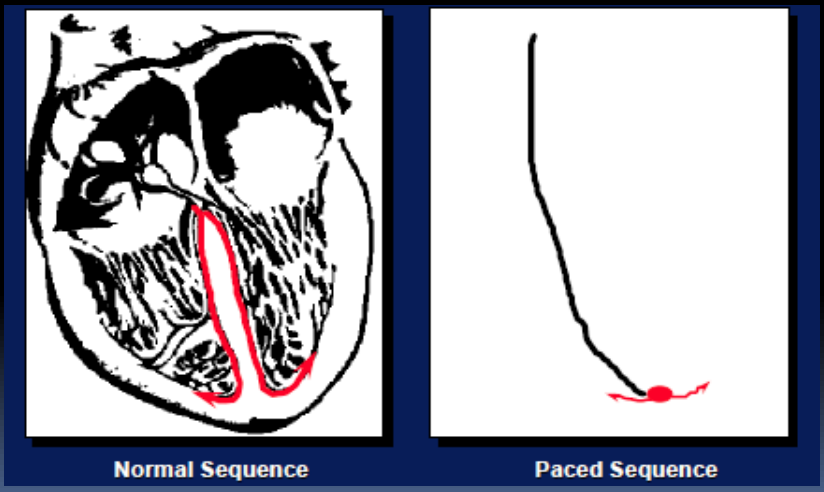
I Chamber Paced	II Chamber Sensed	III Response to Sensing	IV Programmable Functions/Rate Modulation	V Antitachy Function(s)
V: Ventricle	V: Ventricle	T: Triggered	P: Simple programmable	P: Pace
A: Atrium	A: Atrium	I: Inhibited	M: Multi-programmable	S: Shock
D: Dual (A+V)	D: Dual (A+V)	D: Dual (T+I)	C: Communicating	D: Dual (P+S)
O: None	O: None	O: None	R: Rate modulating	O: None
S: Single (A or V)	S: Single (A or V)		O: None	

The ideal pacing mode…

- Heart rate increase
- Stroke volume maximization
- Atrial based pacing
- Normal ventricular activation



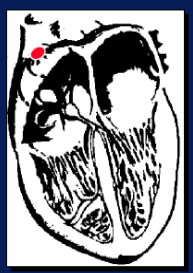
Ventricular activation…



Common indications of pacing

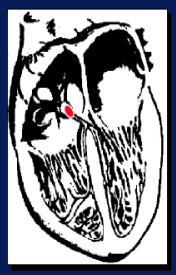
- Sinus Node disease
- AV nodal disease.

Sinus Node Dysfunction



- Sinus bradycardia
- Sinus arrest
- SA block
- Brady-tachy syndrome
- Chronotropic incompetence

AV Block

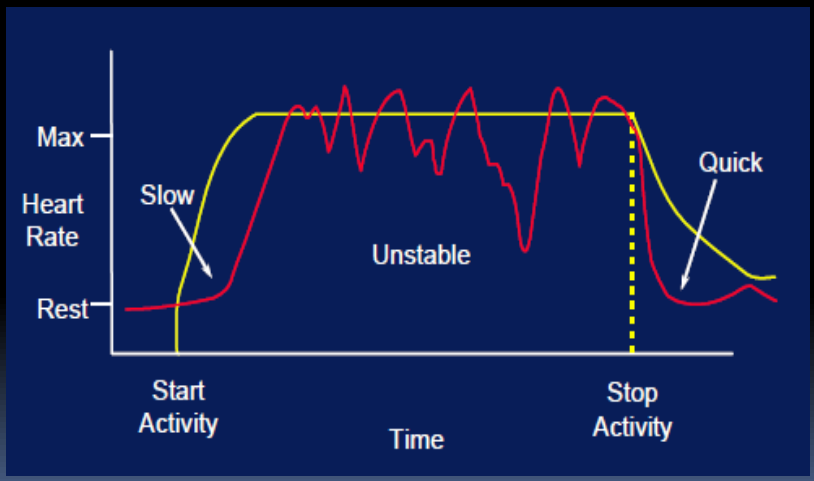


- First-degree AV block
- Second-degree AV block
  - Mobitz types I and II
- Third-degree AV block
- Bifascicular and trifascicular block

