ABIOMED

Impella® Updates

September, 2015

Blood Oxygenation Monitoring During Impella® Support

WHAT'S NEW?

When using pulse oximetry in patients supported by the Impella® Catheter, clinicians may observe issues during nonpulsatile flow conditions. This Impella® Update will help clarify what to expect from commonly available oxygen saturation monitors during situations in which arterial blood pressure may become nonpulsatile due to Impella® support in the face of significant cardiac depression. This Impella® Update also discusses measures to mitigate this issue.

BACKGROUND

Patients can have dramatic hemodynamic variability while undergoing cardiac catheterization lab interventions. During such procedures, multiple monitoring modalities, including pulse oximetry, are routinely and appropriately utilized.

During Impella® use, especially when the device is first started, the patient's pulsatility may drop or disappear completely. This is due to the functional nature of the continuous flow ventricular support systems and may vary depending on the level of myocardial compromise. During periods of severe myocardial depression, the Impella® becomes the dominant contributor to systemic blood flow. With the use of a continuous flow ventricular support systems, blood flow inherently loses its pulsatile nature until the native heart is strong enough to return to pulsatile flow.

PUTTING IT INTO PRACTICE

Effect of Impella® on Common Oximetry Monitoring.

Since a patient may experience a drop in pulsatility as the device provides higher levels of support, it is important to recognize the effect of Impella® on common oximetry monitoring systems. Specifically, pulse oximetry is entirely dependent upon a peripheral pulse in order to determine the oxygen levels of the patient (Figure 1). A decrease in pulsatility may cause a drastic drop or a "zero" value calculated for SpO_2. This displayed or calculated value can occur regardless of the true arterial oxygen saturation and may lead to confusion as to the true clinical state of the patient's arterial oxygenation saturation.

Alarms are set in place within the monitoring device to notify the operator when the readings drop below a specific limit (%SpO_2 below 85% in most popular devices) or when pulse pressure is low.

The root cause of the pulse oximetry false readings is low to no pulsatility which is outside of the intended operating conditions for this monitoring method. Instead, some centers use cerebral oximetry for assessing hemodynamic conditions when more invasive monitoring is not available[3].

Support the Patient and Evaluate Reasons for Alarm.

The first priority is always to support the patient and evaluate potential reasons for an oximetry alarm condition. When Impella® support is initiated, one should always

note the degree of pulsatility. Pulse has been seen to "mean out" with high levels of Impella® support; however, the mean blood pressure should be adequate and in the 60–75 mmHg range. Myocardial depression and/or severe hypovolemia will exacerbate this phenomenon. With this knowledge, one should be prepared and aware that the Impella® alarm of "Impella® Position Unknown" will be displayed if the arterial pulse pressure is <20 mmHg at which point pulse oximetry monitors may simultaneously indicate falling or potentially unknown oxygen saturation condition.

It should be noted that although the blood pressure may be flat and non-pulsatile, the patient is still displaying an acceptable blood pressure mean. Acceptable systemic oxygenation can be validated by a normal or unchanged exam (skin color) or by arterial blood gas analysis.

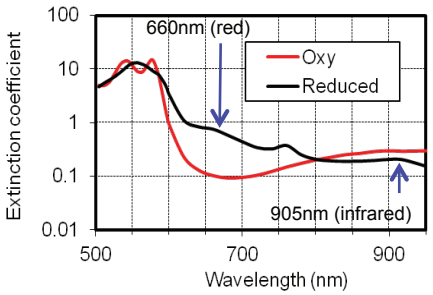
Pulsatility can be returned by reduction of Impella® support level (if the patient can tolerate such a reduction) or by increasing the available blood volume for the native heart and the Impella® to pump. This can be accomplished through IV fluid administration. A more rapid option is through the use of a vasoconstrictor allowing a relatively large volume of blood to be made available to the systemic circulation by the selective vasoconstriction of the abdominal venous capacitance vessels. Small doses of ephedrine or phenylephrine may rapidly increase available intracardiac volume so that Impella® flow remains high and the left ventricle has volume to pump, thus restoring native pulsatility.

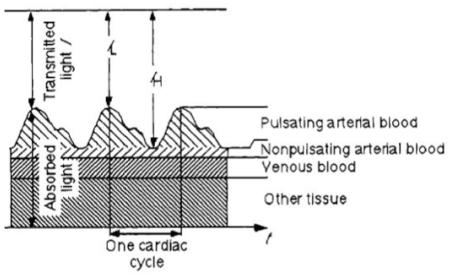
SUMMARY

While on Impella® support, a patient's blood flow inherently loses its pulsatile nature, which may cause a patient's pulsatility to drop or disappear completely. Clinicians may see a drastic drop or a "zero" value calculated for SpO2, regardless of the true arterial oxygen saturation. However, the mean blood pressure should be adequate and in the 60–75 mmHg range and skin color and/or arterial blood gas analysis should reveal acceptable systemic oxygenation. Reducing Impella® support, if the patient can tolerate the reduction, or administering IV fluids to increase blood volume can return pulsatility. Pulsatility may also be restored by administering small doses of ephedrine or phenylephrine to rapidly increase left ventricular volume and keep Impella® flow high.

Figure 1: Basis of Standard Pulse Oximetry and the Implications of Non-Pulsatile Flow (1,2)

- Transilluminate a fingertip with at least 2 wavelengths, e.g., 660nm (red) and 905nm (infrared).
- Determine absorbance of each wavelength by pulsing arterial blood (and not other components of the fingertip) by measuring changing transmission during pulses
- Convert to absorbance (really attenuance).
- Calculate ratio of attenuance of red to attenuance of infrared





From Weiben 1997

Without a discernable pulse, standard pulse oximetry fails

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