GROW PLUS+

The EP Study Using EPICARDIO™ SIMULATION

Demonstration Workbook & Independent Practice Guide

Observe the response.
Explain what happened.
Repeat the exercise.

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LEARNING RESULTS

BY THE END OF THIS EVENT

01 Set up Cardiac EP, identify the diagnostic catheters, and select a pacing site.

02 Distinguish myocardial capture from antegrade or retrograde conduction.

03 Compare continuous decremental pacing with a programmed extrastimulus.

04 Recognize the observed endpoints of VA/AV Wenckebach, VAERP, VERP, AVNERP, and AERP.

05 Use independent practice to connect surface ECG changes with intracardiac EGMs.

HOW TO USE YOUR WORKBOOK

During the Demonstration: predict the next response, then record what you actually see. Identify the paced chamber, captured tissue, and downstream response before naming an endpoint.

On your own: Using the Epicardio simulator platform, follow the setup on page 3 and the practice steps on pages 5–11. Keep the drive cycle length, number of beats, output, and model settings consistent within each test.

KEEP LEARNING

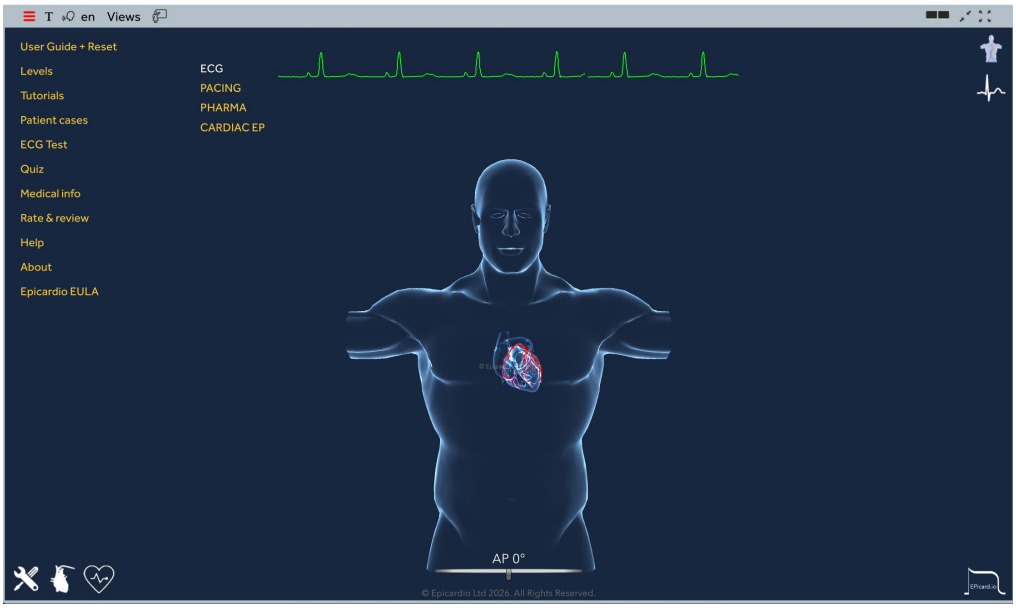
This GROW Plus event introduces a practice pathway: Making the Heart Race provides structured course learning, GROW offers membership support, and Epicardio provides simulator practice. *See the final page for current options and sign-up links.*

This workbook does not establish enrollment or access. Check each offering's current inclusions when you sign up.

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SET UP YOUR EPICARDIO™ SIMULATOR

INDEPENDENT PRACTICE: Subscribe to Epicardio to access the simulator for Cardiac EP functionality.



Interface shown in the event. Labels and access routes may vary by version.

01 Sign in and launch Epicardio. In the event interface, open the three-line menu > Levels > Cardiac EP. Some versions offer Cardiac EP on the home screen.

02 Use Insert catheter to display HRA, HIS, CS, and RVA. An ablation catheter is not required. Keep the His recordings visible for conduction assessment.

03 Display ECG and intracardiac EGMs together. Compare 50 and 100 mm/s; use a faster sweep to separate closely spaced A, H, and V signals.

04 Open Pace and choose HRA for atrial pacing or RVA for ventricular pacing. Some versions use a P checkbox beside the channel to open pacing controls.

