

**CLINICAL SUPPORT SERVICES
MECHANISMS OF COUNTERPULSATION**

CARDIOVASCULAR



MECHANISMS OF COUNTERPULSATION

Course Description:

This one-hour program is designed for health care professionals directly involved with the care of the patient requiring intra-aortic balloon counterpulsation.

The program begins with a brief review of the theoretical aspects of intra-aortic balloon pumping followed by a discussion on insertion of the percutaneous intra-aortic balloon catheter. A detailed explanation of the MAQUET IABP, highlighting set-up and troubleshooting in the clinical setting will conclude the program.

Behavioral Objectives:

At the conclusion of this program the participants will be able to:

- Define the two physiological effects achieved by the mechanics of inflation and deflation of the IAB as it relates to the cardiac cycle illustrated by an augmented arterial pressure waveform.
- Identify three indications and three contraindications for IABP therapy.
- Discuss the insertion of the percutaneous IAB.
- Discuss the set-up, operation and troubleshooting of the MAQUET IABP.

COURSE SCHEDULE

7:00 – 7:05am

Introduction

7:05 – 7:15am

Catheter Selection and Positioning

Balloon Structure and Position

IAB Sizing

Management of the Central Lumen

7:15 – 7:35am

Theory of IABP

Primary Effects of Counterpulsation

- Supply
- Demand

Timing and Trigger

Secondary Effects of Counterpulsation

Systemic Effects

Arterial Waveform Variations during IABC

Factors Affecting Diastolic Augmentation

- Patient
- Catheter
- Pump
 - Timing Errors

Indications

Contraindications

7:35 – 8:00am

Technical Components of the IABP

Set-up and Troubleshooting of the IABP

IAB CATHETER SELECTION AND POSITIONING

Balloon Structure and Position

IAB Sizing

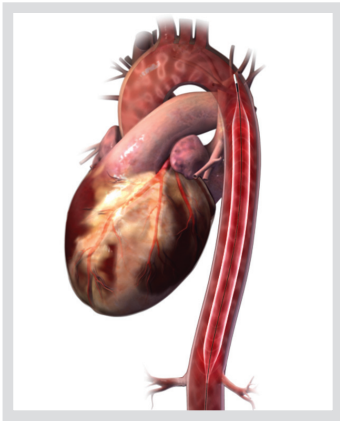
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Management of the Central Lumen

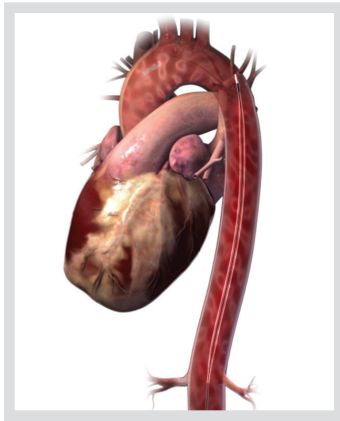
THEORY OF IABP

Primary Effects of Counterpulsation

- Supply
- Demand



Inflate



Deflate

Notes:

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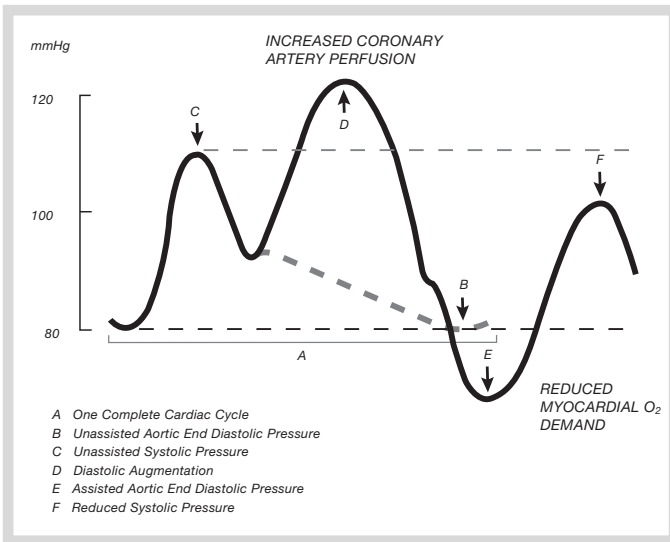
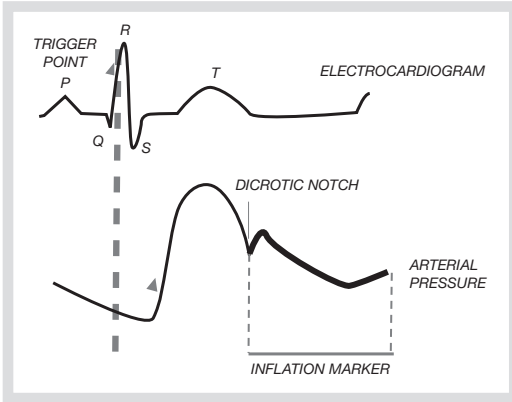
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Timing and Trigger

