



Scenario Guide

C.A.R.E. SimBalloon — Intra-Aortic Balloon Pump Trainer

20 scenarios · 3 difficulty tiers · instructor reference

TRAINING SIMULATOR ONLY — not a medical device. All patient data is synthetic. The physiology is a faithful but illustrative teaching model and must never be used for clinical decisions.

Recommended Progression

Run the cases in order. Demonstrate correct timing and alarm response on the Beginner tier before any fault is injected, and have the learner manage each single fault in isolation before moving to the Advanced multi-fault crises.

Foundations

Initial Setup → Timing Walkthrough → Weaning Protocol

Console orientation, correct inflation and deflation against the dicrotic notch, and the 1:1 → 1:2 → 1:3 → 1:8 wean.

Rhythm recognition

Atrial Fibrillation → V-Paced Rhythm → High HR AFib 130

Adapt trigger source and assist ratio to irregular and paced rhythms.

Single-fault troubleshooting

Helium Leak → Loss of Trigger → Catheter Migration

Manage each fault in isolation before they are combined.

Crisis & integration

Cardiac Arrest → ROSC, Cardiogenic Shock, Gas Embolism / Kink, Device Failure Sim, Full IABP Grand Rounds

Multi-fault crises and the capstone case.

Tiers

Beginner (3) · Intermediate (9) · Advanced (8)

The Scenarios

01 Initial Setup

BEGINNER

CLINICAL PICTURE

A stable patient prepared for counterpulsation. The console is powered but the balloon is not yet pumping — this is the orientation case.

Loads with	HR 72 · 120/80 · NSR
Device config	IABP OFF · ECG trigger · 1:1
Injected fault	None

OBJECTIVE & EXPECTED ACTIONS

Orient to console layout and waveforms. Confirm ECG/pressure triggers, select augmentation, and initiate pumping. No pathology to correct.

02 Timing Walkthrough

BEGINNER

CLINICAL PICTURE

Actively pumping but deliberately mistimed — inflation is late and deflation is early, degrading both diastolic augmentation and afterload reduction. One error in each direction.

Loads with	HR 72 · 120/80 · NSR
Device config	ACTIVE · ECG · 1:1 · Infl +60 / Defl -60
Injected fault	Deliberate mistiming

OBJECTIVE & EXPECTED ACTIONS

Read the arterial trace. Recognise late inflation (inflation after the dicrotic notch, so diastolic augmentation is truncated) and early deflation (the balloon empties before systole, so afterload reduction is lost and the assisted end-diastolic pressure rises back toward baseline). Adjust to inflate at the dicrotic notch and deflate just before systole.

03 Weaning Protocol

BEGINNER

CLINICAL PICTURE

A recovering patient, haemodynamically stable, ready to be weaned from support. See the weaning appendix for the full step ladder.

Loads with	HR 72 · 110/75 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	None

OBJECTIVE & EXPECTED ACTIONS

Confirm stability criteria, then step assist ratio 1:1 → 1:2 → 1:3 → 1:8, holding 15 min at each and watching MAP. Deflate and hand off for sheath removal.

04 Atrial Fibrillation

INTERMEDIATE

CLINICAL PICTURE

Irregularly irregular rhythm at a moderate rate. R-R variability challenges beat-to-beat timing.

Loads with	HR 120 · 100/65 · AFib
Device config	ACTIVE · ECG · 1:1
Injected fault	None

OBJECTIVE & EXPECTED ACTIONS

Understand how AFib disrupts fixed timing. Use R-wave / real-time deflation logic so each beat is tracked despite irregularity. Verify augmentation on the arterial trace.

05 V-Paced Rhythm

INTERMEDIATE

CLINICAL PICTURE

Ventricular-paced rhythm with pacing spikes on the ECG that can be mistaken for native depolarisation.

Loads with	HR 70 · 115/75 · V-Paced
Device config	ACTIVE · V-PACE trigger · 1:1
Injected fault	None

OBJECTIVE & EXPECTED ACTIONS

Select the pacer (V-PACE) trigger so the pump tracks the paced complex and rejects pacing-spike artefact. Confirm reliable synchronisation.