Sinus Node Disease

- Sinus Bradycardia
- Sinus Arrest
- Sinus exit block
- Brady- Tachy

Chronotropic Incompetence



- In the absence of reversible cause PM implantation is the TTT.
- Available modes are : Dual chamber (DDD-DDI), Single chamber (AAI-VVI) +/- R

Class I

1. Dual-chamber pacing (DDD) or single-chamber atrial pacing (AAI) is recommended over single-chamber ventricular pacing (VVI) in patients with SND and intact AV conduction (Level of Evidence: A)
2. Dual-chamber pacing is recommended over single-chamber atrial pacing in patients with SND (Level of Evidence: B)

Class III

1. Dual-chamber pacing or single-chamber atrial pacing should not be used in patients in permanent or longstanding persistent AF in whom efforts to restore or maintain sinus rhythm are not planned (Level of Evidence: C)

Class IIa

1. Rate adaptive pacing can be useful in patients with significant symptomatic chronotropic incompetence and its need should be reevaluated during follow-up (Level of Evidence: C)
2. In patients with SND and intact AV conduction, programming dual-chamber pacemakers to minimize ventricular pacing can be useful for prevention of atrial fibrillation (AF) (Level of Evidence: B)

Class IIb

1. AAI pacing may be considered in selected patients with normal AV and ventricular conduction (Level of Evidence B)
2. Single-chamber VVI pacing may be considered in instances where frequent pacing is not expected or the patient has significant comorbidities that are likely to influence survival and clinical outcomes (Level of Evidence: C)

