Clinical Standard Operating Procedure (SOP)

INTRA-AORTIC BALLOON PUMP MANAGEMENT

SETTING	Service-wide
FOR STAFF	All clinical staff
PATIENTS	All patients requiring Intra-Aortic Balloon Pump (IABP) management

Introduction

This document outlines the principles of safe transfer of a patient requiring Intra-Aortic Balloon Pump (IABP) management and is intended to support the training and education of Retrieve team members. The most commonly used IABPs in the South West are the Maquet C300 Cardiosave and the Teleflex AC3.

The Retrieve team must be able to set up and safely secure an IABP device in the ambulance, monitor and document IABP observations and perform troubleshooting in the event of issues arising.

Background

The IABP is designed to increase coronary artery perfusion and decrease myocardial oxygen consumption when coronary artery supply is impaired. Indications for use include refractory unstable angina, impending myocardial infarction, acute myocardial infarction, refractory ventricular failure, cardiogenic shock and ischaemia-related intractable ventricular arrhythmias. The IABP is used as a bridge to support the patient prior to intervention, often at a specialist cardiac centre. Despite its name, it does not provide any additional pump support to directly replace the function of a failing left ventricle.

The IABP is composed of two principle parts:

- A flexible catheter with one lumen that allows for distal aspiration/flushing or pressure monitoring and a second that permits the periodic delivery and removal of helium gas to a closed balloon.
- A mobile console that contains the system for helium transfer as well as computer control of the inflation and deflation cycle.

The balloon catheter is inserted into the descending aorta percutaneously via the femoral artery, with the catheter tip sitting distal to the left subclavian artery and the base of the balloon above the renal arteries. The catheter is then connected to a console that shuttles helium in and out of the balloon to inflate and deflate in time with the cardiac cycle.

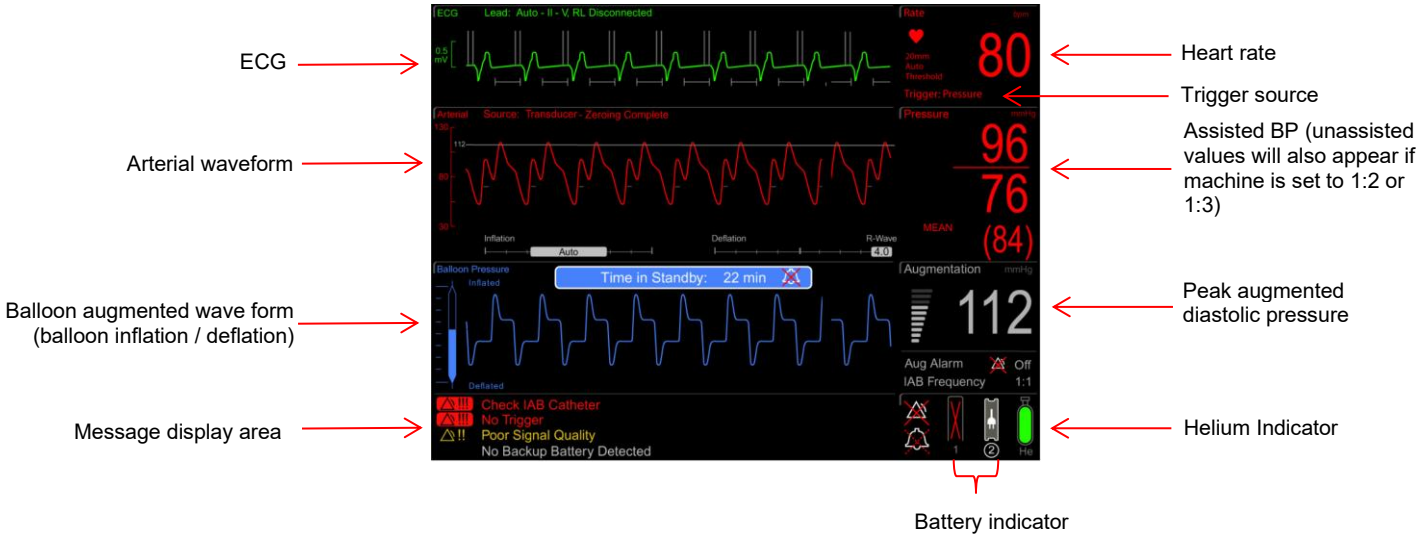
The IABP utilises counterpulsation, meaning the balloon is timed to inflate during diastole when the left ventricle is relaxed and the coronary arteries are filling with blood. This increases the perfusion pressure of the coronary circulation, increasing oxygen delivery to the myocardium. This is referred to as augmentation of aortic diastolic pressure or diastolic augmentation. It also causes some increased run-off into the distal arterial system below the balloon, which causes a reduction in aortic end-diastolic pressure just prior to the next systole. This reduction in pressure (i.e. afterload) makes it easier for the left ventricle to empty, allowing cardiac output to increase for the same myocardial oxygen demand or, a reduced oxygen demand (when supply is short due to coronary occlusion) to achieve the same cardiac output. Just before the left ventricle contracts, the balloon deflates, and the cycle repeats.