06 High HR AFib 130

INTERMEDIATE

CLINICAL PICTURE

Fast atrial fibrillation. At high, irregular rates 1:1 support becomes unreliable and may compromise filling.

Loads with	HR 130 · 95/60 · AFib
Device config	ACTIVE · ECG · 1:2
Injected fault	None

OBJECTIVE & EXPECTED ACTIONS

Recognise that a very fast rate warrants dropping to 1:2 assist to preserve reliable augmentation and diastolic filling. Justify the ratio choice.

07 Helium Leak

INTERMEDIATE

CLINICAL PICTURE

Gradual loss of shuttle gas. Augmentation falls off and a low-helium/leak alarm develops.

Loads with	HR 72 · 110/70 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	Helium leak

OBJECTIVE & EXPECTED ACTIONS

Correlate falling augmentation with the helium/leak alarm. Refill/purge the balloon, check catheter and connections, resume pumping once volume is restored.

08 Loss of Trigger

INTERMEDIATE

CLINICAL PICTURE

The trigger signal drops out — the pump can no longer find a reliable event to synchronise to and stops augmenting.

Loads with	HR 72 · 105/68 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	Trigger loss

OBJECTIVE & EXPECTED ACTIONS

Diagnose the no-trigger alarm. Check ECG leads/signal quality, then select INTERNAL trigger to re-establish reliable synchronisation.

09 Catheter Migration

INTERMEDIATE

CLINICAL PICTURE

The balloon has migrated from optimal position (just distal to the left subclavian). Augmentation degrades and pressure/perfusion suffer.

Loads with	HR 72 · 90/58 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	Catheter migration

OBJECTIVE & EXPECTED ACTIONS

Recognise degraded augmentation with a falling pressure as positional. Escalate for imaging/repositioning; understand malposition risks (subclavian / renal / mesenteric).

10 Cardiac Arrest → ROSC

ADVANCED

CLINICAL PICTURE

The patient deteriorates into VF with a non-perfusing rhythm; ECG triggering fails. Management continues through arrest to return of spontaneous circulation.

Loads with	HR 30 · 55/30 · VF
Device config	IABP OFF · PRESSURE trigger
Injected fault	VF / arrest

OBJECTIVE & EXPECTED ACTIONS

Switch to internal trigger during CPR so the pump keeps a rhythm, manage the arrest, then re-synchronise to ECG on ROSC and restore 1:1 support.

11 Cardiogenic Shock

ADVANCED

CLINICAL PICTURE

Tachycardic and profoundly hypotensive with a low MAP — the classic indication for maximal counterpulsation.

Loads with	HR 110 · 78/50 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	Shock physiology

OBJECTIVE & EXPECTED ACTIONS

Optimise support at 1:1 with maximal augmentation, verify timing under low pressure, and interpret MAP / augmented vs unloaded pressures as the therapeutic target.

12 Gas Embolism / Kink

ADVANCED

CLINICAL PICTURE

Gas-line occlusion or catheter kink obstructs the shuttle gas path, triggering an occlusion alarm and loss of augmentation.

Loads with	HR 72 · 100/65 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	Gas occlusion / kink

OBJECTIVE & EXPECTED ACTIONS

Recognise the occlusion alarm, inspect line and insertion site for kinking, and follow the rupture/gas-loss safety sequence (stop pumping, assess for blood in line, escalate).

13 Device Failure Sim

ADVANCED

CLINICAL PICTURE

Compound failure — helium leak and gas occlusion together with the pump forced to standby. A cold, degraded-device situation.

Loads with	HR 72 · 110/70 · NSR
Device config	STANDBY · ECG · 1:1
Injected fault	Helium leak + occlusion

OBJECTIVE & EXPECTED ACTIONS

Work a systematic device-failure checklist under multiple simultaneous alarms. Decide when to troubleshoot vs. exchange the console/catheter, keeping the patient supported.

14 Full IABP Grand Rounds

ADVANCED

CLINICAL PICTURE

Capstone integration case: tachycardic patient on 1:2 support with mistimed inflation and deflation. Everything the learner has practised, at once.