05 Save your baseline settings. Start in the default rhythm; avoid changing AV nodal properties during a test. If you reset, rebuild the same setup.

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READ THE PACING RESPONSE

LOOK FOR	WHAT IT TELLS YOU
Stimulus (S)	Pacing artifact: a delivered stimulus alone does not prove capture.
A / H / V	Atrial, His, and ventricular electrograms. Confirm which tissue actually depolarized.
Capture	A local A follows atrial stimulation, or a local V follows ventricular stimulation, with a consistent relationship.
Conduction	After capture, look for the next chamber: A → H → V (antegrade) or V → A (retrograde).
CL / S1 / S2	CL = cycle length. S1 = drive train. S2 = one premature stimulus after the final S1.
ERP	The longest tested coupling interval that fails at the stated tissue or conduction endpoint, under the test conditions.

TWO PACING MODES

Continuous: deliver S1 repeatedly, then shorten the S1 cycle length in small steps to assess rate-dependent conduction.

Extra Stimulus: deliver a fixed S1 train followed by one S2. Shorten S2 while keeping S1, train count, and output unchanged.

Before naming block or refractoriness: "Was the paced chamber still captured?"

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SWEEP SPEED & CAPTURE

Exercise 1 / Match the pacing artifact to the local response.



Event example. Record your own settings and endpoint; results may differ.

DURING THE DEMO

Which signals become easier to separate at a faster sweep?

Does every S produce a local A?

What changes as output falls?

TRY IT USING YOUR EPICARDIO™ SIMULATOR SUBSCRIPTION

01 Select HRA. Set S1 to 600 ms and choose Continuous; confirm stable atrial capture.

02 Compare 50, 100, and 200 mm/s. Pause the trace and locate S, A, H, and V.

03 At a fixed pulse width, lower Output (V) one step at a time until local A capture fails.

04 Increase output until every stimulus is captured; record the lowest reliable tested output.

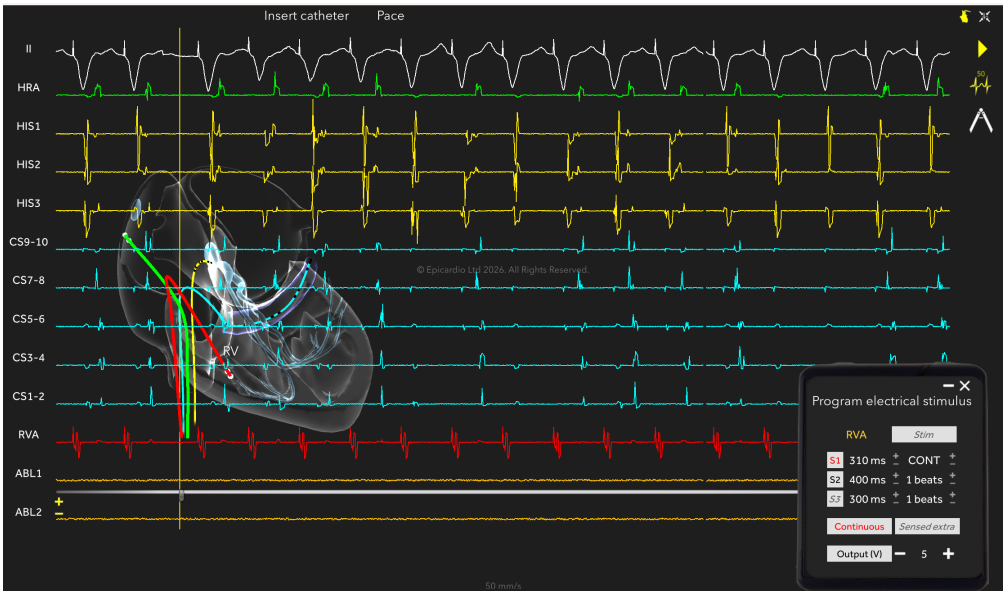
05 Stop pacing and restore the starting output before conduction or ERP testing.

Sweep Used	Lowest Reliable Output	Evidence of Capture
_____ mm/s	_____ V at _____ ms	
Observed noncapture	S without local A	

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VA WENCKEBACH

Exercise 2 / Test retrograde conduction with continuous RVA pacing.