- Timing
- Trigger



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Secondary Effects of Counterpulsation

- CO/CI
- HR
- PAD-PCWP
- SVR
- B/P SYSTOLIC
- DIASTOLIC
- MAP
- DIASTOLIC AUGMENTATION

Systemic Effects

- Neuro
- Renal
- Vascular
- Respiratory

Waveform Analysis (Inflation/Deflation frequencies)

Arterial Waveform Variations During IABC

- Assisted Systole
- Unassisted Systole
- Assisted Aortic End Diastolic Pressure
- Unassisted Aortic End Diastolic Pressure
- Mean
- Diastolic Augmentation

Notes:

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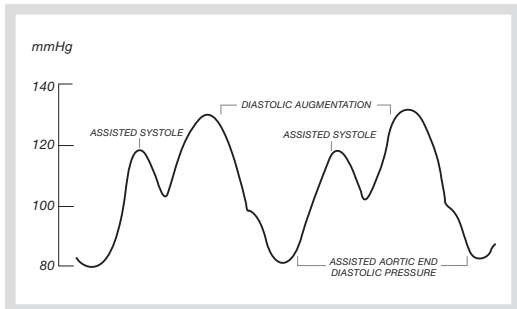
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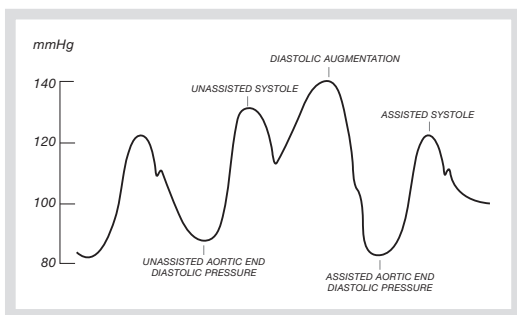
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ARTERIAL WAVEFORM VARIATIONS DURING IABP THERAPY

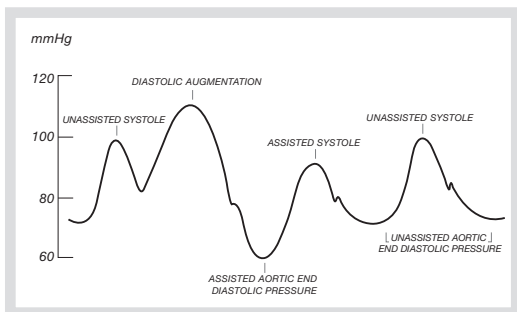
1:1 IABP FREQUENCY



1:2 IABP FREQUENCY



1:3 IABP FREQUENCY



Notes:

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Factors Affecting Diastolic Augmentation

- Patient Hemodynamics
 - Heart Rate
 - Stroke Volume
 - Arterial Pressure
 - System Vascular Resistance

- Intra-Aortic Balloon
 - IAB in Sheath
 - IAB Not Unfolded
 - IAB Position
 - Kink in IAB Catheter
 - IAB Leak
 - Low Helium Concentration

- IABP
 - Position of IAB Augmentation Control
 - Timing Errors

Notes:

