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**Edwards FloTrac Sensor**  
**&**  
**Edwards Vigileo Monitor**

*Comparing Arterial Pressure-Based Cardiac Output and Right Heart Thermodilution Cardiac Output Technologies*

**Edwards FloTrac System**



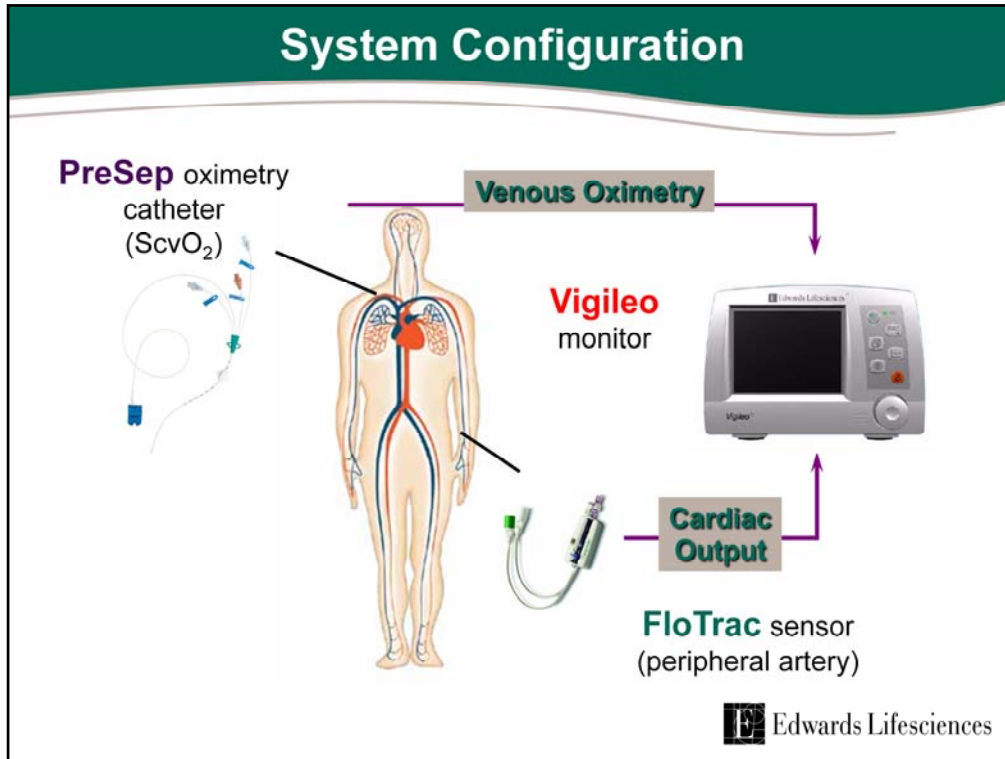
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The image shows a medical monitor on the left with a screen displaying a large number '82' and a waveform. To the right is a FloTrac sensor connected to a tube. The background is light with a green wavy line separating the top and bottom sections.



## Topics

- **System Configuration**
- **Technological Differences and Their Impact on Comparison Results**
- **Sources of Error and Their Impact on Comparison Results**



The Vigileo monitor by Edwards Lifesciences supports both the FloTrac Sensor for continuous cardiac output and the PreSep oximetry catheter for continuous central venous oximetry (ScvO<sub>2</sub>)

## Vigileo Monitor

- Continuously computes stroke volume from the patients arterial pressure signal
- Displays key hemodynamic parameters on a continuous basis (every 20 sec)
- Requires NO manual calibration
  - The user simply enters patient age, gender, height and weight to initiate monitoring
  - Advanced waveform analysis compensates for:
    - Patient-to-patient differences in vasculature
    - Real time changes in vascular tone
    - Differing arterial sites
- Venous oximetry available when used with appropriate Edwards oximetry technology



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The Vigileo monitor continuously displays and updates Continuous Cardiac Output, Cardiac Index, Stroke Volume, Stroke Volume Index, Systemic Vascular Resistance\*, Systemic Vascular Resistance Index\*, and Stroke Volume Variation every 20 seconds when used with the FloTrac Sensor. DO<sub>2</sub> and DO<sub>2</sub>I are also available for intermittent calculation.\*\* These parameters help guide the clinician in optimizing stroke volume through precision guided management of preload, afterload, and contractility.