Event example. Record your own settings and endpoint; results may differ.

DURING THE DEMO

Can you follow V → A?

Is V capture maintained when an A is missing?

Is the block pattern progressive or abrupt?

TRY IT USING YOUR EPICARDIO™ SIMULATOR SUBSCRIPTION

01 Select RVA, set S1 to 600 ms, choose Continuous, and confirm ventricular capture.

02 Confirm 1:1 V-to-A conduction. Reduce S1 in 10–20 ms steps; observe several cycles at each step.

03 Follow VA timing and the atrial response. Keep checking that every stimulus still captures V.

04 At the first block pattern, lengthen S1 and retest to find the longest tested CL with reproducible Wenckebach.

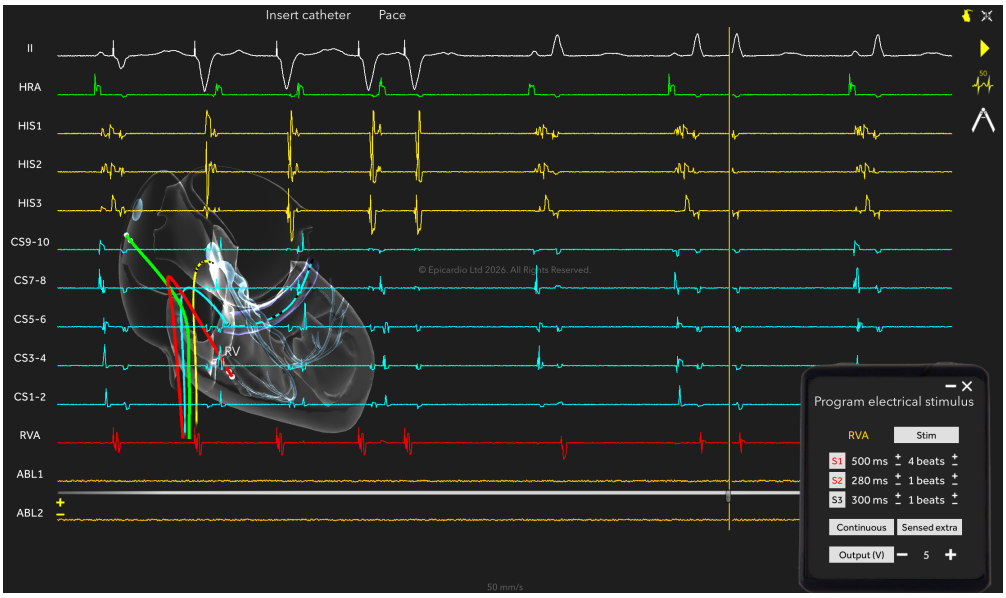
05 Record the last 1:1 CL and first reproducible Wenckebach CL. Stop and restore baseline.

Last 1:1 VA CL	VA Wenckebach CL	V capture maintained?
_____ ms	_____ ms / not reached	Yes / No / uncertain

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VA EFFECTIVE REFRACTORY PERIOD

Exercise 3 / Deliver a ventricular drive train with one premature beat.



Event example. Record your own settings and endpoint; results may differ.

DURING THE DEMO

Identify the final S1, then S2.

Is there a V2 after S2?

If V2 is present, is there an A2?

TRY IT USING YOUR EPICARDIO™ SIMULATOR SUBSCRIPTION

01 Select RVA and programmed stimulation. Set S1 = 500 ms for 8 beats, with one S2 = 400 ms.

02 Disable additional S3/S4 stimuli if present. Choose Send extra and confirm V2 capture with an A2 response.

03 Keep S1 and the train count fixed. Shorten S2 by 10 ms and repeat the same sequence.

04 Find the longest tested S1–S2 with V2 capture but no conducted A2; verify by lengthening and repeating.

05 Record the stimulus interval and V1–V2 if measurable. If V2 capture fails first, record VAERP as not reached.

S1 / train count	VAERP: tested S1–S2	V2 present / A2 absent?
_____ ms / _____ beats	_____ ms / not reached	_____
Last conducted S1–S2	_____ ms	V1–V2: _____ ms

Use the same interval convention throughout. V2 without A2 is a VA conduction endpoint; it does not localize the block by itself.

