QIBA Volume Flow Profile Info

May 5, 2020

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Clinical Objectives

- Provide an accurate and reproducible measurement of volumetric blood flow
  - Determine conditions under which reproducibility is achieved
    - Standard scanning procedures
    - Range of vessel sizes
    - Range of depths
  - Determination of accuracy
    - Identify possible conditions where reference standard exist

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Testing Objectives Achieved

- Establish accuracy of methods in controlled conditions (phantom)
  - Measure bias and variance
    - Range of flow rates
      - 1 to 12 mL/s
    - Range of depths
      - 2.5 to 7 cm
    - Range of Gains
      - 0-100%
    - Constant and Pulsatile Flows
    - Stenotic flow
    - Range of vessel sizes
      - Only 5mm diameter but with stenosis

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Testing To Be Published

- Three systems
  - Canon Aplio 500 (Canon Medical Systems Inc., Tustin, CA) with a mechanically swept 9CV2 probe
  - GE LOGIQ LE9 (GE Healthcare, Milwaukee, WI) with a mechanically swept RSP6-16 probe
  - Philips EPIQ 7 (Philips Healthcare, Bothell, WA) with an X6-1 2D matrix array

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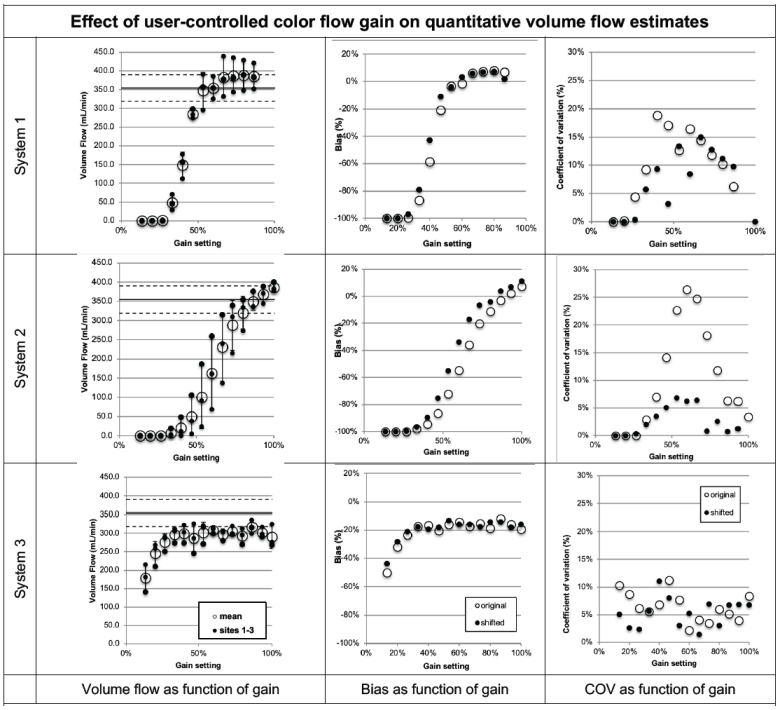
Gain Dependence



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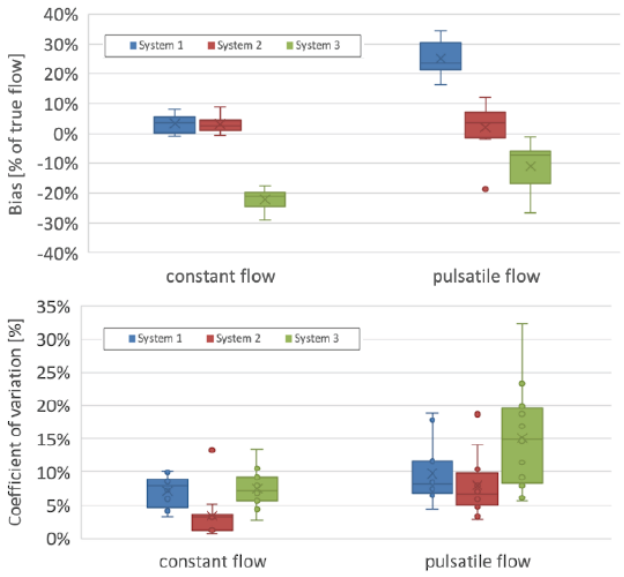
Flow Range Dependence