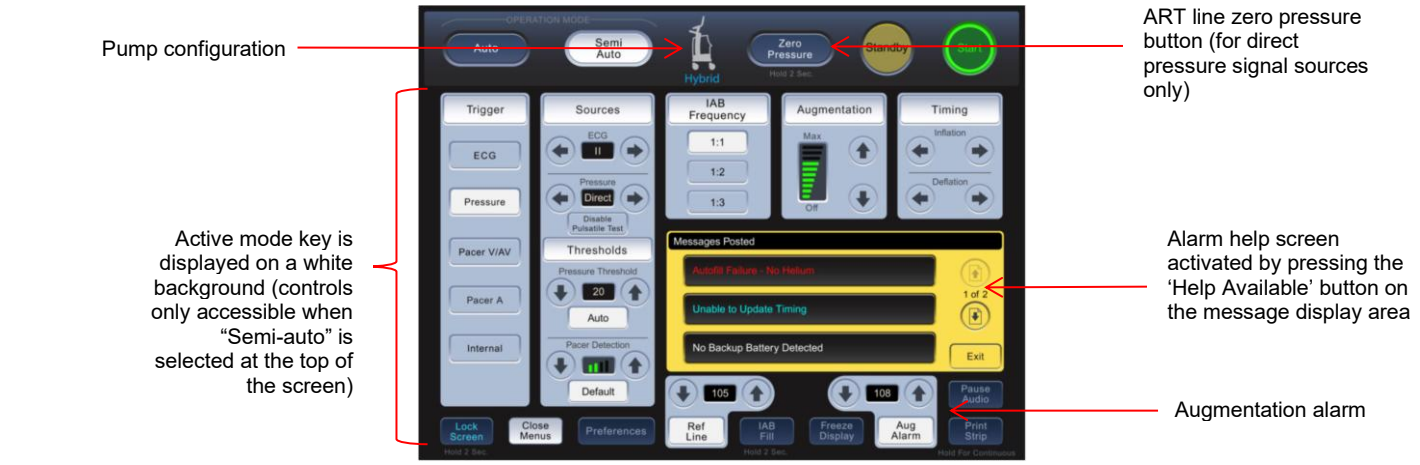
Maquet C300 Cardiosave IABP features

Console and carriage

The Maquet C300 IAPB console can be used in two different modes: either docked into the carriage (Hybrid) or undocked (Rescue). When in Rescue mode, the pump will run on battery power alone. The system will automatically recognise when you have disconnected from the carriage and notify you on screen when it is operating in rescue mode. The IABP contains two batteries each with an estimated running time of 90 mins. The battery status is indicated on the monitor display. The lit green circle indicates which battery is in use. The display will indicate when Battery 2 has less than 30 mins of charge remaining and then less than 5 minutes of charge remaining (see Appendix 1 for more information).

