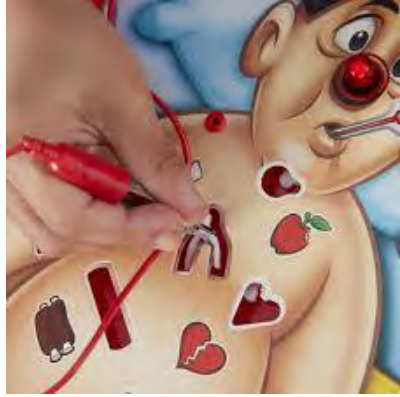


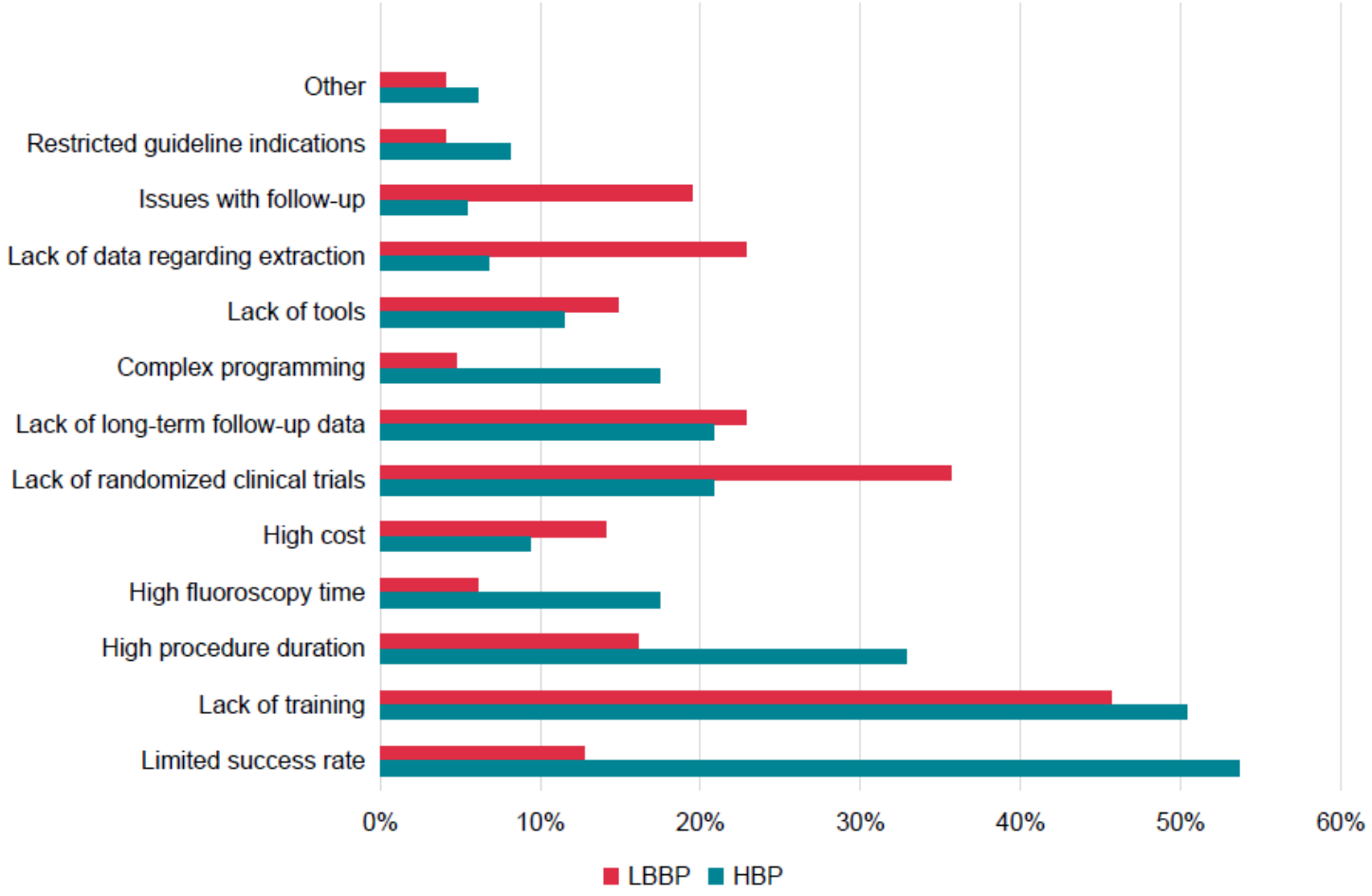
Conduction System Pacing
Summer Summit Berlin
13./14.06.2025

Training and Education

P. Nagel

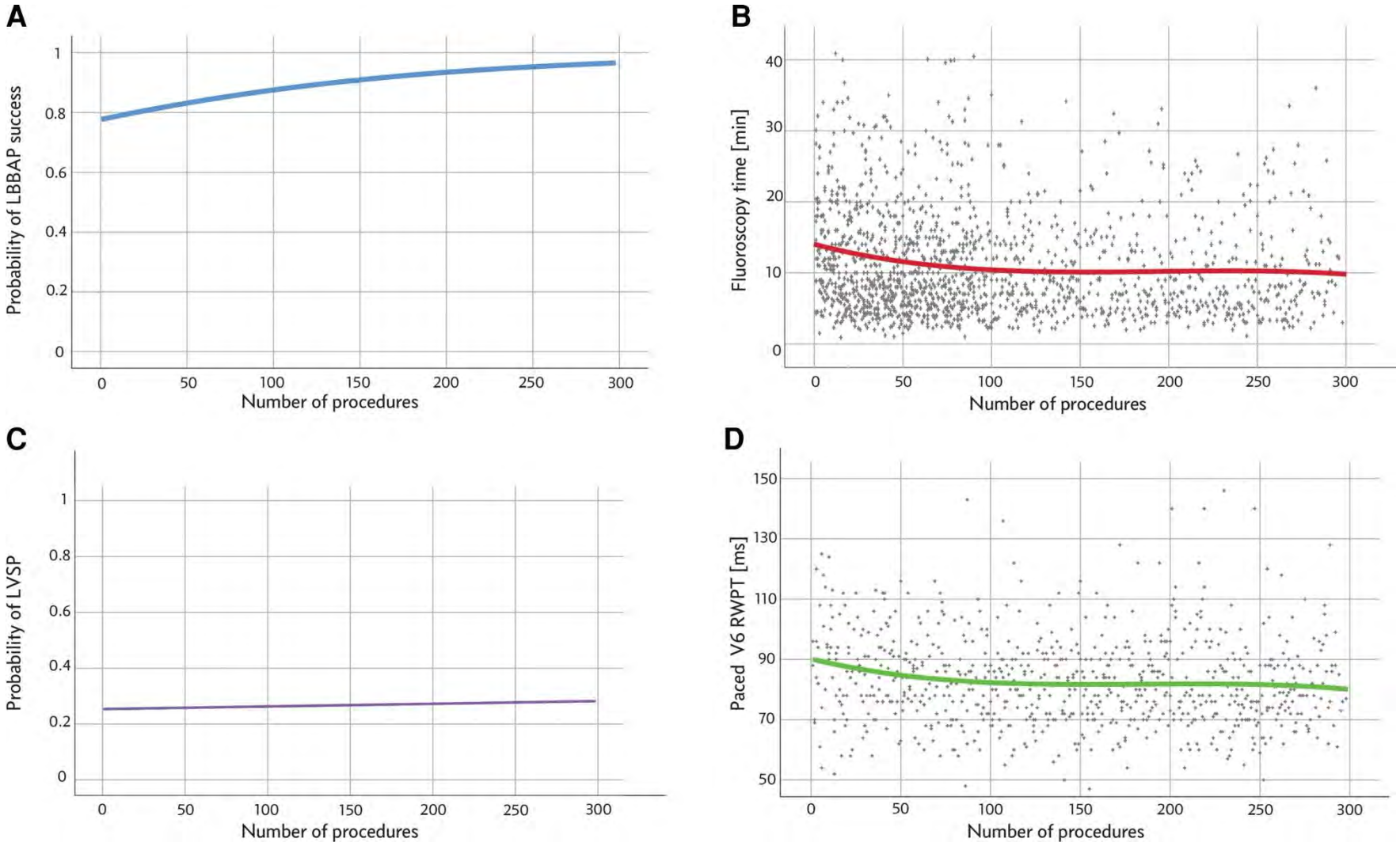
Why do you need Training?

