OREGON HEALTH & SCIENCE UNIVERSITY
Hospitals and Clinics
Point of Care

# Hemoglobin and Oxygenated Hemoglobin Saturation, Whole Blood by ITC AVOXimeter 1000E

## Principle

Hemoglobin is the main chemical substance within red blood cells and is the compound which transports the major portion of oxygen to the tissues. Analysis of hemoglobin and its oxygen carrying capacities are important in many acute and chronic disease states. Many hemoglobin forms or derivatives, including oxyhemoglobin ($HbO_2$), deoxyhemoglobin (Rhb), methemoglobin (MetHb), and carboxyhemoglobin (HbCO) possess an individual and distinctive spectral pattern. The ITC AVOXimeter measures whole blood %HbO2 and total hemoglobin using disposable single-use cuvettes. It measures these parameters at 5 different wavelengths. This reduces interference from dyshemoglobins and other interfering substances such as fetal hemoglobin and bilirubin. The total hemoglobin is measured and the different hemoglobin forms are expressed as a percentage of the total Hgb (tHb).

Oxyhemoglobin saturation (%$HbO_2$) is calculated from the oxygenated hemoglobin ($HbO_2$) and total hemoglobin (THb).

Normally $O_2$ saturation in arterial blood is greater than 95%; a decrease level indicates a low $pO_2$ or impaired ability for the oxygen carrying capacity of hemoglobin.

## Specimen Requirements

1. Whole blood collected in a Lithium or Sodium heparin syringe.

2. Perform test immediately.

3. Do not assay clotted samples.

4. Minimum sample volume is 50 μL.

## Interferences

None

## Linearity

1. Total Hemoglobin; 4.0-25.0 g/dL.
2. Hemoglobin values >25.0 are reported as “greater than” the highest value printed. Note that value exceeds the linearity of the method.
3. HbO2%; 10-100%

Reference Range

| **Total Hemoglobin** | **Age** | **Male (g/dL)** | **Female (g/dL)** |
|---|---|---|---|
| | 0 - 1 day | 13.5 - 19.5 | 13.5 - 19.5 |
| | 1 day - 2 weeks | 14.5 - 22.5 | 14.5 - 22.5 |
| | 2 weeks - 1 month | 12.5 - 20.5 | 12.5 - 20.5 |
| | 1 month - 6 months | 10.0 - 18.0 | 10.0 - 18.0 |
| | 6 months – 1 year | 9.5 - 13.5 | 9.5 - 13.5 |
| | 1 - 12 years | 10.5 - 13.5 | 10.5 - 13.5 |
| | 12 - 18 years | 11.5 - 15.5 | 11.5 - 15.5 |
| | >18 years | 13.5 - 17.5 | 12.2 - 15.0 |
| **Oxygen Saturation** | **Age** | **Male (%)** | **Female (%)** |
| | 0 - 1 month | 40 - 90 | 40 - 90 |
| | >1 month | 92 - 98 | 92 - 98 |

Quality Control

1. Perform both Yellow and Orange Optical Quality Control (QC) test every 24 hours of patient testing.
    a. Run a test using the optical filter in place of a test cuvette.
    b. Record both THb and $\%HbO_2$ results in the QC log book.
    c. Verify results are within acceptable limits.
    d. Repeat steps a-c with second filter.

2. Perform both Low and High liquid Quality Control (QC) [RNA Co-Oximeter] test every week of patient testing.

    To perform High and Low Liquid QC:
    a. Take QC material from the refrigerator and perform test w/in 5 minutes of removal.
    b. Gently invert the QC vial. Flick the top with your finger to remove any air bubbles.
    c. Wrap the tip with a gauze pad and snap the top off.
    d. With a small syringe, aspirate the solution into the syringe.
    e. Dispense the control solution into a plastic cuvette. Leave syringe attached to cuvette.
    f. Verify that the light path area is free of bubbles. If bubbles are in the light path area, a new cuvette must be used.
    g. Place the filled test cuvette into the test chamber (blue filter pad facing to the left) for testing to start.
    f. Record both THb and $\%HbO_2$ results in the QC log book.
    g. Verify results are within acceptable limits.
    h. Repeat steps b-g with second QC.

3. QC results must be within acceptable limits before patient testing is performed. Record QC results in QC Logbook.

4. If QC fails, repeat the failed QC. If repeat QC fails, do not perform patient testing until problem is resolved and QC results are within acceptable limits. Document all action taken in the QC Logbook. Contact ITC for troubleshooting at 1-888-631-5945.

## Procedure

1. Mix patient sample well. Connect syringe to an unused cuvette.

2. While firmly holding the syringe and cuvette at a 45 degree angle, fill the cuvette by gently pressing the syringe plunger. **Do not overfill cuvette**- this will cause the blue filter patch to bulge and the cuvette will not fit into test chamber.

3. Verify that the light path area is free of bubbles. Wipe exterior of cuvette, if necessary, with a KimWipe.

   **Keep the syringe attached to cuvette during testing.**

4. Verify that the instrument is ready to run a test and that the '**READY**' – '**Insert Cuvette'** screen is displayed.

5. Insert cuvette with the Blue Vent Patch held to the left.

6. Enter operator ID and Patient ID at the prompts on the instrument.

7. Results are displayed in about 10 seconds.

## Calculations

None.

## Results Reporting

1. Hemoglobin (THb) is reported in g/dL.

2. Oxygenated Hemoglobin ($HbO_2$) saturation is reported in %.

3. Report all results to the tenth (X.X).

## Calibration

1. The ITC AVOXimeter 100E is factory-calibrated. No additional calibration is necessary.

2. Calibration verification/ linearity and patient correlations are performed by POCT every 6 months.

Cuvette Path Length

Accuracy of total hemoglobin measurements depends on using the correct cuvette pathlength. The user must check the pathlength whenever using a different lot number of cuvettes.
If the cuvette pathlength needs to be changed, follow the below:

1. Press ‘1’ followed by ‘Enter’ (Calibration menu).
2. Press ‘3’ followed by ‘Enter’ (Cuvette Pathlength).
3. To change the interval, press the backspace key and enter new value followed by ‘Enter’.
4. Verify that the new pathlength is correctly displayed, then press ‘Enter’.
5. Press ‘Cancel’ to return to the previous menu.

Reagents

1. ITC AVOXimeter 1000E Cuvettes:

2. Yellow and Orange Optical Quality Control Cuvettes:

3. RNA Co Oximeter Low and High Liquid QC:
   a. Unopened QC vials are stable refrigerated (2°-8°C) until expiration date on the box
   b. Once removed from the refrigerator, QC testing must be done within 5 minutes.
   c. Do not freeze QC vials.

References

1. Operator’s Manual for AVOXimeter 1000E, ITC, 2007.

2. Cardiopulmonary Bypass, by Glenn P. Gravlee - Wolters Kluwer Health/Lippincott Williams & Wilkins (2008)