Display screens



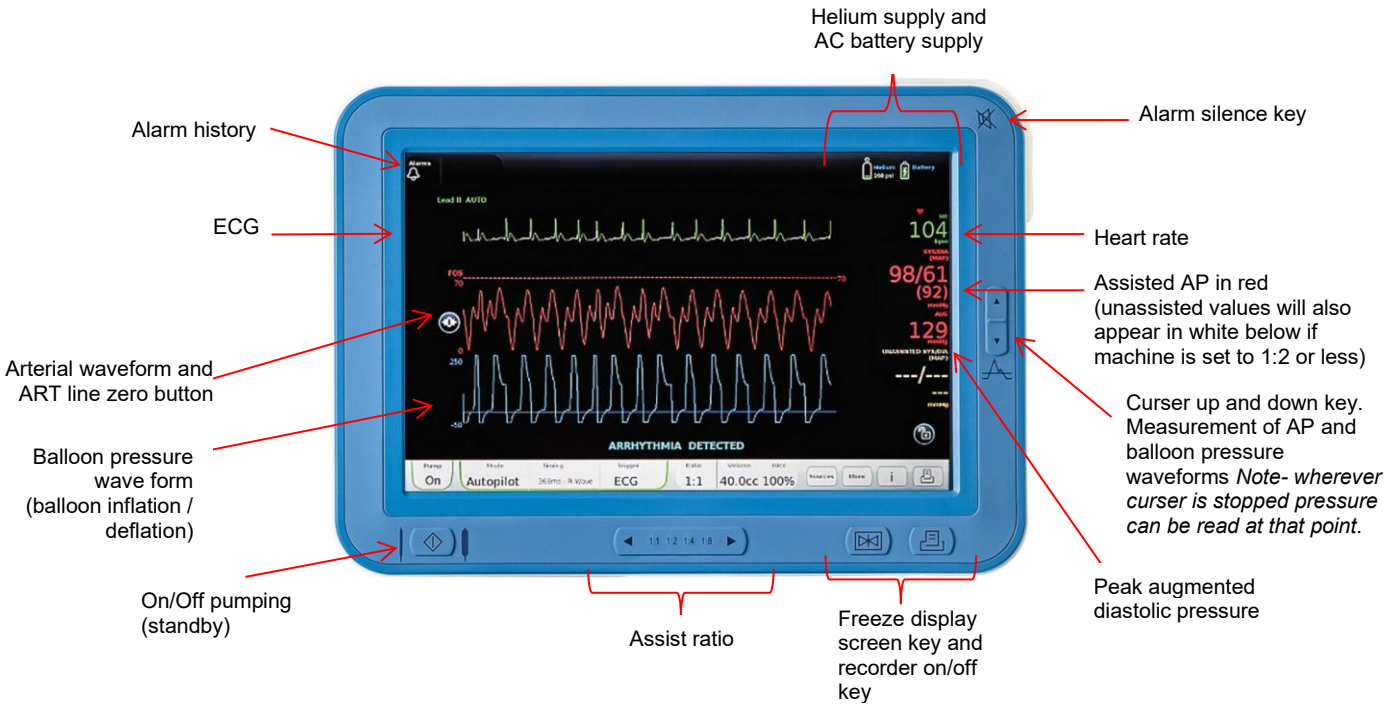


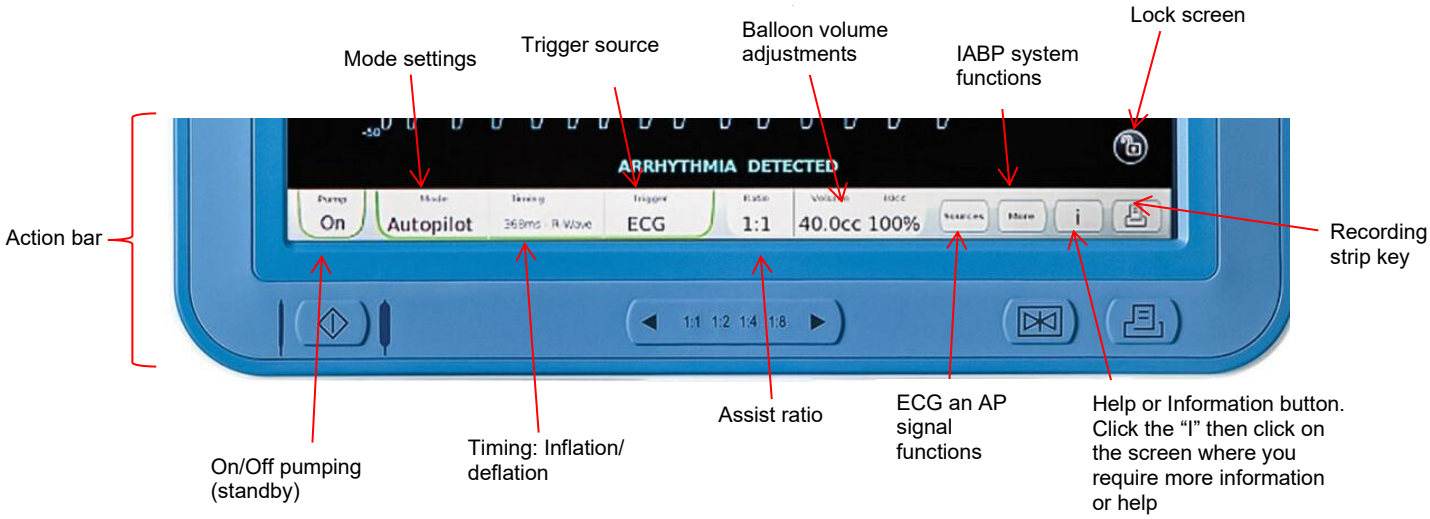
Teleflex AC3 IABP features

Console and carriage

The Teleflex AC3 IABP console is designed to be transported as is. It can be used in two different modes of operation: either in 'AutoPilot' where the console selects the ECG and arterial pressure (AP) source, trigger mode, timing method and optimises timing. It automatically changes settings to optimise assistance. Alternatively, 'Operator' mode allows the clinician to make choices regarding the ECG source, AP source, trigger and timing. The battery status is displayed on the monitor. The console can operate on both AC power and battery power. When fully charged, the battery provides up to 90 minutes of operation. An optional second battery may be available, depending on the hospital. Therefore, the console should be plugged directly into the ambulance power supply. The display will indicate battery alarms as per Appendix 1.

Display screen





Pressure monitoring

A transducer set is attached to the inner lumen on the IABP catheter. The pressure bag should be inflated to 300mmHg with a 500ml bag of 0.9% sodium chloride. Some hospitals may also add 1000i.u. of heparin to the 0.9% sodium chloride. Ensure the pressure bag fluid is labelled correctly and that it matches the hospital prescription.

Upon observing a dampened pressure trace, immediately investigate the cause and rectify in the same way you would approach any damped arterial line trace. If it cannot be rectified, contact the perfusionist/cardiac technician. Ensure the pressure transducer is at the phlebostatic axis (4th intercostal space along mid-axillary line) and is zeroed appropriately using the 'Zero Pressure' button on either display screen. Do not under any circumstances take blood samples from the balloon catheter or on the 3-way tap on the transducer.