- Lack of training perceived as one of the biggest hurdles in establishing CSP-Programm
- Long procedure/fluroscopy time and limited success direct consequences hereof



Kircanski, Europace 2023

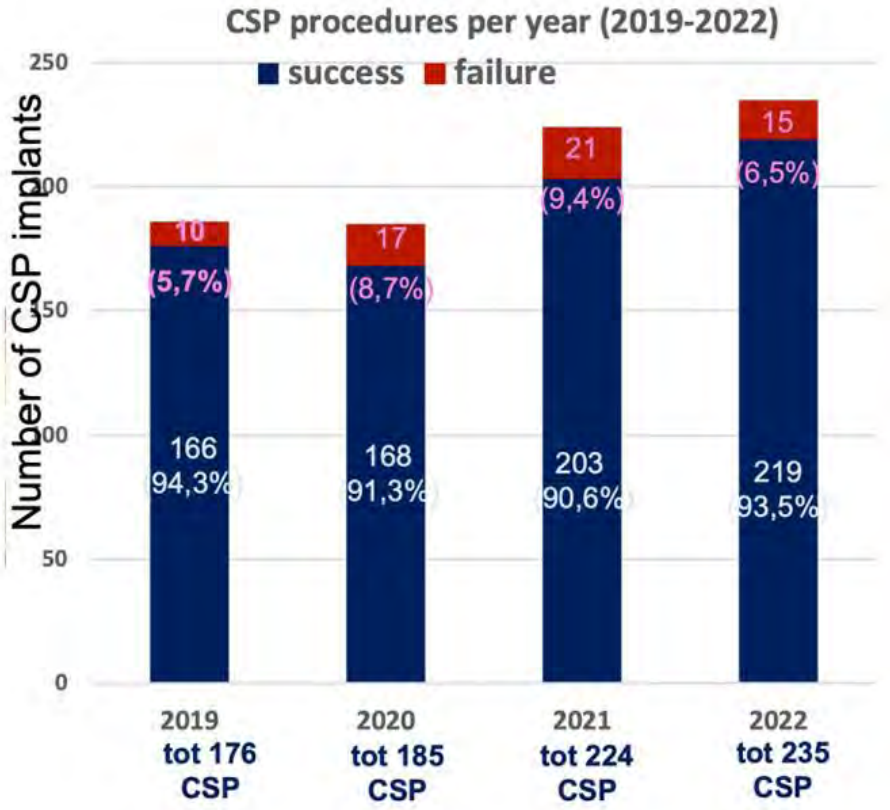
Successrate?



Jastrzebski et al. – Eur Heart J 2022

Successrate?

- Failure Rate will never be 0%
- Achieving CSP gets harder with complexity of patients disease
- Successrate of 90% should be aimed for



Marcantoni et al. – EP Euopace 2024

How to get more successful in CSP?

1. **Inform yourself and get trained**
2. Involve your team
3. Optimize Lab Setup
4. Choose the right patient
5. Choose the right tools
6. Choose the right technique
7. Set your limits
8. Optimize Programming and follow up
9. Monitor your performance
10. Stay up to date

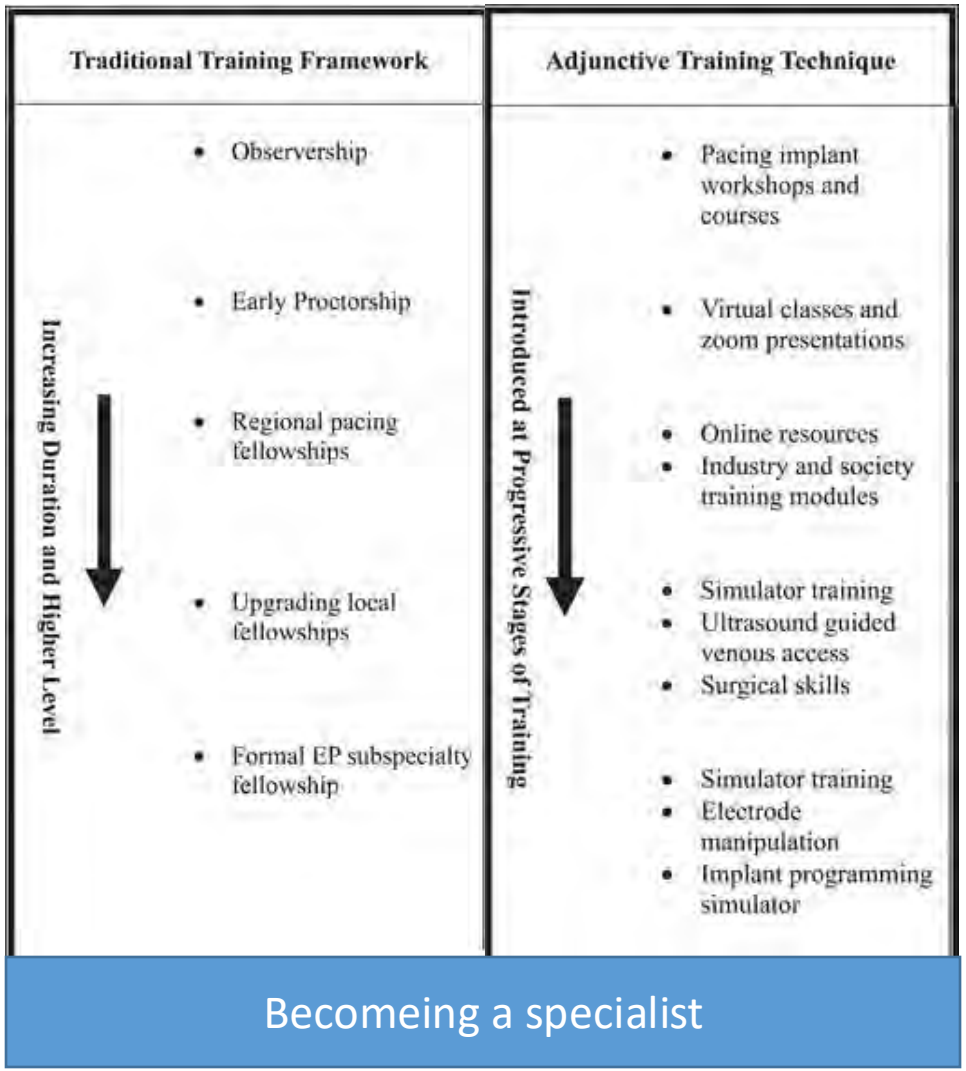
Burri, Rev Port Cardiol 2023

How to train and get informed?