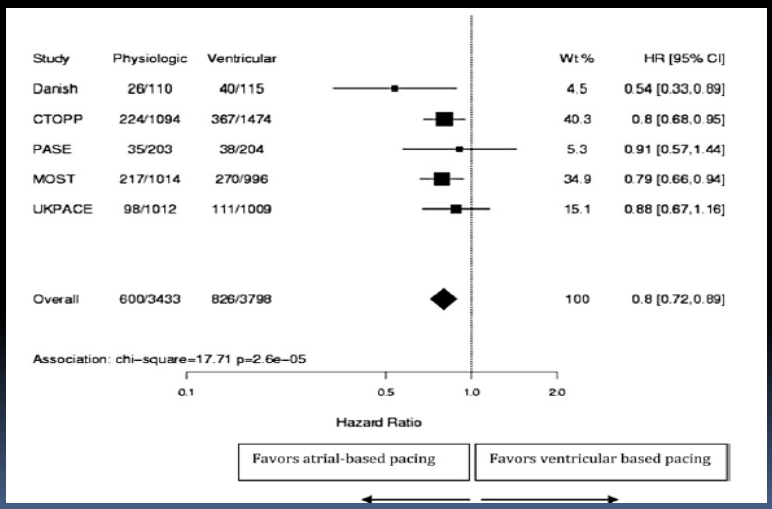
Evidence…

Table 2 Major randomized controlled trials*

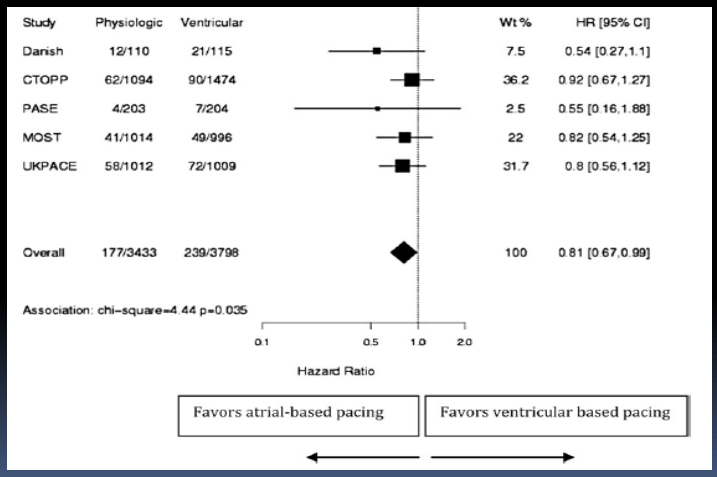
Characteristics	Danish study[14]	PASE[5]	CTOPP[6,7]	MOST[8]	DANPACE[10]	UKPACE[22]
Patient population	SSS	SSS plus AVB	SSS plus AVB	SSS	SSS	AVB
Patients with SSS/AVB	220/0	175/232	1028/1540	2010/0	1415/0	0/2021
Mean or median follow-up (yr)	5.5	1.5	3.5 6.4 (extended CTOPP)	2.8	5.4	3.0
Pacing modes	AAI vs. VVI	DDDR vs. VVIR	DDD/AAI vs. VVI(R)	DDDR vs. VVIR	AAIR vs. DDDR	DDD(R) vs. VVI(R)
Primary endpoint	Composite of mortality, thromboembolism and AF	Health-related quality of life as measured by the SF-36	Stroke or CV mortality	All-cause mortality or nonfatal stroke	All-cause mortality	All-cause mortality
Secondary endpoints	CV mortality, HF, and AVB	All-cause mortality, nonfatal stroke, AF, and pacemaker syndrome	All-cause mortality, AF, HF hospitalization	Composite of all-cause mortality, first stroke, first HF; all-cause mortality; CV mortality; AF; pacemaker syndrome; health-related quality of life; Minnesota Living with HF score	Incidence of paroxysmal and chronic AF, stroke, HF, need for pacemaker reoperation	AF; HF; composite of stroke, transient ischemic attack, or other thromboembolism
Atrial fibrillation	24% AAI vs 35% VVI RRR 46%, $P = .012$	19% VVIR vs 17% DDDR, $P = .80$	Annual rate 6.6% VVI vs 5.3% DDD/AAI, RRR 18%, $P = .05$ Extended CTOPP: Annual rate 5.7% VVI vs 4.5% DDD/AAI, RRR 20.1%, $P = .009$	27.1% VVIR vs 21.4% DDDR, RRR 21%, $P = 0.008$	28.4% AAIR vs 23.0% DDDR, RRR 27%, $P = .024$	Annual rate 3.0% VVI/VVIR vs 2.8% DDD/DDDR, $P = .74$
Stroke/thromboembolism	12% AAI vs 23% VVI RRR 53%, $P = .023$		Annual rate 1.1% VVI vs 1.0% DDD/AAI, $P =$ NS (Extended CTOPP: Remained NS)	4.9% VVIR vs 4.0% DDDR, RRR 18%, $P = .36$	5.5% AAIR vs 4.8% DDDR, RRR 13%, $P = .59$	Annual rate 2.1% VVI/VVIR vs 1.7% DDD/DDDR, $P = .20$
Heart failure or hospitalization for heart failure			Annual rate 3.5% VVI vs 3.1% DDD/AAI, RRR 7.9%, $P = .52$	12.3% VVIR vs 10.3% DDDR, RRR 18%, $P = .13$		Annual rate 3.2% VVI/VVIR vs 3.3% DDD/DDDR, $P = .80$
Mortality, all-cause	35% AAI vs 50% VVI RRR 34%, $P = .045$	17% VVI vs 16% DDDR, $P = .95$	Annual rate 6.6% VVI vs 6.3% DDD/AAI, RRR .9%, $P = .92$ (Extended CTOPP: Remained NS)	20.5% VVIR vs 19.7% DDDR, RRR 3%, $P = .78$	29.6% AAIR vs 27.3% DDDR, RRR 6%, $P = .53$	Annual rate 7.2% VVI/VVIR vs 7.4% DDD/DDDR, $P = .56$
Cardiovascular mortality	17% AAI vs 34% VVI RRR 53%, $P = .0065$			9.2% VVIR vs 8.5% DDDR, RRR 7%, $P = .61$		Annual rate 3.9% VVI/VVIR vs 4.5% DDD/DDDR, $P = .07$

- AF
- Stroke
- HF
- Quality of life
- Mortality
- PM syndrome
- Effect of RV pacing.
- Role of single chamber PM in SND(AAI-VVI)
- Rate adaptive pacing