Note that if a fibre optic IAB catheter is in use, arterial pressure is measured via the fibre optic sensor (FOS) integrated within the IAB catheter rather than via a fluid-filled transducer system. This provides real time AP signal, on a beat-to-beat basis and adjusts inflation timing for that specific beat using fibre optics.

For the Maquet, when a fibre optic IAB is connected the button on the display will also be labelled 'Calibrate Pressure'. This key initiates calibration of the fibre optic IAB while the IABP is assisting.

For the Teleflex, the FOS sensor must be zeroed prior to IAB insertion and can only be zeroed outside the patient. Once an arterial pressure (AP) waveform is detected, zeroing cannot be performed. If the sensor was not zeroed or was zeroed incorrectly, displayed hemodynamic values may be inaccurate. Therefore, the same clinical principles of waveform assessment and investigation of abnormal traces apply. In this case, the console allows MAP calibration to align with a verified arterial pressure from an alternate source. An alternate AP source must be used for clinical decision-making if zeroing was not performed correctly. A fluid-filled pressure bag and transducer system is not used with a fibre optic IAB. When connected, the console displays 'Calibrate Pressure' (MAP calibration) rather than 'Zero Pressure' (transducer zeroing).

Transfer of a patient receiving IABP management

Referral

At the point of referral, the following information should be sought:

- Recent issues and any significant issues at any stage
- Fully charged batteries – ask referrer to ensure that the batteries are fully charged when unplugged from mains power
- Helium tank – sufficient Helium in the tank, the dial must be in the green

Ferno trolley type, brand of IABP console and appropriate securement in each circumstance should be considered. Please refer to Appendix 2 for the correct loading and unloading procedures, including use of the specific securing bracket and details of how the Maquet C300 Cardiosave is secured within the ambulance.