- Observe and learn (eg Preceptorship)
- Gain practical experience
- Use Proctorship Programs in your own institution

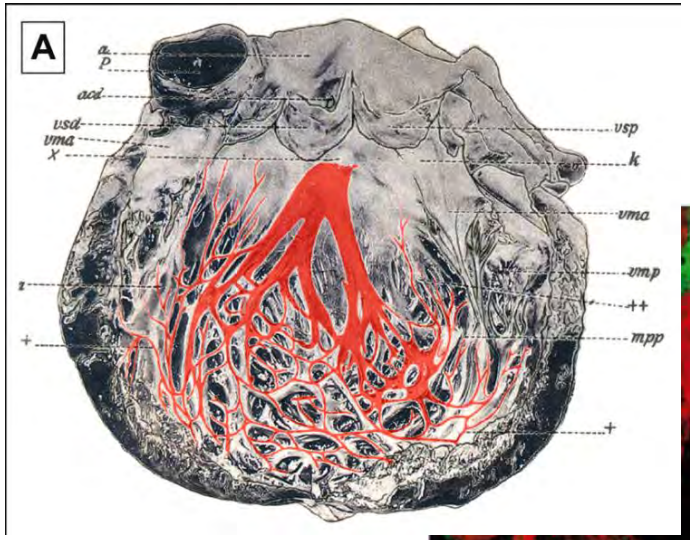
How to train and get informed?

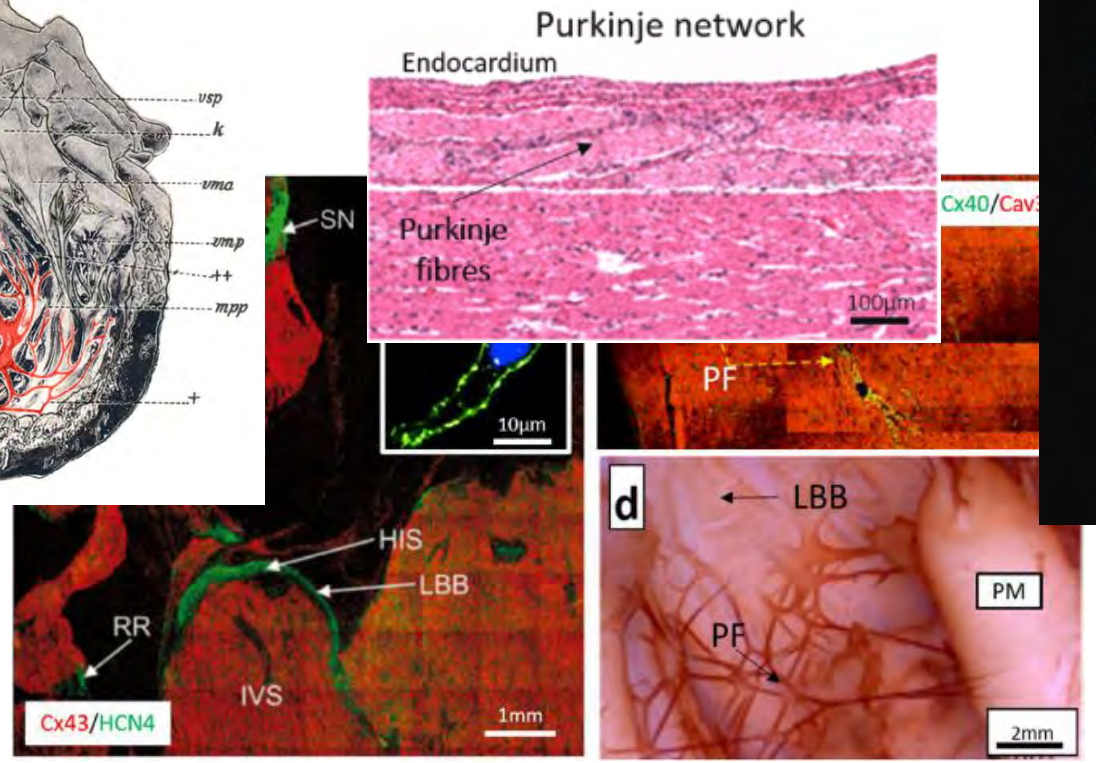
- Observe and learn (eg Preceptorship)
- Gain practical experience
- Use Proctorship Programs in your own institution
- Use all available resources for training
  - → Online resources, webinars, workshops
  - → Simulatortrainings
  - → Anatomy Workshops
  - → Peer Discussions

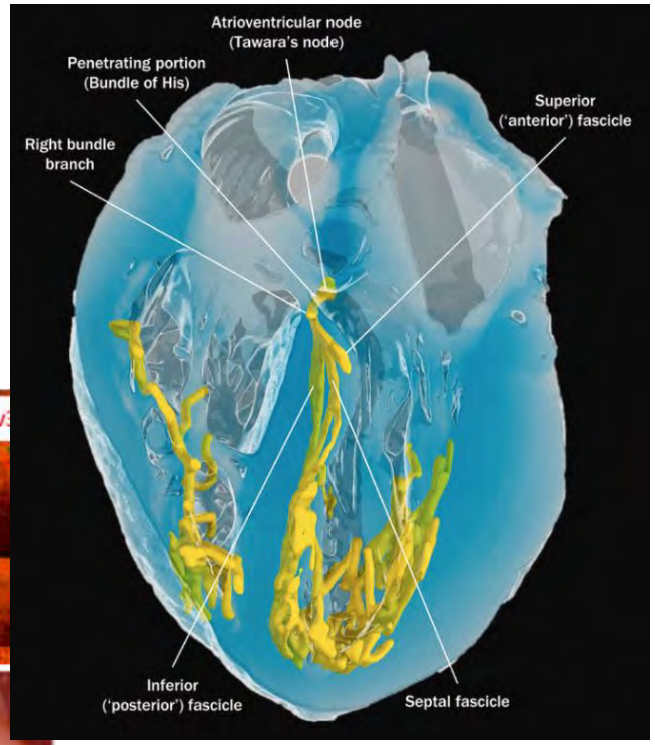


What do you need to train?