AF…


Study
Physiologic
Ventricular
Wt %
HR [95% CI]
Danish 26/110 40/115 4.5 0.54 [0.33,0.89]
CTOPP 224/1094 367/1474 40.3 0.8 [0.68,0.95]
PASE 35/203 38/204 5.3 0.91 [0.57,1.44]
MOST 217/1014 270/996 34.9 0.79 [0.66,0.94]
UKPACE 98/1012 111/1009 15.1 0.88 [0.67,1.16]
Overall 600/3433 826/3798 100 0.8 [0.72,0.89]
Association: chi-square=17.71 p=2.6e-05
0.1
0.5
1.0
2.0
Hazard Ratio
Favors atrial-based pacing
Favors ventricular based pacing

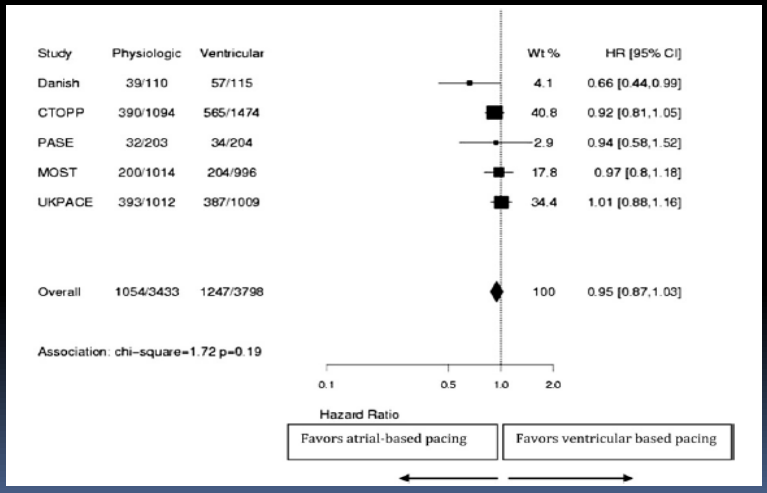
stroke…


Study
Physiologic
Ventricular
Wt %
HR [95% CI]
Danish 12/110 21/115 7.5 0.54 [0.27,1.1]
CTOPP 62/1094 90/1474 36.2 0.92 [0.67,1.27]
PASE 4/203 7/204 2.5 0.55 [0.16,1.88]
MOST 41/1014 49/996 22 0.82 [0.54,1.25]
UKPACE 58/1012 72/1009 31.7 0.8 [0.56,1.12]
Overall 177/3433 239/3798 100 0.81 [0.67,0.99]
Association: chi-square=4.44 p=0.035
0.1
0.5
1.0
2.0
Hazard Ratio
Favors atrial-based pacing
Favors ventricular based pacing

- HF and quality of life
- PM syndrome.
- RV pacing.
- Single chamber: AAI (? < 70 years- DANPACE increase AF ? With AAI)

  VVI (back up non frequent pacing, AF, sedentary life, comorbidities)
- Rate adaptive: evidence of increased HF hospitalization and AF, no increase in exercise time at long term, reassessed at FUP

All cause mortality..



AV Nodal disease

- Class I

1. Dual-chamber pacing is recommended in patients with AV block (Level of Evidence: C)
2. Single-chamber ventricular pacing is recommended as an acceptable alternative to dual-chamber pacing in patients with AV block who have specific clinical situations that limit the benefits of dual-chamber pacing. These include, but are not limited to, sedentary patients, those with significant medical comorbidities likely to impact clinical outcomes, and those in whom technical issues, such as vascular access limitations, preclude or increase the risk of placing an atrial lead (Level of Evidence: B)
3. Dual-chamber pacing is recommended over single-chamber ventricular pacing in adult patients with AV block who have documented pacemaker syndrome (Level of Evidence: B)

- Class II

1. Single-lead, dual-chamber VDD pacing can be useful in patients with normal sinus node function and AV block (eg, the younger patient with congenital AV block) (Level of Evidence: C)
2. VVI pacing can be useful in patients following AV junction ablation, or in whom AV junction ablation is planned, for rate control of AF due to the high rate of progression to permanent AF (Level of evidence B)

- Class III

1. Dual-chamber pacing should not be used in patients with AV block in permanent or longstanding persistent AF in whom efforts to restore or maintain sinus rhythm are not planned (Level of Evidence: C)

Evidence…

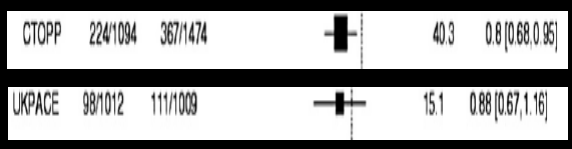
- The optimal pacing mode for patients with AV block has been the subject of debate.
- Randomized clinical trials (PASE, CTOPP, and UKPACE) have compared dual-chamber pacing to VVI pacing in patients with AV block.