Vascular tone = vessel compliance and resistance

Vigileo then helps identify the adequacy of cardiac output by monitoring central venous (ScvO<sub>2</sub>) or mixed venous (SvO<sub>2</sub>) oxygen saturation when used with Edwards venous Oximetry technologies.

\* *These parameters require the CVP value to be slaved from bedside monitor for continuous monitoring. SVR/SVRI can also be assessed on the Derived Value Calculator for intermittent calculations using either slaved or manually entered MAP, CVP, and CO values.*

\*\* *These parameters require the SpO<sub>2</sub> and PaO<sub>2</sub> values to be manually entered. If CO is being continuously monitored, the calculator will default to the existing CO value. Otherwise, the user may override the continuous value to manually enter CO.*

## FloTrac Sensor



The specially designed **FloTrac** sensor provides the high fidelity arterial pressure signal required by the Vigileo monitor to calculate the stroke volume


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The *Vigileo* monitor uses the patient's arterial pressure waveform to continuously measure cardiac output. With inputs of height, weight, age and gender, patient-specific vascular compliance is determined.

The *FloTrac* Sensor measures the variations of the arterial pressure which is proportional to stroke volume. Vascular compliance and changes in vascular resistance are internally compensated for.

Cardiac output is displayed on a continuous basis by multiplying the pulse rate and calculated stroke volume as determined from the pressure waveform.

The *FloTrac* Sensor is easily setup and calibrated at the bedside using the familiar skills used in pressure monitoring.



**FloTrac Sensor and Swan-Ganz Catheter  
Bolus and Continuous Cardiac  
Output Comparison**





## **Technological Differences and Their Impact on Comparison Results**



## Technological Differences

ICO	CCO	FloTrac sensor
Right heart	Right heart	Left heart
CO measurement	CO measurement	SV & PR measurement
Thermal washout	Thermal washout	Pressure variation
15-30s avg (per bolus)	Avg over several min. pending thermal noise	20s SV&PR 1 min $\chi$
Algorithm limits (point selection)	Algorithm limits (signal to noise)	Algorithm limits (observation set)

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When comparing technologies, it is important to understand how each technology works, what can affect their values, and why trending characteristics will be different.

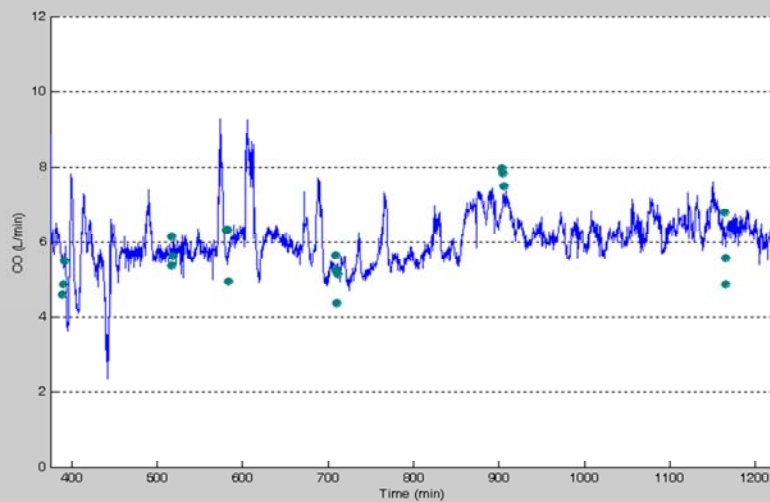
Intermittent Cardiac Output (ICO) is a single point-in-time, thermal washout within the right heart.