- Anatomy ReCap (macroscopic and microscopic)





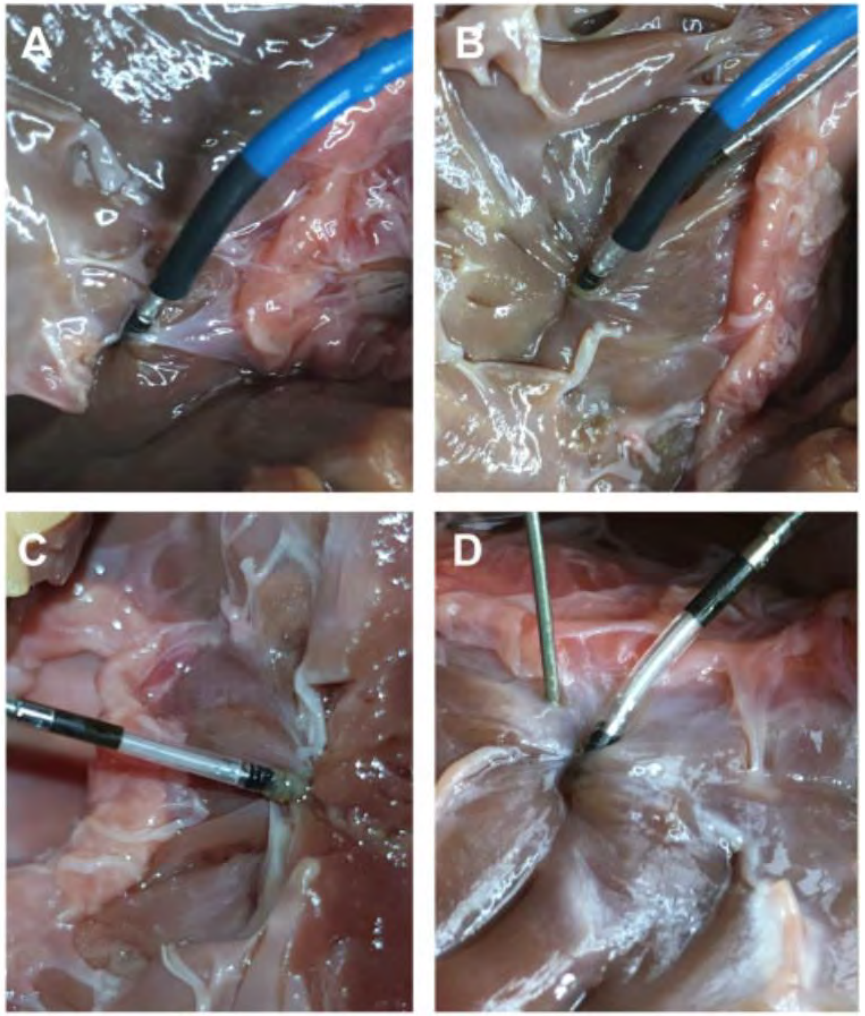


Arshad et al. – Transl Res Anatomy 2022

Vijayaraman et al. – J Am Coll Card EP 2022

Anatomy with the help of animal models

- Understanding anatomy in 3 (4) dimensions
- Gain haptic understanding of tissue differences
- Understand effects like ‚entanglement' or ‚drilling'
- LV perforation is demonstrable



Jastrzebski et al. – Europace 2020

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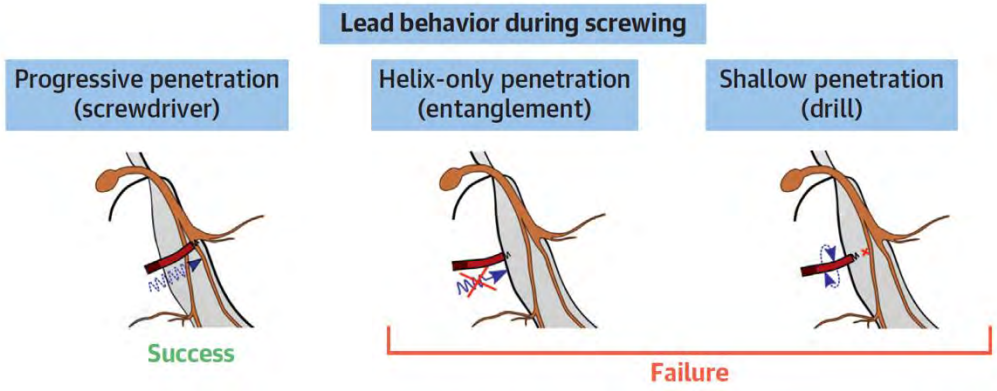
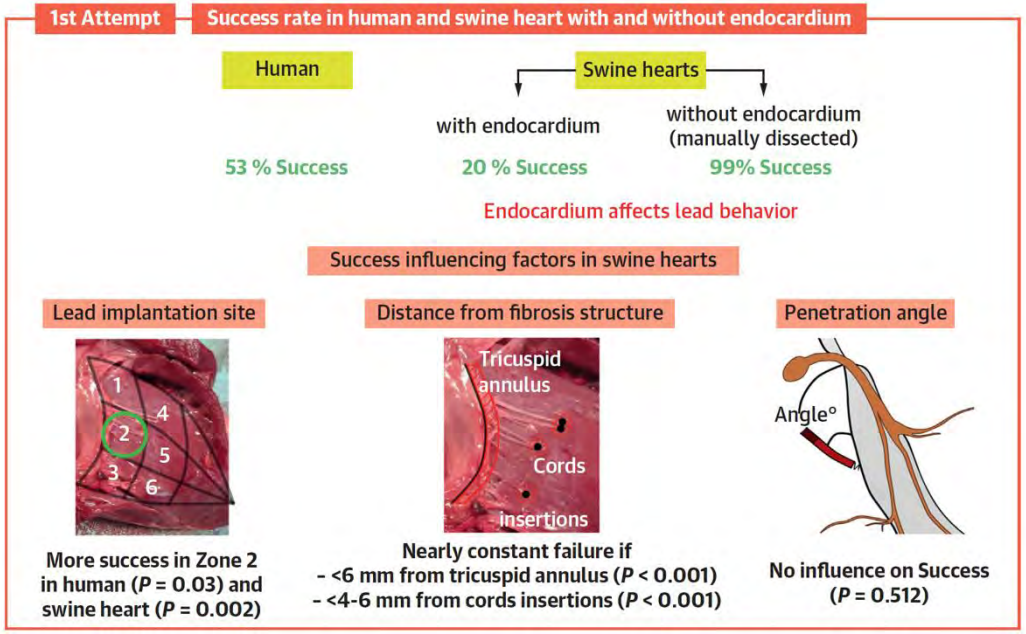




Menet et al. – JACC EP 2024

Limitations in animal models

- Pigs are not humans
- No electrophysiological feedback

- Quality of pig heart specimen and storage
- Procedural approach
- Cultural / ethical concerns of potential trainees

Anatomical Differences Between Human and Pig Hearts and Their Relevance for Cardiac Xenotransplantation Surgical Technique

Aakash Shah, MD,[a] Corbin E. Goerlich, MD, PhD,[a] Chetan Pasrija, MD,[a] Jeffrey Hirsch, MD,[b] Stacy Fisher, MD,[c] Patrick Odonkor, MD,[d] Erik Strauss, MD,[d] David Ayares, PhD,[e] Muhammad M. Mohiuddin, MD,[a] Bartley P. Griffith, MD[a]

Shah et al. – JACC Clinical Case 2022

What do you need to train?

- Anatomy ReCap

- Procedural skills:
  - → Handling of designated implantation tools (leads/sheaths/slitting tools)
  - → Location of lead penetration site
  - → Septal Penetration
  - → Signal Interpretation

Know your tools

- Different lead types
- Different catheters / Sheaths
- Different connectors
- Different programming

Lead with stylet lumen

Empty space into the inner coil allows to insert a stylet.