Findings…

1-AF :

-CTOPP

-UKPACE



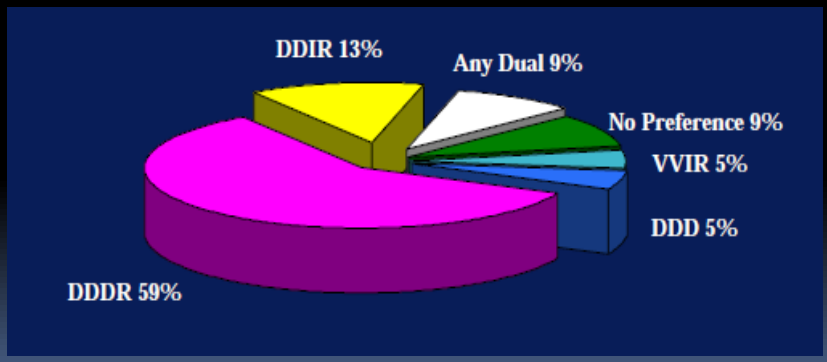
2- Stroke:

3- Mortality:

4- HF:

5- PM syndrome:

6- **Exercise Capacity and patient preference**



- Although it is clear that the majority of patients who have already experienced pacing, prefer dual, neither PASE nor CTOPP reported significant differences in quality of life.
- studies of pacing mode confirmed that pacing clearly improved quality of life over no pacing, but it did not show a difference between dual- and single-chamber pacing

- pacing mode may be more important in younger active patients. Unlike patients enrolled in the PASE study with multiple comorbidities.

Factors Influencing Choice of DDD over VVI

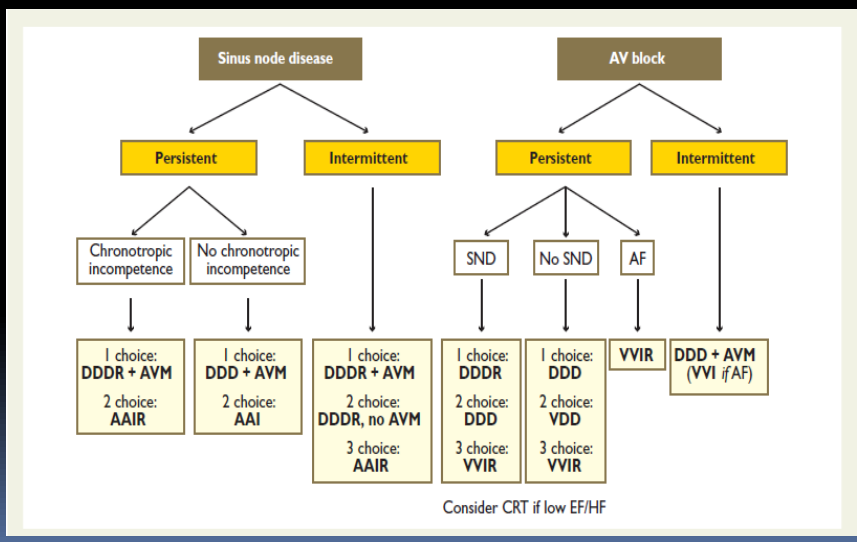
1- DDD preferred for more physically active patient preserve AV synchrony and Sinus chronotropic response rather than by activity sensor

2-Any degree of systolic +/- diastolic dysfunction where maintenance of AV synchrony is important for preserving hemodynamics.