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VENTRICULAR ERP

Exercise 4 / Recognize failure of ventricular myocardial capture.



Event example. Record your own settings and endpoint; results may differ.

DURING THE DEMO

Compare S2 with its local V response.

Is V2 absent, or only A2?

What separates VERP from VAERP?

TRY IT USING YOUR EPICARDIO™ SIMULATOR SUBSCRIPTION

01 Select RVA. Use S1 = 500 ms for 8 beats and one S2 = 400 ms; verify baseline capture.

02 Deliver the train with Send extra. Keep the output and pulse width unchanged.

03 Shorten S2 by 10 ms and repeat until S2 fails to capture the ventricle.

04 Confirm that a slightly longer S2 captures, then reproduce failure at the longest tested noncapturing S2.

05 Record that S1–S2 interval as VERP for these settings. Stop and restore baseline.

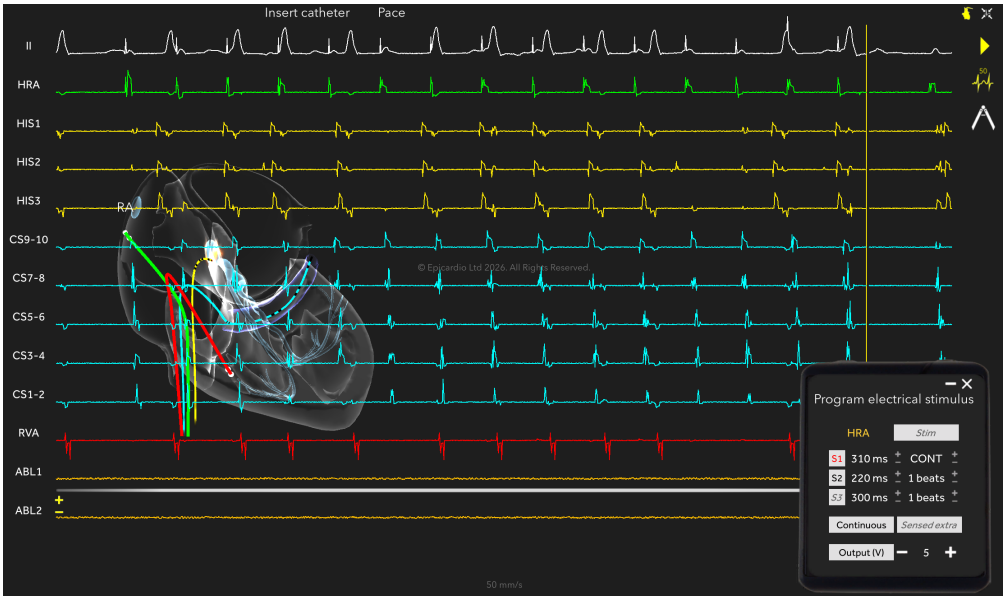
Last S2 with V2 capture	VERP: S1–S2	Output / pulse width
_____ ms	_____ ms / not reached	_____ V / _____ ms

Loss of A2 alone is not VERP. Confirm failure of the local ventricular response after S2.

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AV WENCKEBACH

Exercise 5 / Test antegrade conduction with continuous HRA pacing.



Event example. Record your own settings and endpoint; results may differ.

DURING THE DEMO

Is every atrial stimulus captured?

How do AH or AV timing change?

Does an A eventually fail to conduct?