Advantages

- Wider diameter and differet choice of stylets may guarantee better support during lead placement.
- Easy continuous monitoring of ECG and impedance.

Limitations

- Possible failure of inner conductor coil at sites of sharp bends and high stress.
- Complex system of stylet together with catheter delivery.
- Incresed outer diameter.

Lumenless lead

Cable to tip occupies center space.

Advantages

- Lead body tensile strength with cable inner conductors.
- Only needs a fixed shape or a deflectable catheter for delivery.
- Efficient use of cross-sectional area.

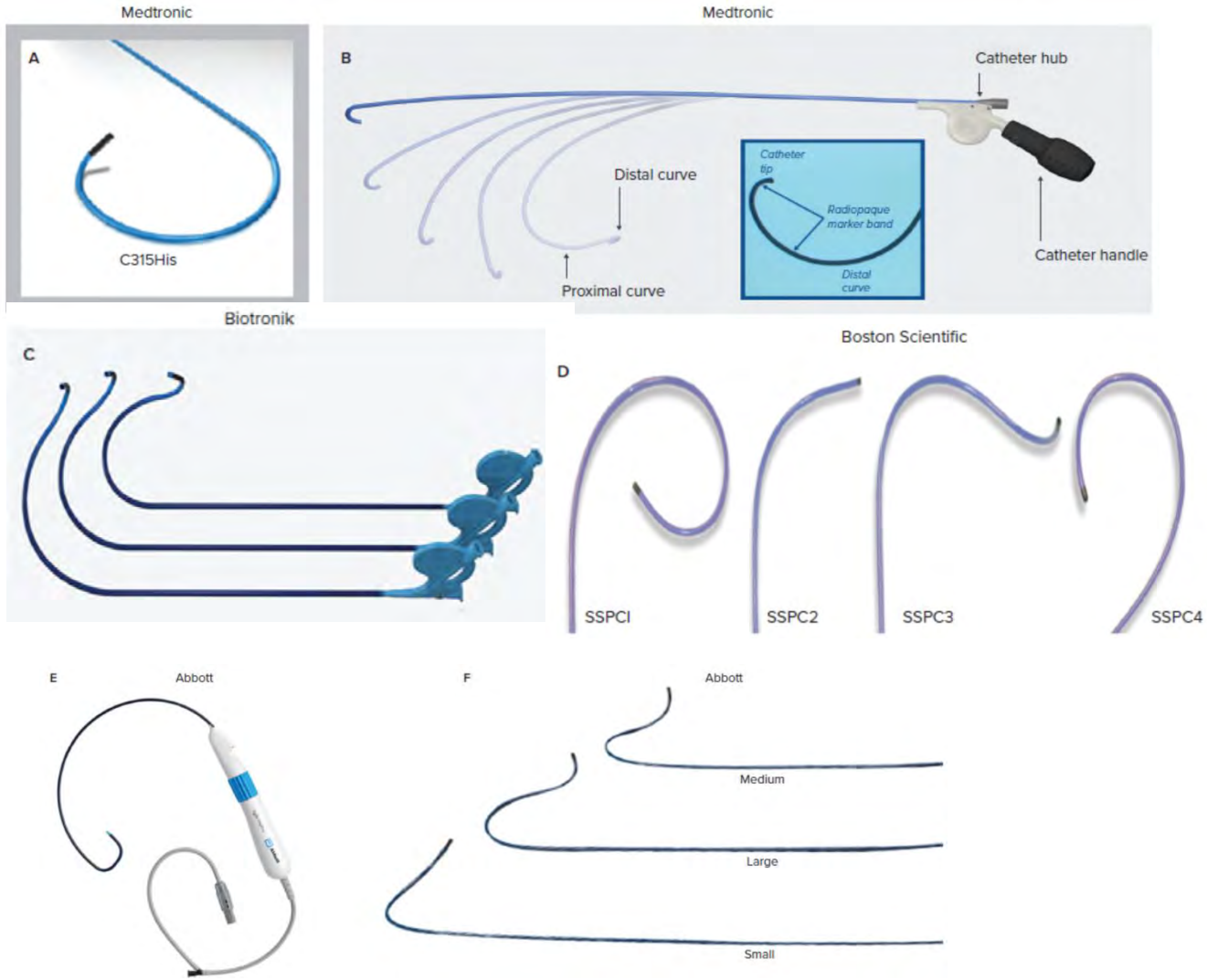
Limitations

- Change in implant/extraction procedure.
- Non retractable helix during lead extractions. Limited experience.

Taddeucci et al. – J Clin Med 2024

Know your tools

- Different lead types
- Different catheters / Sheaths
- Different connectors
- Different programming



Cano et al. – AER 2024

Know your tools

- Different lead types
- Different catheters / Sheaths
- Different connectors
- Different programming

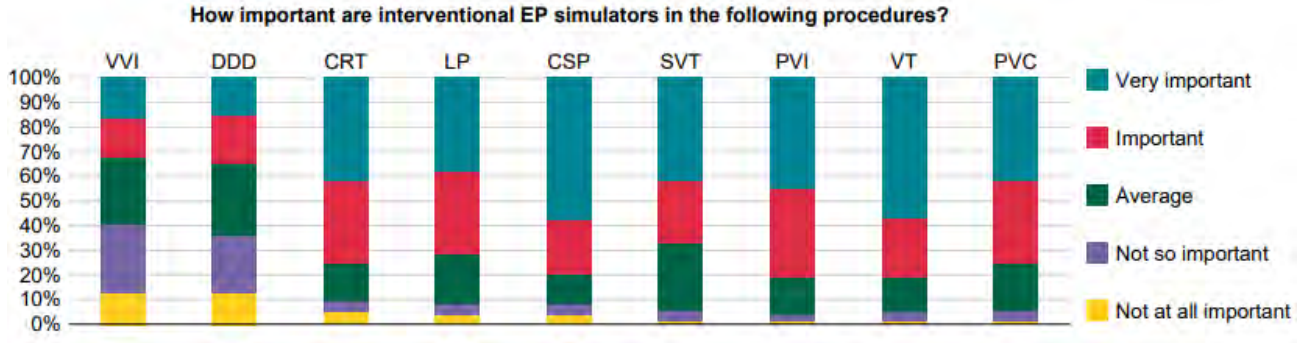
Table 1: Programming Recommendations for Conduction System Pacing