Outcome of randomized controlled trials of dual-chamber versus ventricular pacing

Outcome	References	Dual-chamber benefit over ventricular pacing	Notes
All-cause deaths	2, 11–15	No benefit	
Stroke, embolism	2, 11–15	Benefit (in meta-analysis only, not in single trial)	HR 0.80.[12] Benefit higher in SSS.
Atrial fibrillation	2, 11–15	Benefit	HR 0.81[12] and 0.76.[13] Benefit higher in SSS.
HF, hospitalization for HF	2, 11, 12, 14, 15	No benefit	
Exercise capacity	15	Benefit	Overall standardized mean improvement of 35%. Not significant compared to VVIR.
Pacemaker syndrome	11–13, 15	Benefit	Documented in up to 25% of VVI patients.
Functional status	11, 12, 15	No benefit	
Quality of life	11–13, 15	Variable	Consistent direction of effect on quality of life, but the size cannot be estimated with confidence.
Complications	2, 11–13, 15	More complications with dual-chamber	Higher rate of lead dislodgment (4.25 vs. 1.4%) and inadequate pacing (1.3 vs. 0.3%).

Mode Selection Algorithm



Other indications…

Hypersensitive Carotid Sinus Syndrome

- AAI pacing alone has been shown to be ineffective in this syndrome.
- Class IIa

1. Dual-chamber or single-chamber ventricular pacing can be useful for patients with hypersensitive carotid sinus syndrome (Level of Evidence: C)

- Class III

1. Single-chamber AAI pacing is not recommended for patients with hypersensitive carotid sinus syndrome (Level of Evidence: C)

Neurocardiogenic syncope

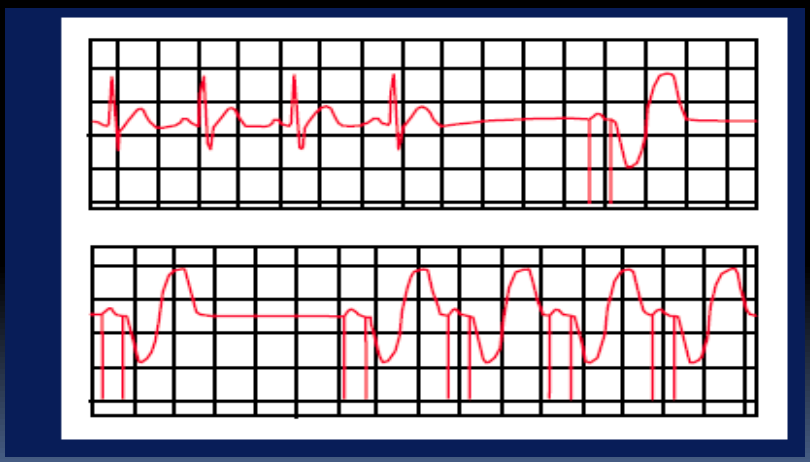
- Class IIa

1. Dual-chamber pacing can be useful for neurocardiogenic syncope (Level of Evidence: C)

- Class III

1. Single-chamber AAI pacing is not recommended for neurocardiogenic syncope (Level of Evidence: C)

Rate drop response…



Long QT

- Class I

1. Dual-chamber or atrial pacing compared to ventricular pacing is recommended for symptomatic or high-risk patients with congenital long QT syndrome (Level of Evidence: C)

HOCM

- Class IIa

1. Dual-chamber pacing can be useful for patients with medically refractory, symptomatic hypertrophic cardiomyopathy with significant resting or provoked left ventricular outflow obstruction (Level of Evidence: C)

- Class III

1. Single-chamber (VVI or AAI) pacing is not recommended for patients with medically refractory, symptomatic hypertrophic cardiomyopathy (Level of Evidence: C)

Take home message

- SND derive benefit from atrial or dual-chamber pacing compared with ventricular pacing with regard to the risks of AF, stroke, pacemaker syndrome, and improved quality of life
- AV Block DDD failed to show benefit over ventricular pacing regarding major outcomes including mortality, stroke, HF, and AF, it can reduce the incidence of PM syndrome and improve some indices of quality of life

- For less common indications for pacing, the recommendations to consider dual-chamber pacing are based on small clinical studies. It is unlikely that large randomized trials will ever be conducted in these unique clinical subgroups.


Thank
you!