Continuous Cardiac Output (CCO) is continuous thermal washouts in the right heart that are averaged over several minutes. The averaging period is dependent upon the amount of thermal noise the CO computer registers. The less thermal noise there is the shorter the averaging time will be.

FloTrac System calculates CO, which is measured from Stroke Volume and Pulse Rate generated from the left heart and calculated every 20 seconds.

Calculation timing plays a significant role in creating variance, especially with a patient who is hyperdynamic.

## FloTrac Sensor Compared to ICO

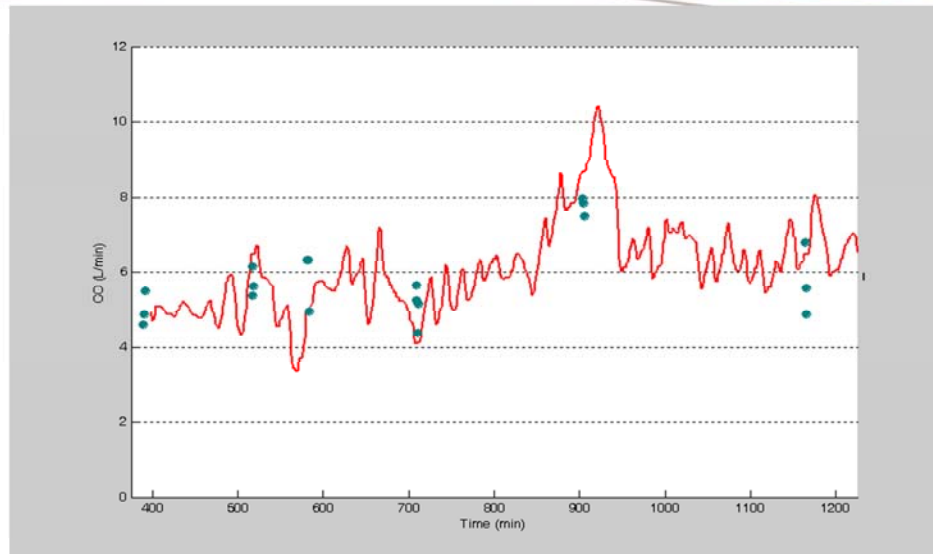


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The following 4 slides are all from the same patient. This initial slide compares FloTrac to ICO over approximately 14 hours. FloTrac is represented by the blue trend line.

During this period, there were 6 episodes of boluses. In each case, the FloTrac CO trend moves through the middle of the boluses; where they would take the average to report ICO. Correlation between ICO and FloTrac is very tight.

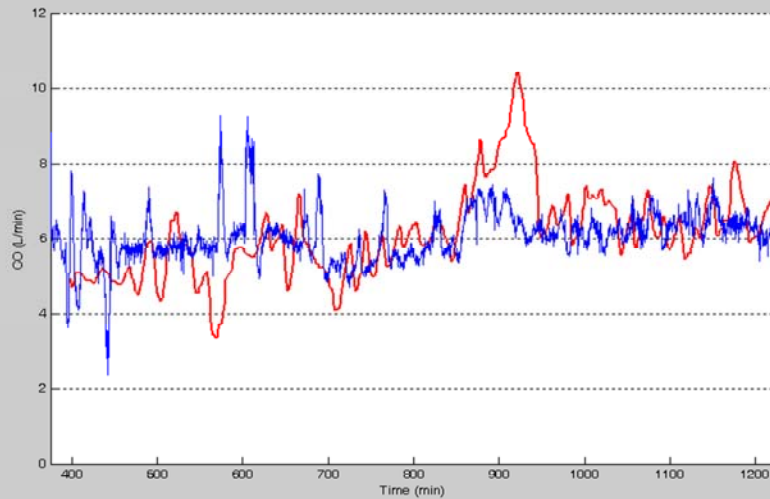
## CCO Compared to ICO



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In this same patient, CCO, shown in red, move through the same boluses as shown on the previous slide. With clinical experience, one could say that these two methods appear to correlate very well.