For the Teleflex AC3, there is currently no dedicated securing bracket available for the display screen. Although the display screen can be removed from the main unit, the absence of a suitable securing mechanism presents a risk of the screen becoming a projectile during ambulance movement. On balance, it is therefore safest to keep the display screen attached to the main unit, despite potential limitations to visibility from seated positions within the ambulance.

To support visibility, the display screen is capable of a full 360-degree pivot while remaining attached to the main unit. On the rare occasions when access to the display screen is required, a dynamic risk assessment should be undertaken.

When dismounted from the main unit, the display screen will continue to charge as long as it is plugged into the ambulance mains power supply. Please refer to Appendix 3 for the correct loading and unloading procedures for the Teleflex AC3.

At the referring hospital

Insertion site should be checked for any signs of bleeding, infection, or swelling and the date and time of insertion must be documented. Circulation distal to insertion site should also be assessed and posterior tibial and dorsalis pedis pulses recorded (and ideally marked to ease ongoing assessment). If pulses are not palpable, perfusion must be assessed using a hand-held Doppler. If no pulsatility is detected, this must be discussed with the referring team prior to departure.

To ensure that the catheter has not migrated since insertion, its length should be checked against the insertion procedure record.

With both IABP machines check to ensure that:

- Which The battery is fully charged and works correctly when unplugged from mains power
- The helium cylinder is ‘on’, and it is sufficiently filled (check dial is in the green)
- Assess helium line for any signs of balloon rupture (rust-coloured flakes in line)

Set the following alarm:

- On the Maquet pumps, provided augmentation is clinically adequate, press ‘Aug Alarm’ button and set alarm limit to 10mmHg below current augmentation pressure.
- On the Teleflex AC3, provided augmentation is clinically adequate, press on the AP waveform, press ‘Set AP Alarm’. Below AP source, select AUG then press ‘On’.

Prior to moving the patient onto the transfer trolley, document the following settings:

- Trigger setting currently in use (ECG,AP, Pattern, Peak, AF, Apace, Vpace)
- Maquet pump ratio setting (1:1, 1:2, 1:3), Teleflex AC3 pump ratio setting (1:1, 1:2, 1:4, 1:8)
- Current augmentation pressure

Once the patient has been transferred onto the transfer trolley, complete the following:

- Re-zero ART line transducer
- Verify accurate arterial waveform / readings
- Assess correct inflation / deflating timing
- Assess balloon optimal occlusivity range

If there are any concerns with the IABP, consult the referring consultant or perfusionist before packaging the patient.

Before leaving the referring hospital, you must contact the receiving unit to request a Perfusionist/Cardiac Technician to be available to meet you at the receiving unit. Ensure that you provide them with an estimated time of arrival.

The referring unit must be made aware that it is their responsibility to organise the return of their IABP as per the Referring to Retrieve SOP and it should be discussed whether they would like to arrange collection from the receiving hospital or Retrieve base.

Transfer of patient onto transfer trolley and ambulance

During lateral movement of the patient onto the trolley, one person must be responsible for the IABP at all times to ensure that the catheter line is appropriately secure and not pulled. The patient can be sat up by 30 degrees if required.

Using the Maquet C300 Cardiosave

During ambulance transfer, the Maquet C300 must be secured within its carriage to enable it to be plugged into mains power and reduce the risk of running out of battery mid-transfer. However, the machine can be difficult to manoeuvre whilst in its carriage, so for loading/unloading, the following is recommended:

- Place IABP in Rescue mode
- Secure to trolley via IABP bracket on Ferno bariatric trolley whilst moving around hospital
- Secure display screen to the round bracket on side of trolley
- Load trolley into ambulance and secure as usual
- Place IABP back in it's carriage, plug in and check it is charging
- Place display screen on top of the carriage and secure to mount. It can be rotated to ensure when team members are seated in the seats
- Secure IABP machine as per Appendix 2. This **must** be completed prior to the ambulance moving to ensure it is not a missile in the event of an accident

When offloading the patient, the reverse should be followed. A Retrieve team member must take full responsibility of the IABP when being moved around and loaded/unloaded from the trolley.