Parameter	Recommendation HBP	Recommendation LBBAP
Pacing mode	Single-chamber device: VVI Dual-chamber or CRT device: • HBP lead in a ventricular port: DDD(R), DDI or managed ventricular pacing mode • HBP lead in atrial port (chronic AF) with backup ventricular lead: DDD(R), DDI(R) or DVI(R) if available	Single-chamber device: VVI Dual-chamber or CRT device: • LBBAP lead in a ventricular port: DDD(R), DDI or managed ventricular pacing mode. • LBBAP lead in atrial port (chronic AF) with backup ventricular or ICD lead: DDI(R) or DVI(R) if available
Pacing polarity	Unipolar (better visibility of the pacing spike to avoid confounding with intrinsic rhythm, lower capture thresholds) Bipolar (lower durrent drain due to higher impedance)	Bipolar (lower current drain due to higher impedance; anodal capture may narrow the QRS) Unipolar if anodal capture is not desirable
Sensing vector	Bipolar (unipolar can be tried if low sensing amplitude or P wave/HB potential oversensing)	Bipolar
Sensitivity	HBP lead connected to atrial channel: set to the maximum value (minimum sensitivity), as ventricular sensing is provided by the backup ventricular lead HBP lead connected to RV channel: adjust the level to ensure ventricular sensing, yet avoid oversensing of atrial or HB potentials	Usually, not an issue as R waves are of high amplitude
Output voltage	2 × threshold voltage Fixed safety margin, e. g. 1 V above the threshold, in non-dependent patients	2 × threshold voltage
Impulse duration	0.4 ms (1.0 ms if high capture threshold). 0.2–0.4 ms may be programmed according to chronaxie	0.4 ms (capture threshold is rarely an issue)
Automatic capture control algorithms	Deactivate, monitoring only (may be inaccurate or impossible to measure, especially if the HBP lead is connected to the atrial port)[6], or activate only once the accuracy has been confirmed in the patient	Set to monitor or automatic once the accuracy has been confirmed in the patient
AV delay	HBP lead in ventricular port: Subtract HV interval (e.g. 40 ms) from desired AV interval HBP lead in atrial port with backup ventricular pacing: AV delay >His pace-RVS interval (e.g. 150 ms) HBP lead in atrial port with HOT-CRT: optimise AV interval based on QRS narrowing, or program empirically to 60% of the His pace – RV sense interval (usually 40–60 ms)[6]	LBBAP lead in ventricular port: Subtract LBB-V interval (e.g. 20 ms) from desired AV interval LBBAP lead in atrial port with backup ventricular pacing: AV delay >LBBAP–RVS interval (e.g. 150 ms) LBBAP lead in atrial port with LOT-CRT: optimise AV interval based on QRS narrowing
VV delay (CSP lead connected to LV port)	With backup RV pacing: program maximum LV channel pre-excitation (e.g 80 ms) In case fusion with RV pacing is desirable (e.g. in case of uncorrected RBBB): program LV channel pre-excitation 30–60 ms, optimised by surface ECG	With backup RV pacing (e.g. with ICD lead): program maximum LV channel pre-excitation (e.g 80 ms)
Ventricular safety pacing	Deactivate if the HBP lead is connected to the atrial port with an RV back-up lead, after having verified absence of crosstalk	Deactivate if the LBBAP lead is connected to the atrial port with an RV back-up lead (e.g. with an ICD or in case of LOT-CRT), after having verified absence of crosstalk
Automatic sensing control algorithms	Deactivate (P wave oversensing and HB sensing (may lead to asystole!)	Can be left on
Sensing if CSP lead connected to LV port	Deactivate (Biotronik, Boston-Scientific)	Deactivate (Biotronik, Boston-Scientific)
AV and VV optimisation algorithms	Deactivate	Deactivate
Ventricular triggered pacing (ventricular sense response, etc.)	Deactivate	Deactivate

AV = atrioventricular; CSP = conduction system pacing; HB = His bundle; HBP = His bundle pacing; HV = His-ventricle; HOT-CRT = His-optimised CRT; LBB = left bundle branch; LBBAP = left bundle branch area pacing; LOT-CRT = left bundle branch pacing optimised CRT; LV = left ventricular; RBBB = right bundle branch block; RV = right ventricular; VSP = ventricular safety pacing; VV = interventricular.

Training with Simulators

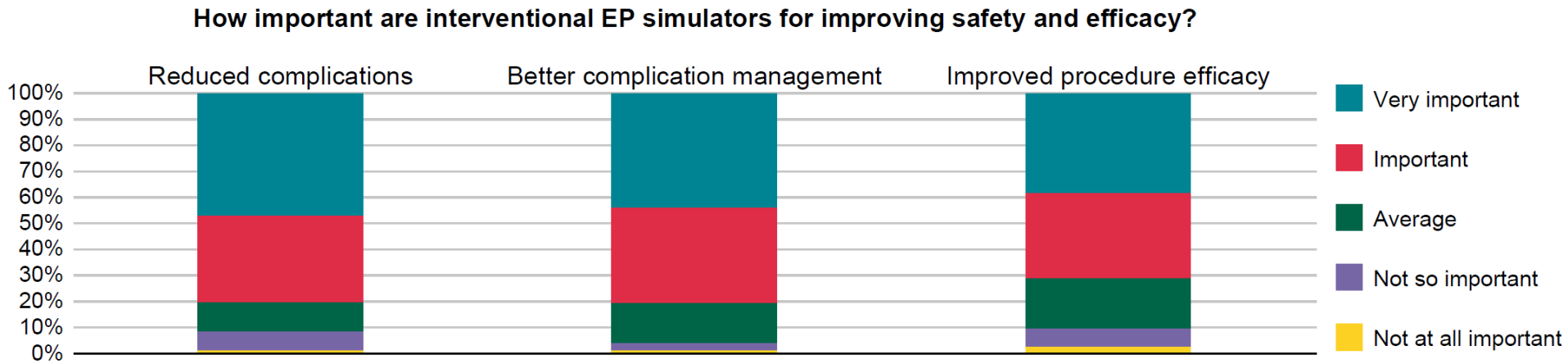
- Specially designed programs for CSP-lead implantation available
- Different levels of difficulty can be trained
- Mentice Simulator Device is transportable



Tjong et al, Europace 2024

Training with Simulators

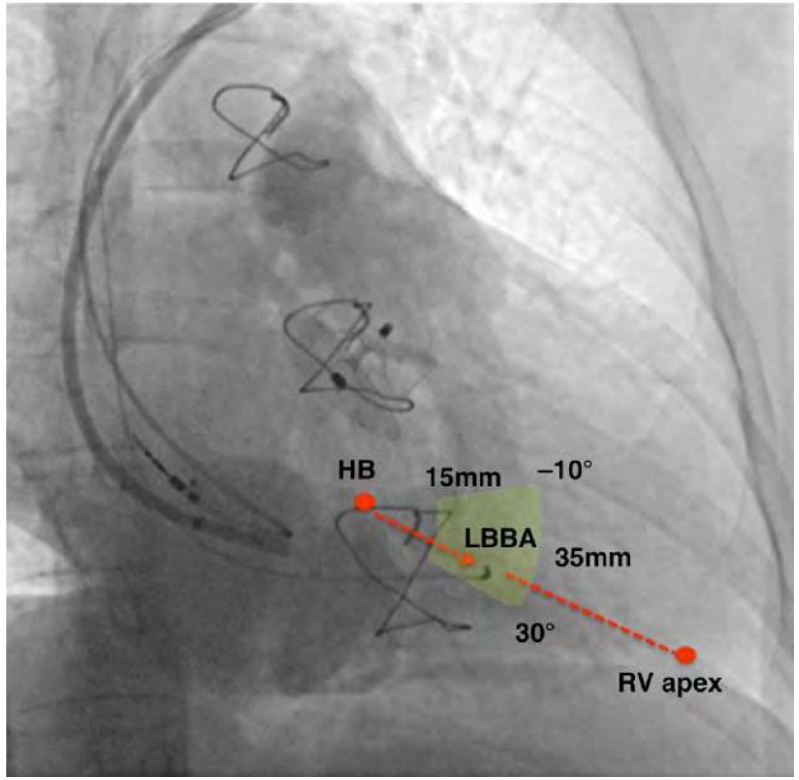
- Perceived improvement in reduction of complications, management of complications and procedure efficacy
- Reduced radiation exposure
- Patient safety increase due to upskilling in virtual environment