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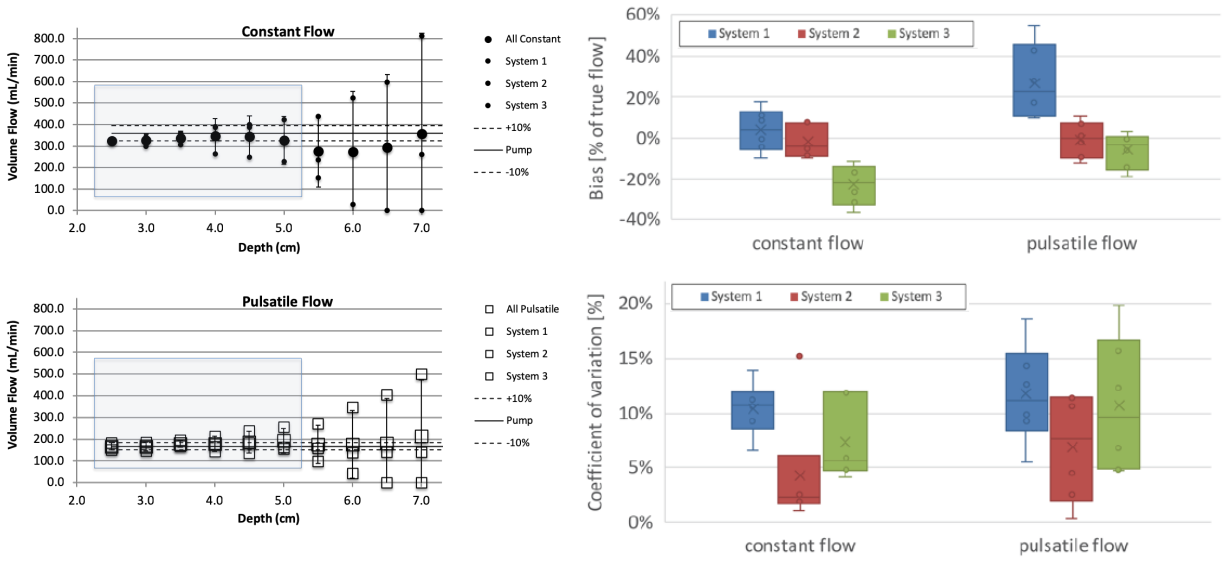
Depth Range Dependence



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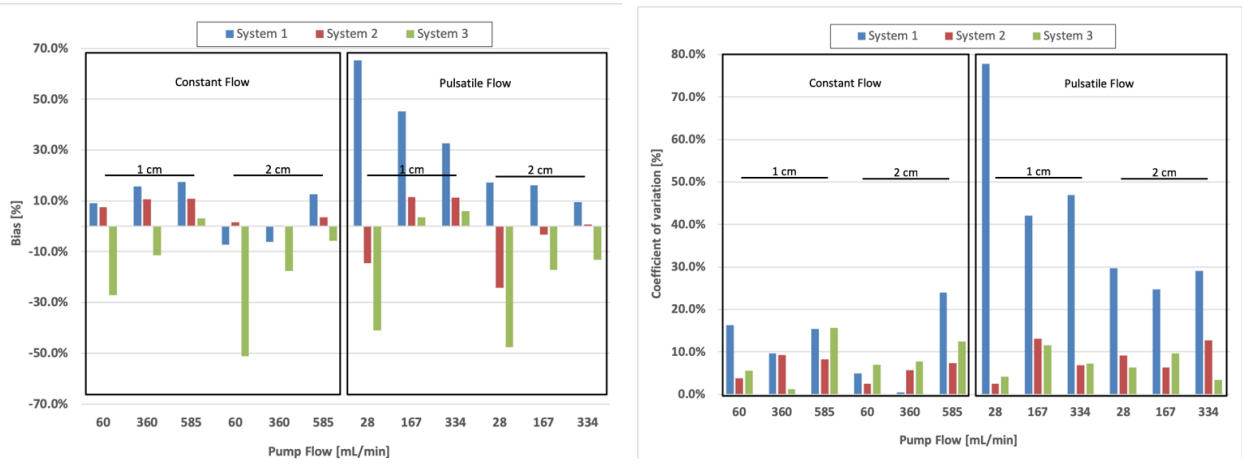
Effect of Stenosis



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Summary of Phantom Results

- Volume flow estimated by 3D color flow ultrasound was
  - Accurate (11.5% mean bias)
  - Reproducible (10.4% mean within-subject COV)
- There were differences among systems that are still being examined.
- There are changes being made to systems expecting to improve performance.

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Testing Objectives Achieved

- Two studies in human umbilical venous flow
  - Pinter et al. (JUM 2017)
  - Rubin et al. (Abstract for 2020 AIUM meeting and manuscript submitted)

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Pinter et al.

- 35-patient cohort could be classified into 3 groups
  - 21 at-risk patients
  - 5 patients with preeclampsia
  - 9 patients with normal pregnancies
- LOGIQ E9 ultrasound system (GE Healthcare, Milwaukee, WI)
  - 2.0–8.0-MHz bandwidth convex array transducer (RAB6-D)
  - Mechanically- swept array
  - 30 volumes per data set
  - 5-10 minute acquisition time

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Pinter et al.