Using the Teleflex AC3

During ambulance transfer, the Teleflex AC3 console cannot be fully undocked from the main unit. The display screen can be detached using a clip-secured mounting system; however, it remains connected to the main unit via a charging cable. Therefore, a member of staff must take responsibility of the pump while transferring the patient from the hospital to the ambulance; this should be wheeled alongside the patient. When ready to load onto the ambulance the following is recommended:

- Move the pump to the foot end of the trolley (If using ambulance ramp access, the console can be wheeled up behind) or to the left-hand side of the patient trolley (if using tail lift ambulance access). Ensure that there is enough slack on the line to avoid migration of the catheter.
- When using the tail lift, the Ferno trolley must be positioned tightly against the left-hand side, with the Teleflex AC3 console placed on the right. Space is limited; take care to ensure the Hamilton ventilator does not catch on the head end of the trolley. It is essential the winch is used at all times.
- Once the trolley is secured into the ambulance the IABP pump can be secured to the ambulance as shown per Appendix 3.

When offloading the patient, the reverse should be followed. A Retrieve team member must take full responsibility of the IABP when being moved around.

Documentation

In addition to standard Retrieve documentation (as per Documentation SOP), patients receiving IABP management should have the following documentation included in the record with the specific IABP care plan found under 'circulatory support' within ARC-EMS.

The Retrieve patient assessment should include documentation of the following:

- IABP trigger.
- IABP frequency.
- Systolic/diastolic (MAP) pressures.
- Augmented diastolic pressure.
- Catheter size, balloon volume, insertion depth, and insertion site.
- Any recent changes to the settings.
- The quality the dorsalis pedis and posterior tibial pulses, the colour, temperature and CRT in the lower limbs pre-transfer and on arrival at the receiving hospital.

Every 15 minutes during transfer, in addition to BP, record:

- Augmented diastolic pressure.

Training requirements for Retrieve team members

Although IABP transfers are infrequent, all team members are required to complete the Maquet and Teleflex online training courses during induction. Knowledge should then be refreshed as part of the annual declaration to maintain familiarity with the device and associated troubleshooting. Both courses require you to create your own log in account. Further resources can be found under the EOLAS app under 'Daily education'.

Access Maquet C300 Cardiosave training: **click here**

Access Teleflex AC3 training: **click here**

Troubleshooting

Troubleshooting issue	Maquet C300 Cardiosave	Teleflex AC3
Alarms	Alarms will be displayed at the bottom of the monitor screen. Alarms faults can be referenced in the embedded 'Help Available' menu on the control panel of the IABP. If unable to troubleshoot the alarm and resume pump operation, follow the "IABP failure" procedure (below) and contact the receiving hospital consultant immediately.	Alarms will be displayed at the top of the screen, with a visual corner indicator on the top right. Blue indicates a low level of severity, while yellow or red signals a critical issue requiring immediate action. Selecting the 'i' in the alarm bar provides guidance on the alarm. By pressing the 'Alarm' button in the top left corner and then choosing 'History,'

		you can review past alarms for reference. If you are unable to troubleshoot the alarm and resume pump operation, follow the "IABP failure" procedure and contact the receiving hospital consultant immediately.
IAB (helium line) disconnection	If the IAB (Helium line) catheter tubing is disconnected: • Reattach the IAB catheter and extension tubing • Press the START key to refill the IAB and resume support	If the IAB (Helium line) catheter tubing is disconnected: • Reattach the IAB catheter and extension tubing • Press the START key to refill the IAB and resume support
IABP failure	Not all patients will immediately deteriorate, depending upon the degree of support the IABP has been giving. The following actions should be taken while actively monitoring the patient's physiological response to loss of support: • Disconnect catheter from pump • Quickly inflate and deflate balloon with air (10mls of air less than total balloon volume - 30ml for a 40ml IAB) into the balloon connector and aspirate immediately • Manual inflation/deflation should be done every 5-10 minutes • Contact receiving hospital consultant immediately and request for replacement IABP to be prepared **Do not let IABP catheter sit more than 20 minutes with no movement or shuttling of air.**	Immediate Action: If the IAB pump shuts down, record the time. Time-Sensitive Response: If the pump cannot be restored within 15–30 minutes, manual intervention is required to reduce the risk of thrombus formation. Manual Inflation/Deflation: Connect a 50–60 ml syringe to the balloon connector. Inflate and deflate the balloon manually several times per hour to reduce the risk of thrombus formation. Ongoing Monitoring: Continue manual inflation/deflation until the pump is restored or the balloon can be safely removed/replaced. Notify the receiving hospital. Note: Thrombus formation may result from blood becoming trapped in the folds of a dormant balloon.
Gas loss in circuit / autofill failure – blood suspected	If blood is noted inside balloon lumen/catheter tubing (may be the colour and consistency of brown/copper/rust fleck of dirt), immediately disconnect from IABP to allow any residual gas to be released. Once this has been completed clamp off the helium line using the endotracheal tube clamps found in the primary bag. Contact receiving hospital consultant immediately and request for replacement IABP to be prepared. The team should anticipate deterioration of the patient physiology as a result of a lack of IABP support.	
Removal of balloon	Retrieve will not remove balloons unless directed to do so by the receiving hospital consultant. This has been agreed with the Perfusionists at UHP and UHBW as the risk of removal and subsequent requirement for direct groin pressure outweighs the potential benefit within an ambulance.	
Cardiac arrest	If counterpulsation is to be continued and synchronised to CPR, then arterial/pressure trigger should be selected. To do this, select "Semi-Auto" from the top of the console, then open the "Trigger" menu, and select	During cardiac arrest, the pump will display a yellow "Trigger Loss" alarm, keeping it active and ready to assist. In 'Autopilot' mode, disconnect the ECG cable from the pump console during