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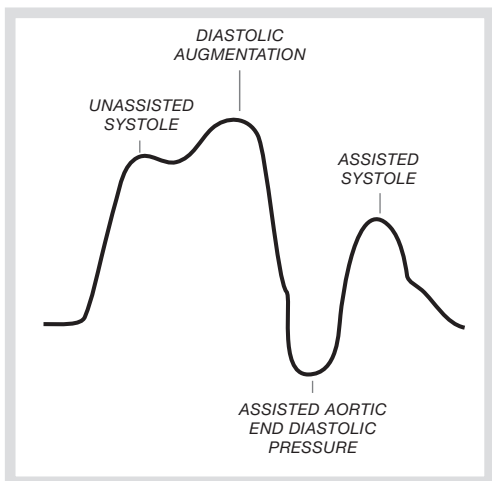
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EARLY INFLATION



Inflation of the IAB prior to aortic valve closure

Waveform Characteristics:

- Inflation of IAB prior to aortic valve closure
- Diastolic augmentation encroaches onto systole (may be unable to distinguish)

Physiologic Effects:

- Potential premature closure of aortic valve
- Potential increase in LVEDV and LVEDP or PCWP
- Increased left ventricular wall stress or afterload
- Aortic Regurgitation
- Increased MVO_2 demand

Notes:

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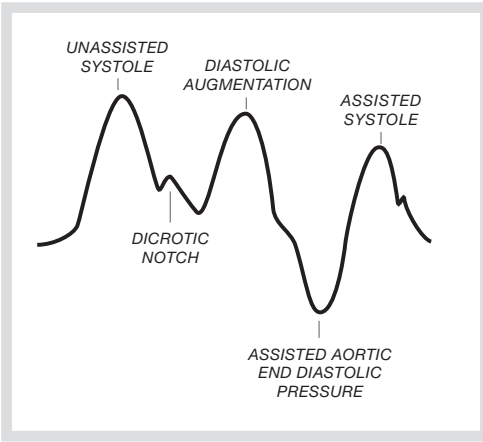
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LATE INFLATION



Inflation of the IAB markedly after closure of the aortic valve

Waveform Characteristics:

- Inflation of the IAB after the diastolic notch
- Absence of sharp V
- Sub-optimal diastolic augmentation

Physiologic Effects:

- Sub-optimal coronary artery perfusion

Notes:

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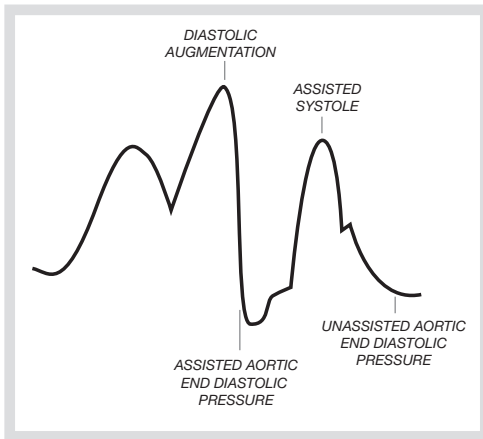
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EARLY DEFLATION



Premature deflation of the IAB during the diastolic phase

Waveform Characteristics:

- Deflation of IAB is seen as a sharp drop following diastolic augmentation
- Sub-optimal diastolic augmentation
- Assisted aortic end diastolic pressure may be equal to or less than the unassisted aortic end diastolic pressure
- Assisted systolic pressure may rise

Physiologic Effects:

- Sub-optimal coronary perfusion
- Potential for retrograde coronary and carotid blood flow
- Angina may occur as a result of retrograde coronary blood flow
- Sub-optimal afterload reduction
- Increased MVO_2 demand

Notes:

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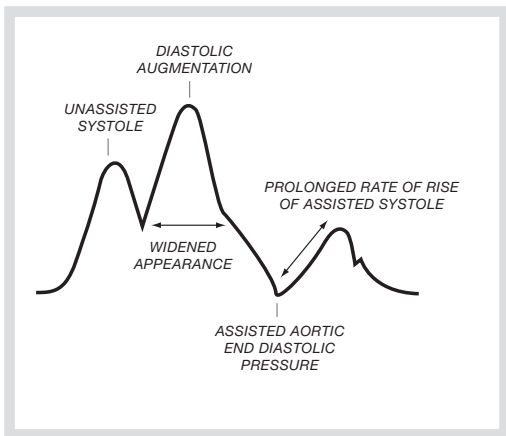
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LATE DEFLATION