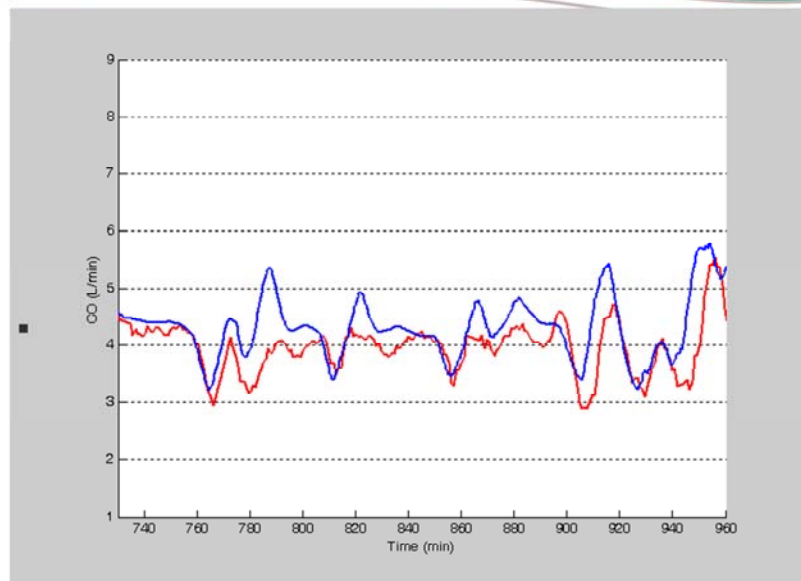
## FloTrac Sensor Compared to CCO



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Overlaying FloTrac and CCO, the dynamic response of FloTrac relative to CCOs longer averaging is evident. The two trends, however, tend to meet in many instances. Also evident are instances where Swan Ganz CCO is still responding to changes in the patient that occurred 8-12 minutes prior. In such instances, its possible FloTrac and Swan Ganz trends appear to temporarily be moving in opposite directions. This is due largely to differences in response time to the patient's real time physiological changes (e.g., vascular tone, pulse pressure increase due to sudden increase/decrease in volume).

## Closing the Averaging Time Gap



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Above is the same patient example, but the FloTrac output has been adjusted to trend along the same averaging speed as Swan Ganz CCO.