	"Pressure". If CPR generates sufficient blood pressure, then in most cases, the IABP will detect this and may improve perfusion to the coronary and carotid arteries. In the event that the CPR does not generate a consistent and reliable trigger, then the following additional steps should be taken: • Change the assist interval to 1:1 If the trigger remains unreliable and the IABP is not effective, the IABP should be turned off. The IAB should now be manually inflated as described above.	CPR. The trigger on the pump will automatically change to 'AP' when chest compressions are detected. Re-plug in the ECG lead to the pump console once the patient is stable. In 'Operator' mode, change the trigger source to 'AP' (if not already) so chest compressions are detected. Can be used with LUCAS and defibrillator.

Pump Modes

Maquet C300 Cardiosave

Hybrid mode

Rescue mode (transport mode). Runs on battery power only

Teleflex AC3

Remains as one unit and designed to be transported as is. Running on AC and battery

Document Change Control

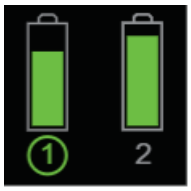
Date of Version	Version Number	Lead for Revisions	Type of Revision	Description of Revision
01/2026	2.0	Clinical Education Team	Major	Changes to reflect new Teleflex IABP
04/2026	2.1	Clinical Education Team	Minor	Changes to pictures in appendix, to reflect updated securing straps

Document Governance

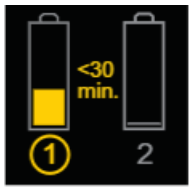
REFERENCES	Maquet Cardiosave Hybrid Operators Manual Maquet Cardiosave Rescue Operators Manual Teleflex Operational Manual Teleflex User Guide Arrow Intra-Aortic Balloon Pump Series Timing Guidelines
RELATED DOCUMENTS AND PAGES	Packaging SOP Documentation SOP
AUTHORISING BODY	
SAFETY	The IABP must be adequately secured according to this SOP prior to movement of the ambulance.
QUERIES AND CONTACT	Retrieve Leadership Team

Appendix 1 – Battery Icons

Maquet C300 Cardiosave battery icons



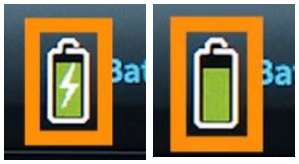
When both batteries are installed in the battery bay, the circled battery bay indicates the one in use. Once depleted the pump will automatically transition to the next battery.



When the second battery reaches less than 30 mins remaining, an approximate time will be displayed in 5-minute intervals.

An AC plug icon will be displayed over the greyed-out battery icon to indicate that the pump is using AC power

Teleflex AC3 battery icons



A green battery icon with a lightning bolt present indicates the device is plugged into AC power. Solid green indicates, that it is running on battery.

