Evaluation of Single- versus Multi-point Barometer Calibration For Reference Dosimetry

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Introduction

- Errors in barometer measurements introduce **systematic dose uncertainties** during reference dosimetry.
- AAPM **WGTG51 Report 374** recommends cross-calibrating field barometers against a reference barometer before reference dosimetry measurements to ensure accurate pressure corrections.
- Conventional barometer calibration relies on a **single-point offset correction**, assuming a linear and uniform instrument response over the clinically relevant pressure range. This approach may not detect changes in **barometer sensitivity** or **malfunctioning** instruments that exhibit an incorrect response slope despite agreeing at the calibration point.
- This study evaluates whether **single-point calibration** remains valid across **a range of altitudes** and investigates whether a **multi-point calibration** (slope and offset) improves **accuracy**, **identifies faulty barometers**, and provides an additional layer of **quality assurance** for pressure-based dosimetry corrections.

Methods and Materials

Barometers Evaluated

- **Three aneroid** and **one digital** ADCL-calibrated field barometers compared against an **ADCL-calibrated** reference barometer.

Data Collection

- Pressure measurements acquired at **8 altitudes** spanning approximately **300 ft (Δ≈10 mmHg)**

Data Analysis

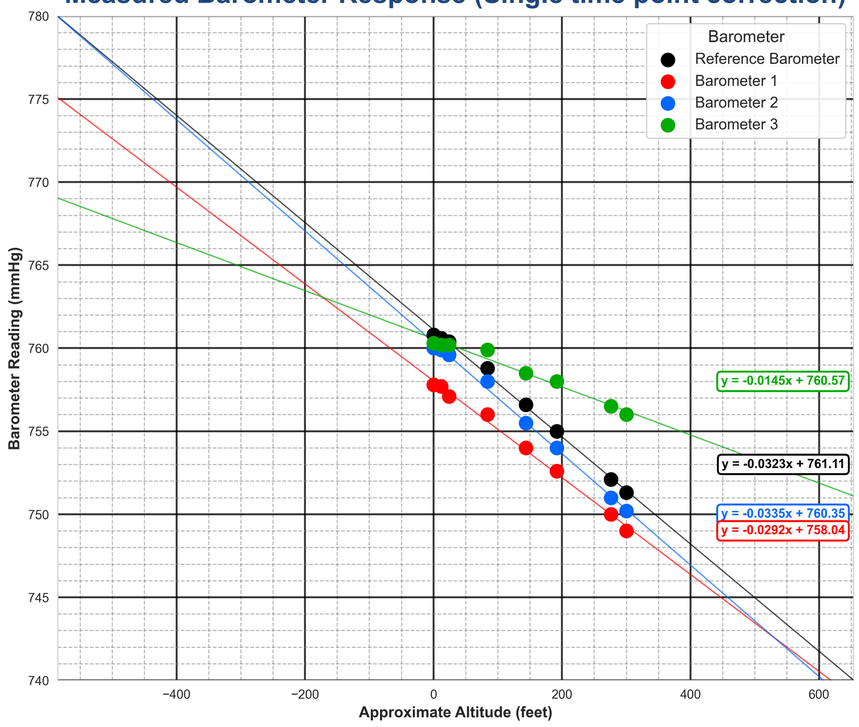
- Linear regression used to determine pressure–altitude relationships and correct versus reference barometer
  - **Single-point calibration** (offset only)
  - **Multi-point calibration** (slope + offset)

Performance Evaluation

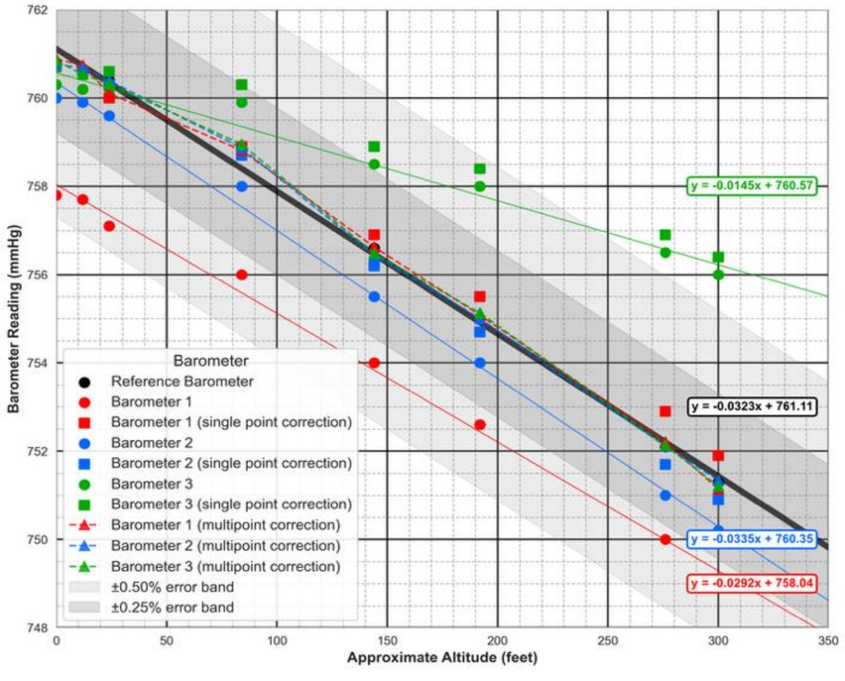
- Maximum absolute percent difference from the reference barometer calculated for each calibration method
- Corrected pressure–altitude gradients compared with theoretical gradients from the **barometric formula.**
- Effect on the pressure–temperature correction factor P_{TP} evaluated for pressures of **740–780 mmHg** at a constant temperature of **24°C**

Results

Measured Barometer Response (Single time point correction)



Barometer Response Correction Method Comparison



Results

Metric	Single-Point Calibration	Multi-Point Calibration
Maximum absolute deviation from reference barometer	$\leq 0.65\%$	$\leq 0.1\%$
Agreement with theoretical pressure gradient	0.013 mmHg/ft	0.003 mmHg/ft
Maximum P_{TP} error	1.5% (740 mmHg) 1.3% (780 mmHg)	0.53% (740 mmHg) 0.39% (780 mmHg)

Conclusions

- Single-altitude barometer calibration may not detect faulty instruments across varying pressures.
- Multi-point calibration provides slope and intercept values, enabling accurate corrections at other altitudes.
- Despite the limited altitude range used, this study demonstrates that multi-point calibration can detect anomalies and complement the single-point calibration method.

References

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