TRY IT USING YOUR EPICARDIO™ SIMULATOR SUBSCRIPTION

01 Select HRA, set S1 to 600 ms, and choose Continuous. Confirm atrial capture and 1:1 conduction.

02 Reduce S1 in 10–20 ms steps. At each step, follow A, His, and V over several cycles.

03 Look for progressive conduction delay and a nonconducted A while atrial capture persists.

04 Lengthen and retest to identify the longest tested CL with reproducible Wenckebach; retain the last 1:1 CL.

05 Record the pattern and His response. Stop pacing and restore baseline settings.

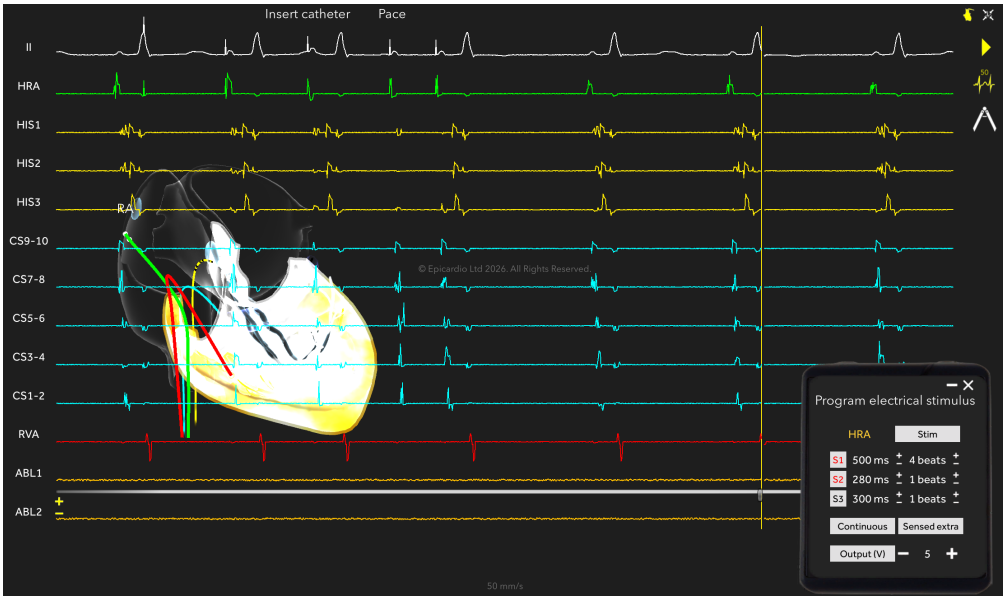
Last 1:1 AV CL	AV Wenckebach CL	A capture maintained?
_____ ms	_____ ms / not reached	Yes / No / uncertain
AH / AV observations		

A capture without V is conduction block. A–V crossover reflects marked delay; alone it does not establish dual AV nodal physiology.

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AV NODAL ERP

Exercise 6 / Use the His electrogram to support the site of block.



Event example. Record your own settings and endpoint; results may differ.

DURING THE DEMO

Does S2 capture A2?

Is H2 present after A2?

Is V2 absent because conduction failed?

TRY IT USING YOUR EPICARDIO™ SIMULATOR SUBSCRIPTION

01 Select HRA. Use S1 = 500 ms for 8 beats and one S2 = 400 ms; keep His recordings visible.

02 Deliver with Send extra. Identify A2, H2, and V2; shorten S2 by 10 ms while holding S1 and output fixed.

03 If A2 is captured but no H2 follows, assess for AV nodal block. Check all visible His channels.

04 Lengthen and repeat to confirm the longest tested coupling interval producing the same response.

05 Record A1–A2 for AVNERP and S1–S2 separately. If A2 capture fails first, the nodal endpoint was not reached.

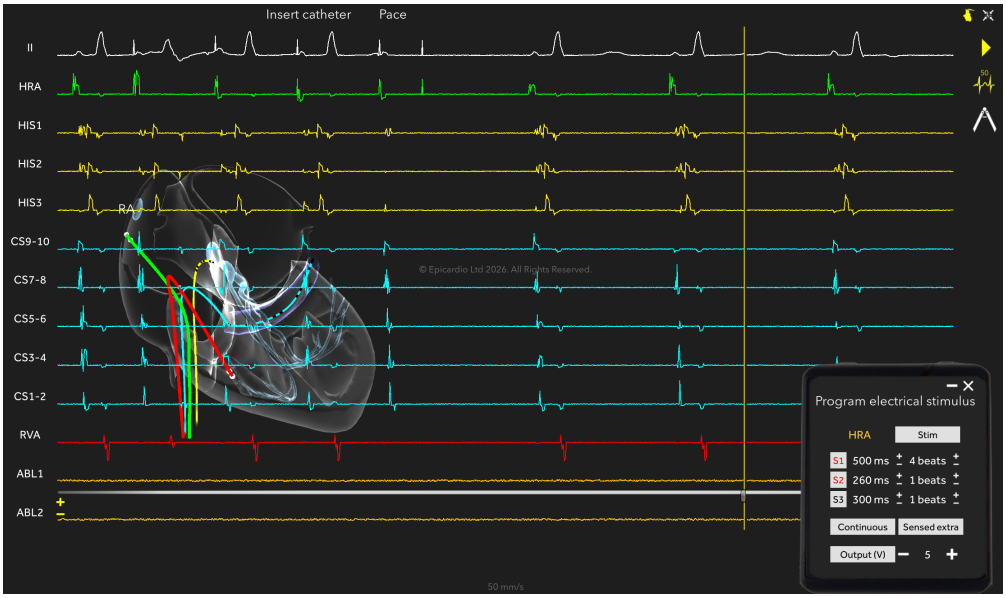
Stimulus S1–S2	A1–A2 at nodal endpoint	A2 / H2 / V2 response
_____ ms	_____ ms / not reached	