## **Sources of Error and Their Impact on Comparison Results**



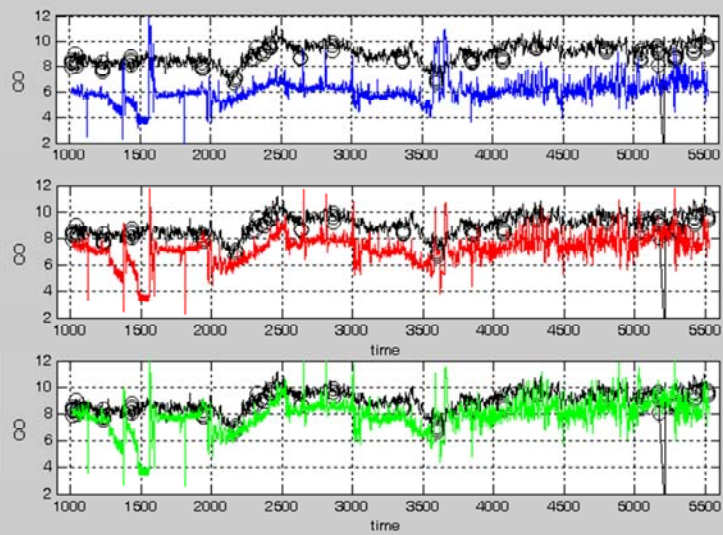
## Error Sources

ICO	CCO	FloTrac sensor
Comp constant	-----	Patient data Age Height & weight Gender
Clinician technique Injectate Volume Injectate Temperature Injection Timing	-----	-----
Catheter migration	Catheter migration	Sensor height
Ventilator timing	Sequential compression device	Aortic balloon pump
Patient temperature shifts	Patient temperature shifts	Patient arm movement
Infusions & drips	Infusions & drips	Line bubbles catheter whip (fem)
Valve regurgitation	Valve regurgitation	Pressure dampening (extreme vasopress)

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Additional sources of error are noted and should be taken into consideration when comparing these two very different technologies.

## Impact of Incorrect Setup



Original  
comparison



Corrected for  
transducer  
height



Corrected for  
patient weight

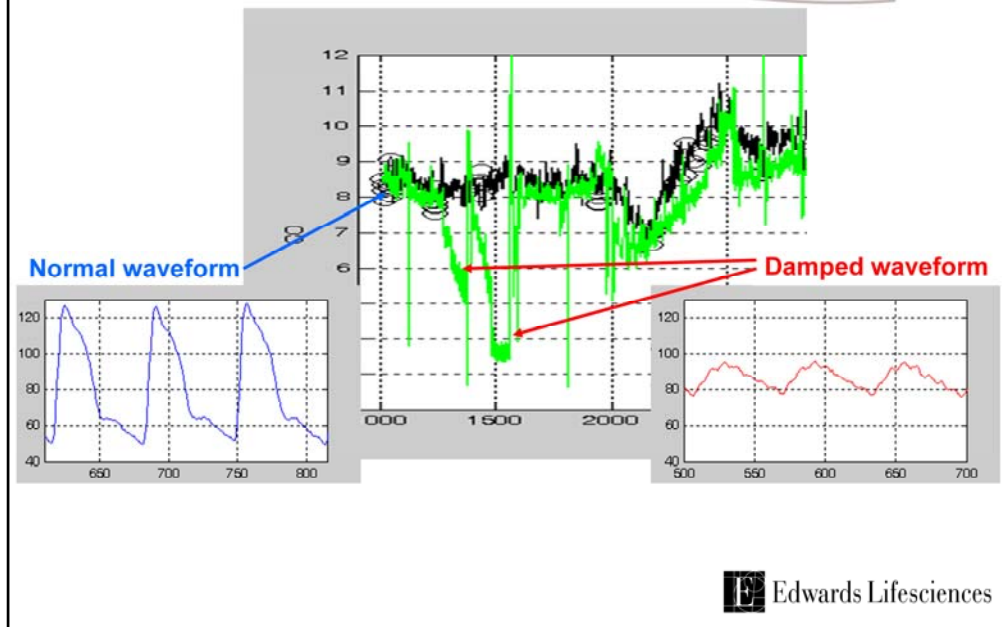
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Above is a comparison of FloTrac to CCO and ICO. FloTrac is the blue/red/green trend line, CCO is represented by a black trend line and ICO is noted by the black circles. The initial trace demonstrates a 2 liter difference on average.

The second trace is corrected for misaligned transducer height.

The third trace is corrected for entry of inaccurate patient weight. All demonstrate the importance of ensuring correct techniques are practiced.

## Line Damping -> CO Changes



Good waveform fidelity is crucial in obtaining accurate data. The traces above show the impact of a dampened line on the cardiac output values.

## Summary

- Technological differences must be taken into consideration when comparing the **FloTrac** sensor to thermodilution cardiac output
- Attention to detail and technique should be observed in order to obtain the most accurate data
- Even when technique is at its best, differences in data averaging can create periods of wide variation between values

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Edwards Lifesciences LLC · One Edwards Way · Irvine, CA 92614 USA · 949.250.2500 · 800.424.3278 · [www.edwards.com](http://www.edwards.com)



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