Waveform Characteristics:

- Assisted aortic end-diastolic pressure may be equal to the unassisted aortic end diastolic pressure
- Rate of rise of assisted systole is prolonged
- Diastolic augmentation may appear widened

Physiologic Effects:

- Afterload reduction is essentially absent
- Increased MVO_2 consumption due to the left ventricle ejecting against a greater resistance and a prolonged isovolumetric contraction phase
- IAB may impede left ventricular ejection and increase the afterload

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Indications:

- Refractory Unstable Angina
- Impending Infarction
- Acute MI
- Refractory Ventricular Failure
- Complications of Acute MI (i.e. acute MR or VSD, or papillary muscle rupture)
- Cardiogenic Shock
- Support for diagnostic, percutaneous revascularization, and interventional procedures
- Ischemia related intractable ventricular arrhythmias
- Septic Shock
- Intraoperative pulsatile flow generation
- Weaning from bypass
- Cardiac support for non-cardiac surgery
- Prophylactic support in preparation for cardiac surgery
- Post surgical myocardial dysfunction/low cardiac output syndrome
- Myocardial contusion
- Mechanical bridge to other assist devices
- Cardiac support following correction of anatomical defects

Contraindications:

- Severe aortic insufficiency
- Abdominal or aortic aneurysm
- Severe calcific aorta-iliac disease or peripheral vascular disease
- Sheathless insertion with severe obesity, scarring of the groin, or other contraindications to percutaneous insertion

Please Refer to the Instructions for Use Prior to Insertion of the IAB

Notes:

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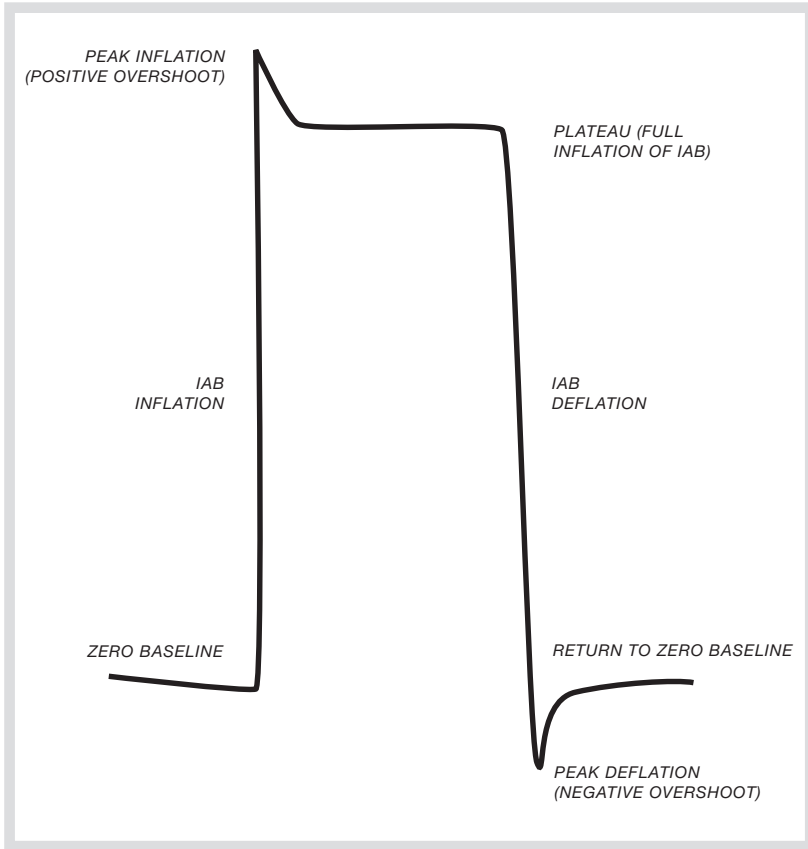
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TECHNICAL COMPONENTS OF THE MAQUET IABP

Set-up and Troubleshooting of the IABP

NORMAL BALLOON PRESSURE WAVEFORM



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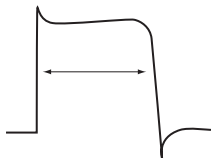
VARIATIONS IN BALLOON PRESSURE WAVEFORMS

Variations in balloon pressure waveforms may be due to the following conditions of the waveform.