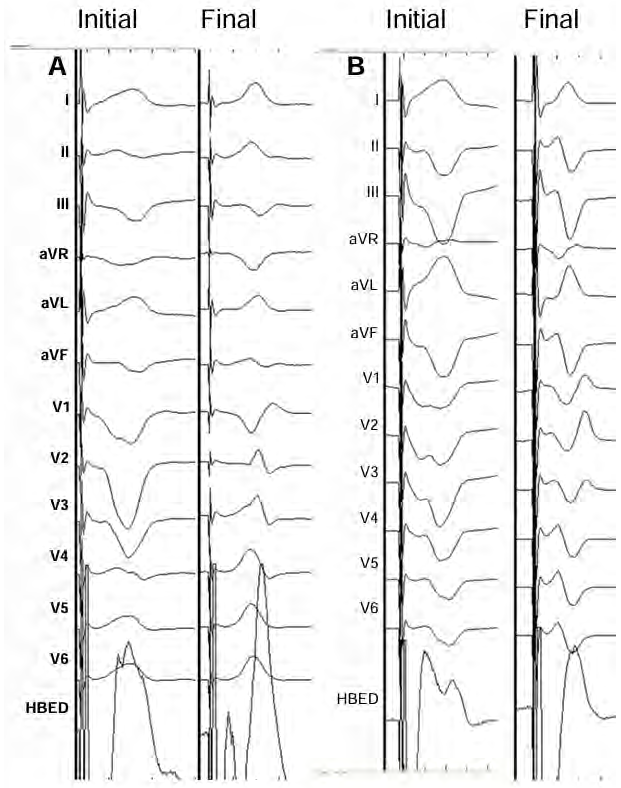


Tjong et al, Europace 2024

What can be simulated?

- Lead Positioning on the septum
- Electrophysiological behavior during septal passage





Burri et al. – Europace 2023

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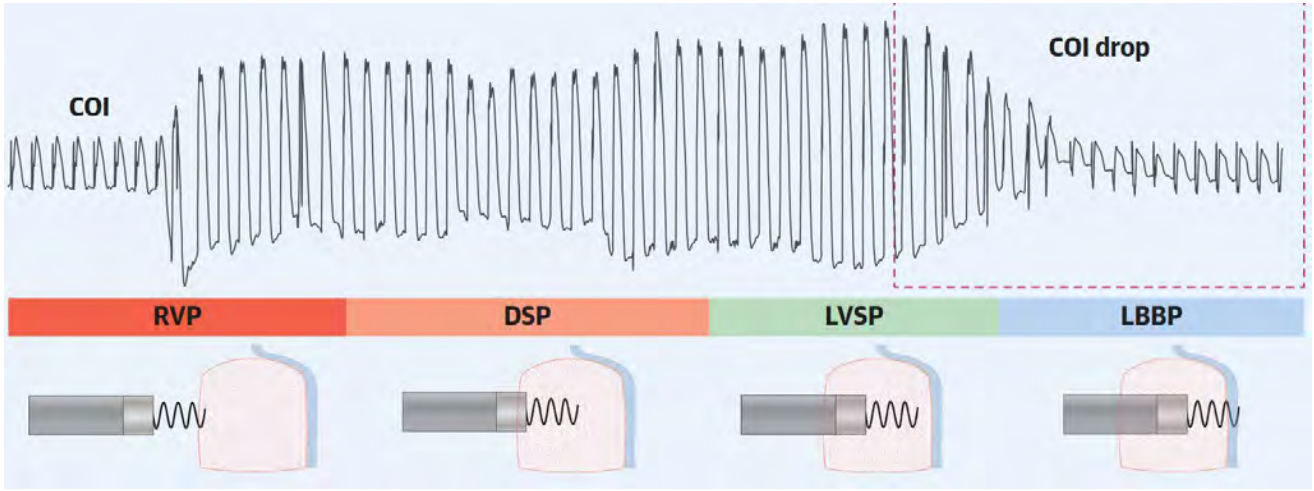


Jastrzebski et al. – JACC EP 2024

Limitations of Simulators

- Limitations in simulating tissue-lead interaction
- Procedural effects as entanglement or drilling are hard to be simulated
- Limited availability in educational organizations
- Gain for already trained professionals?

Simulator programmes are therefore perceived useful not only by electrophysiologist at the initial phase of their career but also by electrophysiologist in a more advanced stage, as reported in the present survey where half of the respondents were aged below 40 years old, but 47% were aged in the range 40–59 years, with a mean of 10 years of experience in EP.

Tjong et al, Europace 2024

What do you need to train?

- Anatomy ReCap

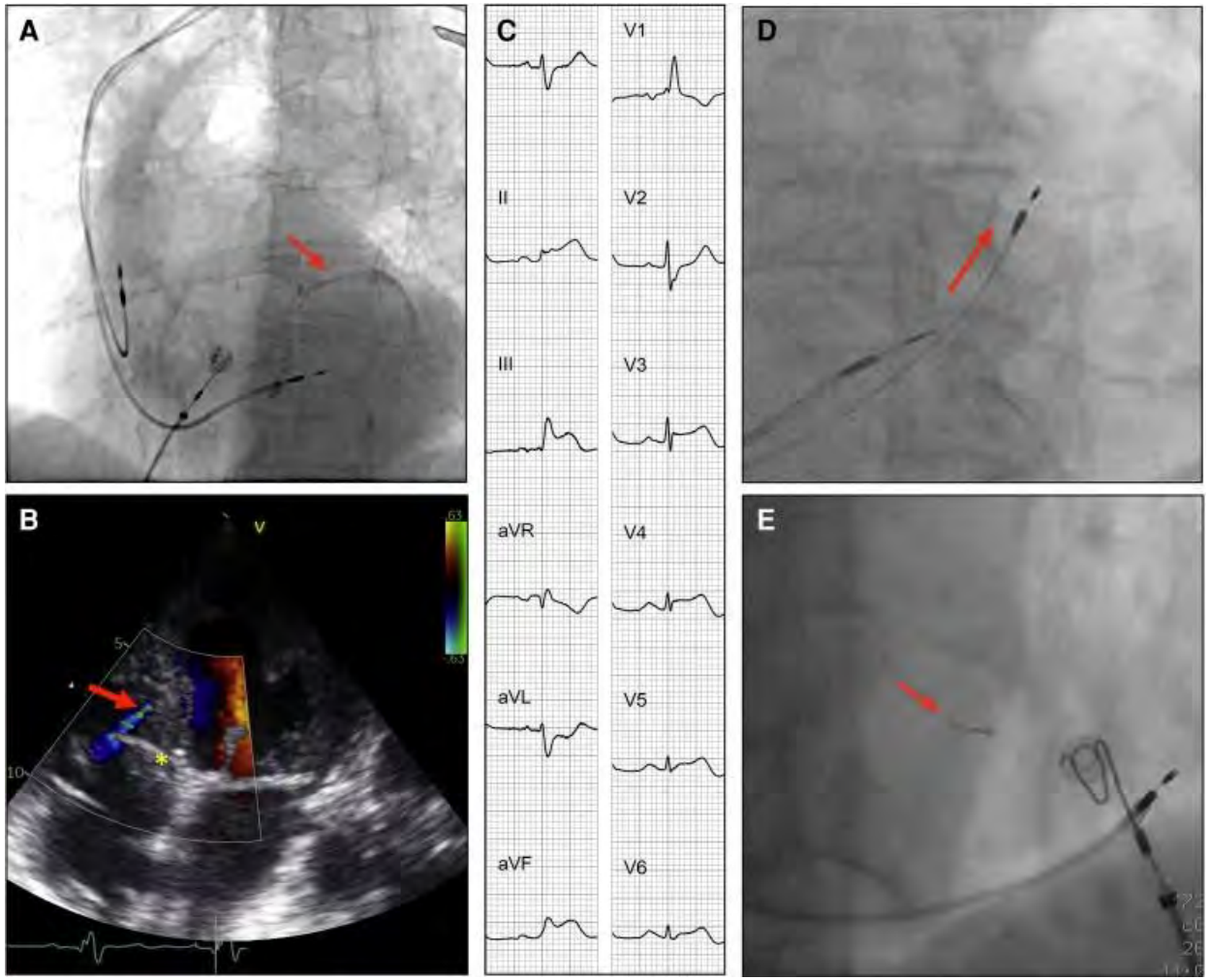
- Procedural skills:
  - → Handling of designated implantation tools (leads/sheaths/slitting tools)
  - → Location of lead penetration site
  - → Septal Penetration
  - → Signal Interpretation