- Free cord loop imaged
  - Generally 3 different free loop positions along the length of the umbilical cord
    - 5 patient had only two positions
    - 1 patient had only one position
  - Imaging depth range
    - 3.3-11.0 cm

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Study Results

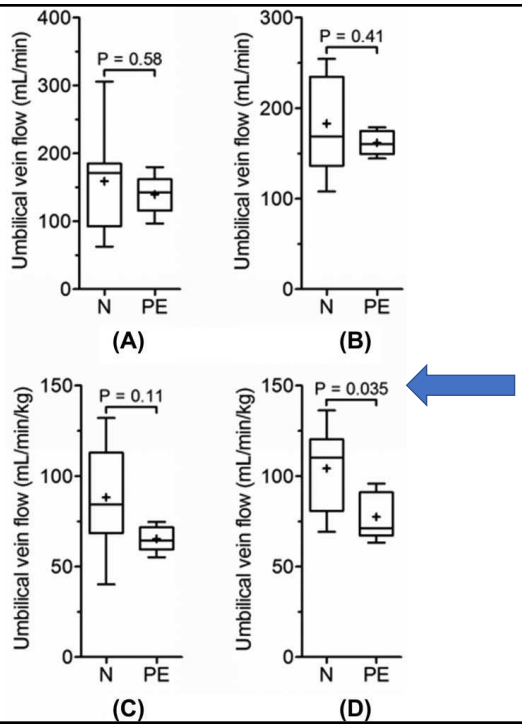
Prediction of Preeclamcia

A) Absolute flow

B) Depth-corrected flow

C) Weight-normalized flow

D) Depth-corrected and weight normalized flow



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Study Results - Reproducibility

Table 1. Volume Flow Estimate Variability (All Patients, Absolute Flow)

Statistic	Value
Intrapatient relative SD (CV), %	20.3 ± 10.1
Intrameasurement relative SD (CV), %	29.6 ± 9.6
Intrapatient relative SE, %	12.1 ± 5.9
Intrameasurement relative SE, %	5.6 ± 1.9

Data are presented as mean ± SD. CV indicates coefficient of variation.

wCV

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Rubin et al.

- 12 subjects
  - High risk gestations
  - Hospitalized during pregnancy
  - Gestation
    - 24 to 35 5/7 weeks
    - Singleton
- Philips EPIQ 7 ultrasound scanner
  - 2D array transducer
  - X6-1 or XL14-3
    - Body habitus
    - Depth range
    - Availability

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Rubin et al.

- Free cord loop imaged
  - At least six separate volume flow measurements were made along the vein
    - Generally three each for 3D volume flow and 2D spectral Doppler method for comparison

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Study Results

- The true flow was unknown for these case (no reference standard)
- Mean within-subject coefficient of variation (wCV)
  - Spectral Doppler method : 46 ± 17%
  - Gaussian surface method : 18 ± 14%

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Potential Associated Claims

- **Claim 1: (cross-sectional) For a measured volume blood flow of *X* mL/min , a 95% confidence interval for the true flow is *X* mL/min ±15%.**
- **Claim 2 : (technical performance claim) The volume flow measurement has a within-subject coefficient of variation (wCV) < 20%.**

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Thoughts on Claim 1

- If we look at the results of the QIBA phantom study there can be additional restrictions considered.
- 1) Depth range over which a given accuracy can be achieved.
- 2) Velocity range over which it has been tested.
- 3) Any difference in such specifications between pulsatile and constant flow.
- Need to define the range over which we will intend for the profile to apply.
- What is the rationale?
- What can be stated from work done so far (QIBA round robin study, etc.)
- Reconsider in favor of defining a PSF/vessel diameter criteria

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Thoughts on Claim 2

- Add any application specific claim(s) (absolute or longitudinal).
- The term "**technical performance claim**" appears appropriate for a similar type of claim.
- This is based on the performance in umbilical venous flow.
  - Consider other sources such as dialysis grafts
    - Average COV 9.89 ± 8.02% based on 2D spectral Doppler

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Overall Considerations

- What is needed for the clinical purpose?
  - Accuracy
  - Reproducibility
- Claims construction process

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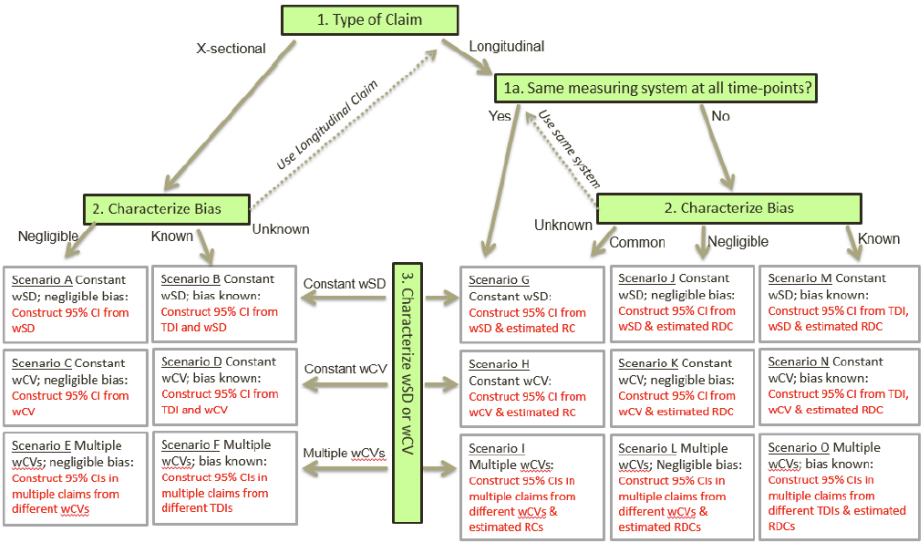
QIBA Claim Guidance



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