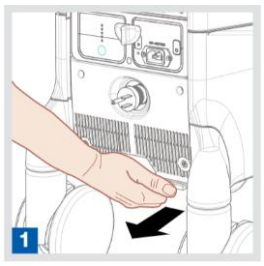
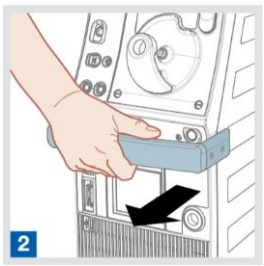
A yellow battery icon with associated alarm indicates that charge is estimated at less than 20 minutes.

A red battery icon with associated alarm indicates that charge is estimated at less than 10 minutes.

A black battery icon with associated alarm indicates that charge is estimated at less than 5 minutes and near depletion. If there is a red X present, there is a battery failure and it is not safe for transfer.

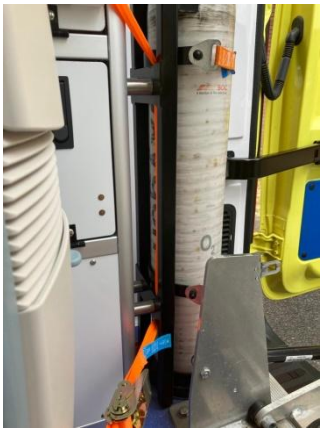
Appendix 2 – Maquet C300

Removal of the Maquet C300 pump console from the carriage

		
Release latch located below the pump console (ensure wheels and locked)	Grab handle and slowly slide console out	Grab the handles located on top and front of the console, then remove from carriage

Securing the Maquet C300 console and display monitor to trolley

		
Unscrew the grey cap and lift support arm	Pull out the red lever	Drop down the flap
		
Place the pump console sideways onto the bracket with the front of the console facing the right hand side of the patient	Lift the flap back into place ensuring both the red leaver and grey cap are secure	Secure both the pump and the flap with the seatbelt straps

		
Place the display monitor onto the round mount on the side of the trolley. once mounted the screen can be opened	Once the trolley has been moved into the ambulance and secured, the pump console needs to be placed back into the carriage and the display monitor placed back onto the carriage mount	Using the ratchet strap ensure the IABP is safely secured
		
The strap must pass through the black oyygen holder as this is bolted to the ambulance chassis	Bring the strap up through the handle. DO NOT wrap the strap around the handle	Pass the strap through the black D-ring seen in bottom left of photo. Ensure the strap is around the base the of unit and not around the wheels.

Appendix 3 – Securing the Teleflex AC3 console

During ambulance transfer, the Teleflex AC3 console cannot be fully undocked from the main unit. It can be detached using a clip-secured mounting system; however, it remains connected to the main unit via a charging cable. Therefore, a member of staff must take responsibility of the pump while transferring the patient from the hospital to the ambulance; this should be wheeled alongside the patient ensuring that there is enough slack on the line to avoid migration of the catheter.

<table>
<tr><td>  </td><td>Secure the Teleflex console to the Ferno trolley using the rear belts when moving between the hospital and ambulance. This will ensure the device does not pull away from the trolley or patient. Ensure sufficient staff are present to safely navigate the transfer.</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>Winch the trolley onto the tail lift. The Ferno trolley must be positioned tightly against the left-hand side, with the Teleflex AC3 console placed on the right. Space is limited- take care to avoid equipment catching, in particular the back left trolley wheel. Apply the brakes.</td><td>Once the trolley has been moved onto the ambulance and secured, using the ratchet straps with floor mounts (Please secure the Teleflex with the black 10G ratchet straps as per picture), ensure the IABP is safely secured.

Re-apply IABP brakes.</td><td>Secure the unit using both horizontal and vertical ratchet straps.</td></tr>
</table>

		
Pass one ratchet strap through the black securing handle at the base of the unit.	Continue the strap up over the top of the console and secure it to the opposite floor mount through the opposite black securing handle at the base of the unit.	Repeat the process vertically over the top of the Teleflex unit, ensuring all straps are tight and secure and avoiding the helium canister door and the connections on the front panel.
Once secure, plug the power cable directly into the ambulance mains power. As there is currently no dedicated securing bracket, leave the screen mounted in the main unit with the ability to pivot 360°. On the rare occasions when access to the display screen is required, a dynamic risk assessment should be undertaken. The screen continues to charge from the ambulance mains power while dismounted from the main unit.		