1. HEART RATE

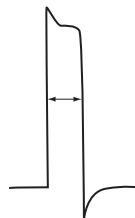
BRADYCARDIA

Increased duration of plateau due to longer diastolic phase



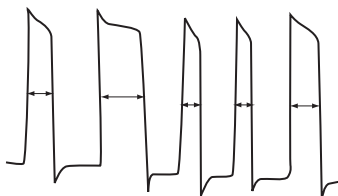
TACHYCARDIA

Decreased duration of plateau due to shortened diastolic phase



2. RHYTHM

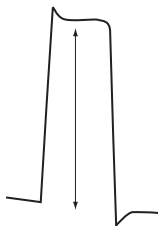
Varying R-R intervals result in irregular plateau durations



3. BLOOD PRESSURE

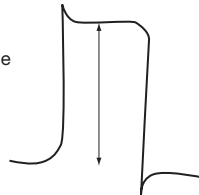
HYPERTENSION

Increased height or amplitude of the waveform



HYPOTENSION

Decreased height or amplitude of the waveform



Notes:

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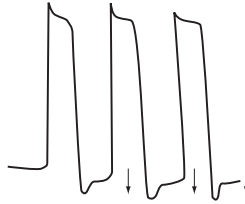
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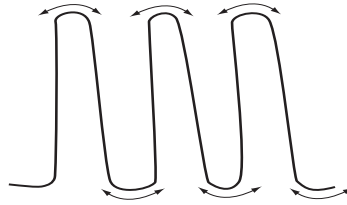
4. GAS LOSS

Leak in the closed system causing the balloon pressure waveform to fall below zero baseline. This may be due to a loose connection, a leak in the IAB catheter, H₂O condensation in the external tubing, or a patient who is tachycardiac and febrile which causes increased gas diffusion through the IAB membrane.



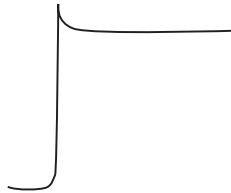
5. CATHETER KINK

Rounded balloon pressure waveform, loss of plateau resulting from a kink or obstruction of shuttle gas. This may be caused by a kink in the catheter tubing, improper IAB catheter position, sheath not being pulled back to allow inflation of the IAB, the IAB is too large for the aorta, the IAB is not fully unwrapped, or H₂O condensation in the external tubing.



6. SUSTAINED INFLATION

Theoretical possibility if the IAB remains inflated longer than 2 seconds. The intra-aortic balloon pump will activate the System Failure alarm and deflate the IAB.



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BIBLIOGRAPHY

Elahi MM, Chetty GK, Kirke P, Azeem T, Hartshorne R, Spyt TJ. Complications Related to Intra-Aortic Balloon Pump in Cardiac Surgery: A Decade Later. *European Journal of Vascular and Endovascular Surgery* 2005;29(6):591-4

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**PROGRAM AND SPEAKER
EVALUATION**

**Mechanisms of Counterpulsation
Program Code 02:**

Date:

Please rate the program and speaker items by placing a mark in the appropriate column.

PROGRAM EVALUATION	1 POOR	2 FAIR	3 GOOD	4 VERY GOOD	5 EXCELLENT
Program met the stated objectives					
Content covered topic adequately					
Overall quality of this program					
Overall quality of speaker(s)					
Quality of the program objectives					
Program met my personal objectives					
I can incorporate program content into my practice					

Speaker Name:

SPEAKER EVALUATION	1 POOR	2 FAIR	3 GOOD	4 VERY GOOD	5 EXCELLENT
Objectives- Stated objectives met					
Audiovisual- Contributed to presentation					
Content- Relevance of content to objectives					
Presentation- Speaker qualified and held interest					
Effectiveness- Speaker was organized and effective					
Practice- Validated and/or changed practice					

Comments:

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Participant Name:



MAQUET

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