Loads with	HR 88 · 105/68 · NSR
Device config	ACTIVE · ECG · 1:2 · Infl +20 / Defl -30
Injected fault	Mistiming on 1:2

OBJECTIVE & EXPECTED ACTIONS

Assess the whole picture, correct timing on a 1:2 ratio, judge whether to return to 1:1, and articulate the full rationale as in a grand-rounds discussion.

15 Early Inflation Error

INTERMEDIATE

CLINICAL PICTURE

The balloon inflates before the aortic valve closes, on the systolic downstroke rather than at the dicrotic notch.

Loads with	HR 75 · 112/74 · NSR
Device config	ACTIVE · ECG · 1:1 · Infl -130
Injected fault	Early inflation

OBJECTIVE & EXPECTED ACTIONS

Recognise inflation encroaching on systole (premature closure of the aortic valve, increased LV wall stress). Delay inflation back to the dicrotic notch.

16 Late Deflation Error

INTERMEDIATE

CLINICAL PICTURE

The balloon stays inflated into the next systole, so the ventricle ejects against an inflated balloon.

Loads with	HR 75 · 112/74 · NSR
Device config	ACTIVE · ECG · 1:1 · Defl +130
Injected fault	Late deflation

OBJECTIVE & EXPECTED ACTIONS

Recognise the raised assisted end-diastolic pressure and impeded ejection. Advance deflation so it completes just before the next systolic upstroke.

17 Sinus Bradycardia

INTERMEDIATE

CLINICAL PICTURE

A slow sinus rhythm with a long diastole — a wide window for augmentation.

Loads with	HR 48 · 100/66 · Sinus Brady
Device config	ACTIVE · ECG · 1:1
Injected fault	None

OBJECTIVE & EXPECTED ACTIONS

Appreciate how a long R-R lengthens the inflation window, and confirm timing still lands at the dicrotic notch rather than drifting with rate.

18 Balloon Rupture

ADVANCED

CLINICAL PICTURE

Sudden helium loss — augmentation ceases immediately and the IAB trace flatlines.

Loads with	HR 72 · 98/62 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	Balloon rupture

OBJECTIVE & EXPECTED ACTIONS

Recognise abrupt loss of augmentation with a flat balloon trace. Stop pumping, assess for blood in the gas line, and escalate for immediate catheter exchange.

19 AC Power Loss

ADVANCED

CLINICAL PICTURE

The console has dropped to battery backup and the battery is low — a countdown to loss of support.

Loads with	HR 72 · 105/68 · NSR
Device config	ACTIVE · ECG · 1:1
Injected fault	AC power loss + low battery

OBJECTIVE & EXPECTED ACTIONS

Restore mains power, notify biomedical engineering, and plan for continued support if the console fails entirely.

20 VT Storm

ADVANCED

CLINICAL PICTURE

Sustained monomorphic VT at 180 with a marginal pressure — very short diastole, unreliable ECG triggering.

Loads with	HR 180 · 82/55 · VT
Device config	ACTIVE · PRESSURE trigger · 1:1
Injected fault	VT at 180

OBJECTIVE & EXPECTED ACTIONS

Recognise that a very fast rate leaves almost no diastole to augment. Manage the arrhythmia; consider trigger source and assist ratio while treating the cause.

Appendix · Weaning Protocol

Available in the app on the **Weaning Protocol** scenario. The instructor's Session tab shows the ladder once the scenario is running.

Step	Stage	Criteria
—	Prerequisite	Confirm haemodynamic stability: MAP $\geq$ 65 mmHg, off inotrope escalation for $\geq$ 2 hours.
Step 1	1:1 Assist	Confirm haemodynamic stability: MAP $\geq$ 65 mmHg. Off inotrope escalation for $\geq$ 2 hours.
Step 2	1:2 Assist	One in two beats assisted (every other beat). Watch ART alternation (AUG vs native). Monitor UNLD and MAP for 15 min.
Step 3	1:3 Assist	One in three beats assisted. Assess intrinsic cardiac output. Accept MAP $\geq$ 60 mmHg.
Step 4	1:8 Assist	Minimal assist — final check. HR < 110 bpm, MAP $\geq$ 60 mmHg sustained for 15 min.
Complete	Complete	Weaning complete. Balloon deflated. Proceed with sheath removal per unit protocol.

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