

# Pulmonary Diagnostics: Shunt Fraction Calculation Right-to-Left

## Site Applicability

St. Paul's Hospital

## Practice Level

Respiratory Therapist

## Requirements

Ordering of a shunt calculation is restricted to Specialist (Respirology, Cardiology, or after consultation with the PFT medical director) only. A special booking will need to be made through the Pulmonary Function Lab and coordinated with the Bronchoscopy suite, as the test must be performed in the suite.

## Need to Know

A shunt is the portion of the cardiac output that traverses the pulmonary capillaries without participating in gas exchange. The shunt calculation determines the ratio of shunted blood ( $Q_s$ ) to total perfusion ( $Q_t$ ) and is reported as a percent of total cardiac output or as a simple fraction.

The right-to-left shunt fraction is reflected by the degree to which arterial oxygen content is improved by the application of a high fraction of inspired oxygen ( $FiO_2$ ). The marked rise in alveolar  $PO_2$  during 100%  $O_2$  breathing facilitates the transfer of  $O_2$  into the capillary blood and will overcome the other mechanisms causing hypoxemia (i.e. alveolar hypoventilation, ventilation perfusion ratio inequity, diffusion impairment). Normally, the P (A-a)  $O_2$  during 100%  $O_2$  breathing is less than 160 mmHg and any increase greater than 160 mmHg is an indication of an increased right-to-left shunt.

## Equipment and Supplies

- Stretcher
- Hans-Rudolph valve
- Reservoir bag
- Silicone mouthpiece
- Microgard filter
- Nose clips
- 100%  $O_2$  source
- Arterial Blood Gas kit x2

## Indications

- To determine if a right-to-left shunt exists

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- To determine the degree of right-to-left shunt

## Procedure

### Steps

1. Verify physician's order in CST Cerner and review patient chart for pertinent information including anticoagulant therapy and contraindications to ABG sampling.
2. Verify the correct patient by identification and generate an ABG specimen label:
  - a. Using a workstation on wheels (WOW), open PowerChart for the appropriate patient.
  - b. Click the "Sunquest Collect" icon. Scan QR code on the wireless printer to pair as prompted.
  - c. Scan barcode on patient label. Select the appropriate specimen label from the displayed list (i.e. ABG) and print. Click 'Done -EXIT' to close program.
3. Place patient in a supine or semi-recumbent position on the stretcher.
4. Perform a room air arterial blood gas as per B-00-12-12002 - [Arterial Blood Gas Puncture](#) and send to laboratory for analysis.
5. Assemble the mouthpiece/filter to Hans-Rudolph valve and reservoir bag.
6. Inflate reservoir with 100% O<sub>2</sub> and adjust flowmeter to keep reservoir bag adequately inflated throughout the procedure.
7. Instruct the patient to apply nose clips and allow them to breathe 100% O<sub>2</sub> via mouthpiece for 20 minutes.
8. Perform another arterial blood gas while patient is still breathing 100% O<sub>2</sub> and send sample to lab for analysis.
9. Patient may remove mouthpiece. Perform shunt calculation once both ABG results are available from the lab.

### Calculation

A simplified calculation of right-to-left shunt fraction (Chiang 1968) may be used if mixed venous (pulmonary artery) blood is unavailable and if the following two assumptions are fulfilled:

1. The pulmonary end capillary and peripheral arterial blood are both fully saturated, the difference in their oxygen contents (CoO<sub>2</sub>-CaO<sub>2</sub>) being due solely to the oxygen dissolved in physical solution. This requires that the SaO<sub>2</sub> be greater than 90% (PaO<sub>2</sub> greater than 150 mmHg at a temperature of 37 degrees Celsius and pH 7.40).
2. The arterial venous oxygen difference [C(a-v)O<sub>2</sub>] is 5 mL O<sub>2</sub>/100 mL of blood(5 volume %). When the C(a-v) O<sub>2</sub> is different from 5, major errors may be encountered (Torda 1981).

If it is assumed that the two conditions listed above are satisfied, then the following formula may be used to estimate the right-to-left shunt fraction during 100% O<sub>2</sub> breathing:

$$\frac{Q_s}{Q_t} = \frac{0.0031 \times P(A-a)O_2}{0.0031 \times P(A-a)O_2 + 5}$$

For convenience, the Microsoft Excel spreadsheet labeled **Shunt Calculator.xls** may be used to determine right-to-left shunt fraction. Values for barometric pressure, PaO<sub>2</sub>, and PaCO<sub>2</sub> from the 100%

O<sub>2</sub> arterial blood gas results are entered into the appropriate fields and Q<sub>s</sub>/Q<sub>t</sub> is calculated and expressed as a percentage.

## Documentation

- Document the ABG punctures using the “ABG Collection” AdHoc Powerform in CST PowerChart.
- Complete the “Shunt Calculation” Powerform in CST PowerChart
- Print and submit shunt report along with room air and 100% O<sub>2</sub> arterial blood gas results for physician interpretation.

## References

1. Thorax (1968) – A Nomogram for venous shunt calculation.

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