- Manage (or learn to avoid) your complications
  - → Learn about possible complications
  - → Develop strategies to cope with complications

Complications in CSP

- Train yourself to look out for possible complications
- Get your team trained to react on complications
- Avoid the avoidable

LBBAP lead complications	8.3%
• Acute perforation to LV	3.7%
• Lead dislodgement	1.5%
• Acute chest pain	1.0%
• Capture threshold rise	0.7%
• Acute coronary syndrome	0.4%
• Trapped/damaged helix	0.4%
• Delayed perforation to LV	0.1%
• Other	0.7%



Jastrzebski et al. – Eur Heart J 2022

Know your mistakes, and overcome them

- Document your advances
- Adjust your technique according to your results
- Look for hidden errors (Lab Setting, Lead Handling, Programming,..)
- Be your own worst critic

Know the literature..

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]

[1]Cardiac Pacing Unit, Cardiology Department, University Hospital of Geneva, Rue Gabrielle Perret Gentil 4, 1211 Geneva 14, Switzerland; [2]First Department of Cardiology and Electrocardiology and Arterial Hypertension, Jagiellonian University, Kopernika 17, 31-501 Kraków, Poland; [3]Hospital Universitario y Politecnico La Fe, Avinguda de Fernando Abril Martorell 106, 46026 Valencia, Spain; [4]Centro de Investigaciones Biomédicas en RED en Enfermedades Cardiovasculares (CIBERCV), Av. Monforte de Lemos, 3-5 Pabellón 11, Planta 0 28029 Madrid, Spain; [5]Cardiocenter, Third Faculty of Medicine, Charles University and University Hospital, Kralovske Vinohrady, Ruská 87, 100 00 Prague 10, Czech Republic; [6]Heart Centre, University Hospital Ghent, Corneel Heymanslaan 10, 9000 Gent, Belgium; [7]The First Affiliated Hospital of Wenzhou Medical University, Nanbaixiang, Wenzhou 325000, China; [8]Bethel-Clinic, Burgsteig 13, 33617, Bielefeld, Germany; [9]Department of Medicine, McGill University Health Center, 1001 Decarie Boulevard, H4A 3J1 Montreal (Quebec), Canada; [10]Brigham and Women's Hospital, 75 Francis St, Boston, MA 02115, USA; [11]Department of Cardiology, Cardiovascular Research Institute Maastricht (CARIM), Maastricht University Medical Center, Universiteitssingel 50, 6229 Maastricht, the Netherlands; [12]Geisinger Wyoming Valley Medical Center, 1000 East Mountain Blvd., Wilkes-Barre, PA 18711, USA; [13]National Heart and Lung Institute, Imperial College London, Guy Scadding Building, Dovehouse St, London SW3 6LY, UK; and [14]Arrhythmia and Electrophysiology Unit, Santa Maria della Misericordia General Hospital, Viale Tre Martiri 140, 45100 Rovigo, Italy

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ESC European Society of Cardiology
Europace (2025) 27, euaf050
https://doi.org/10.1093/europace/euaf050

EHRA DOCUMENT

EHRA European Heart Rhythm Association

European Society of Cardiology (ESC) clinical consensus statement on indications for conduction system pacing, with special contribution of the European Heart Rhythm Association of the ESC and endorsed by the Asia Pacific Heart Rhythm Society, the Canadian Heart Rhythm Society, the Heart Rhythm Society, and the Latin American Heart Rhythm Society

Michael Glikson, FESC (Chair)[1,2]*, Haran Burri, FEHRA, FESC (Chair)[3]*, Amr Abdin[4], Oscar Cano[5,6], Karol Curila[7], Jan De Pooter[8], Juan C. Diaz, (LAHRS Representative)[9], Inga Drossart, (ESC Patient Forum Representative)[10,11], Weijian Huang, (APHRS Representative)[12], Carsten W. Israel[13], Marek Jastrzębski[14], Jacqueline Joza, (CHRS Representative)[15], Jarkko Karvonen[16], Daniel Keene[17], Christophe Leclercq, FESC, FEHRA[18], Wilfried Mullens[19], Margarida Pujol-Lopez[20], Archana Rao[21], Kevin Vernooy, FESC, FEHRA[22], Pugazhendhi Vijayaraman, (HRS Representative)[23], Francesco Zanon[24], and Yoav Michowitz, (Document Coordinator)[1,2]*

…and use it to your advantage

Personal Experience with Training / Education

- First 30 CSP procedures in 2018-2019 (HBP)
- Initial success rate ~50-75%. Mean procedure time ~120-150 min

- LBBP Proctoring in 08/2021
- Educational training in CSP since 2021

- Preceptorship since 06/2024
- >100 cases in last 12m, mean procedure time ~60 min

Personal Experience with Training / Education

Preceptorship Programm DHZC:

> 100 Trainees from:

- Germany
- Malta
- Japan
- South Korea
- Thailand
- Saudi Arabia
- Kuwait
- Greece
- Iran
- Irak
- Norway
- Israel
- Kazachstan
- Uzbekistan
- Turkey
- South Africa
- Cyprus
- Sweden

DEUTSCHES HERZZENTRUM
DER CHARITÉ

Thank you for your attention!

DHZC Campus
Mitte
Charitéplatz 1
10117 Berlin
T: +49 30 450 - 50

DHZC Campus
Virchow-Klinikum
Augustenburger Platz 1
13353 Berlin
T: + 49 30 4593 - 1000

DHZC Campus
Benjamin Franklin
Hindenburgdamm 30
12203 Berlin
T: +49 30 450 - 50

patrick.nagel@dhzc-charite.de | www.dhzc.charite.de

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