A2 without V2 establishes AV block, but AV nodal localization requires a reliable His assessment. If unclear, document "site uncertain."

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ATRIAL ERP (AERP)

Exercise 7 / Recognize failure of atrial myocardial capture.



Event example. Record your own settings and endpoint; results may differ.

DURING THE DEMO

Find S2 and the local HRA signal.

Does A2 disappear?

How is this different from a captured A2 that blocks?

TRY IT USING YOUR EPICARDIO™ SIMULATOR SUBSCRIPTION

01 Select HRA. Use S1 = 500 ms for 8 beats and one S2 = 400 ms, with baseline output restored.

02 Deliver with Send extra. Confirm an atrial response to S2 before shortening its coupling interval.

03 Decrease S2 by 10 ms, keeping S1, the train count, output, and model settings fixed.

04 When A2 is absent, lengthen S2 to confirm capture, then reproduce failure at the longest tested noncapturing S2.

05 Record the S1–S2 interval as AERP under these settings. Stop pacing and save your observations.

Last S2 with A2 capture	AERP: S1–S2	
_____ ms	_____ ms / not reached	
Noncapture evidence		

The defining observation for AERP is failure of local atrial capture after S2.

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YOUR INDEPENDENT PRACTICE LOG

Use the same setup for a repeat run. Record “not reached” or “uncertain” when the observed response does not support the endpoint.

TEST	RESULT (ms)	CAPTURE / RESPONSE EVIDENCE
VA Wenckebach		
VAERP		
VERP		
AV Wenckebach		
AVNERP (A1–A2)		
AERP		

WHEN YOUR RESULT DIFFERS

Check the pacing site, S1/S2 mode, number of drive beats, extra stimuli, output, pulse width, sweep speed, and model settings. Review the local response before interpreting a missing downstream signal.

Do not force a match to the event’s example intervals. Drive history and settings affect refractoriness. If an earlier endpoint prevents the intended measurement, document the limit you actually reached.

MY NEXT PRACTICE GOAL / QUESTION FOR GROW

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INTERPRETATION SELF-CHECK

Cover the interpretation column first. Explain each response aloud, then check your reasoning. In each example, confirm that the stimulus was delivered.

OBSERVED RESPONSE	SUPPORTED INTERPRETATION
RVA S2 → V2, with no A2	Retrograde conduction block; a VAERP endpoint may be reached if reproduced with the stated protocol.
RVA S2, with no local V2	Ventricular noncapture; supports VERP at the longest tested noncapturing S1–S2.
HRA S2 → A2, with no H2 or V2	Supports AV nodal block when the His signal is reliably assessed; document A1–A2.
HRA S2, with no local A2	Atrial noncapture; supports AERP at the longest tested noncapturing S1–S2.
Continuous pacing: progressive delay, then a dropped response, with local capture	Wenckebach conduction pattern. Retest to bracket the last 1:1 CL and longest tested Wenckebach CL.

REFERENCES & PLATFORM HELP

Epicardio Cardiac EP User Guide (2024)

Interface guidance and platform controls. Use the in-platform help for your version.

ACC/AHA/HRS EP study definitions (2006)

Standard terminology for electrophysiological studies and procedures.

Event images: CHART GROW Plus, Epicardio and the EP Study (2026).
Simulator screenshots retain Epicardio's copyright notice.

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