

TRENDING PERFORMANCE OF CHANGES IN CARDIAC OUTPUT OF FOUR NON-INVASIVE CARDIAC OUTPUT DEVICES AFTER CARDIAC SURGERY.

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Introduction: Cardiac index (CI) is frequently measured during the early management of patients after cardiac surgery (1,2). Currently, this is obtained with a pulmonary artery (PA) catheter and thermodilution (TD) measurements. Newer non-invasive cardiac output devices may provide an alternative (3–6). Most studies have examined the accuracy and precision of these devices (agreement analysis), but another important function is the ability to track changes in response to fluid challenges or vasoactive drugs (7–10). We examined the agreement ability of each device and tested trending performance using a polar plot format.

Objectives: To evaluate the agreement and trending performance of four non-invasive cardiac output monitoring devices compared to thermodilution.

Methods: This was a prospective quality assurance study in a non-randomized convenience sample of patients post cardiac surgery at a tertiary academic ICU. Accordingly, individual consent was not required. All patients had PA catheters as part of routine care. Four currently approved devices were tested (Cheetah NICOM™, Edwards Vigileo/FloTrac™, LiDCO Rapid™ or PhysioFlow Enduro™). CI measurements were taken simultaneously from the PA catheter and the non-invasive device over the first 24 hours in the ICU whenever a TD measurement was obtained. We compared agreement performance of the devices to TD measurement by Bland-Altman analysis, concordance correlation coefficient, and ability to identify “panic values” (CI < 2.2 L/min/m²) by inter-rater kappa (11–18). Trending performance was evaluated with polar plots (8,9).

Results: We studied 73 patients (NICOM 19, Vigileo 14, LiDCO 19, PhysioFlow 21). Measures of bias and upper and lower limits of agreement ((L/min/m², 95% CI) by Bland-Altman analysis were: NICOM 0.11 (1.65-1.43), FloTrac -0.11 (0.98-1.20), Physioflow 0.10 (1.70-1.51) and LiDCO -0.56 (1.11-2.24). Concordance correlation coefficient was weak (less than 0.8) for all devices (95% CI): NICOM 0.22 (0.21–0.23), FloTrac 0.67 (0.64-0.71), PhysioFlow 0.35 (0.34–0.37) and LiDCO 0.21 (0.20–0.22). Agreement of detection of “panic” CI by Kappa statistic was poor for all devices: 0.08 (0.03-0.14) for NICOM, 0.25 (0.20–0.29) for FloTrac, 0.21 (0.16–0.25) for PhysioFlow and 0.34 (0.30–0.38) for LiDCO. All devices showed excellent trending performance by polar plot analysis. No device demonstrated deviation > 45° from the line of identity. Greater than 99% of the trend data for all four devices was within the accepted limit of agreement of 10% (0.3 L/min/m², see Figure 3).

Conclusion: The NICOM, PhysioFlow and FloTrac devices demonstrated minimal bias, with reasonable limits of agreement, compared to TD. However, the LidCO device tended to overestimate the change in CI with increasing CI. The suboptimal concordance correlation of the devices could limit the use of these devices in certain critical situations. Especially concerning is the high miss rate of panic values of cardiac output. Based on polar plot analysis, all four

devices tracked cardiac output well (8). Polar plot analysis is likely a more intuitive and clinically meaningful measures of trending. In clinical situations where CI trend is useful, such as monitoring response to fluid challenges or vasoactive medications, our results suggest all four devices would be well suited to track cardiac function.

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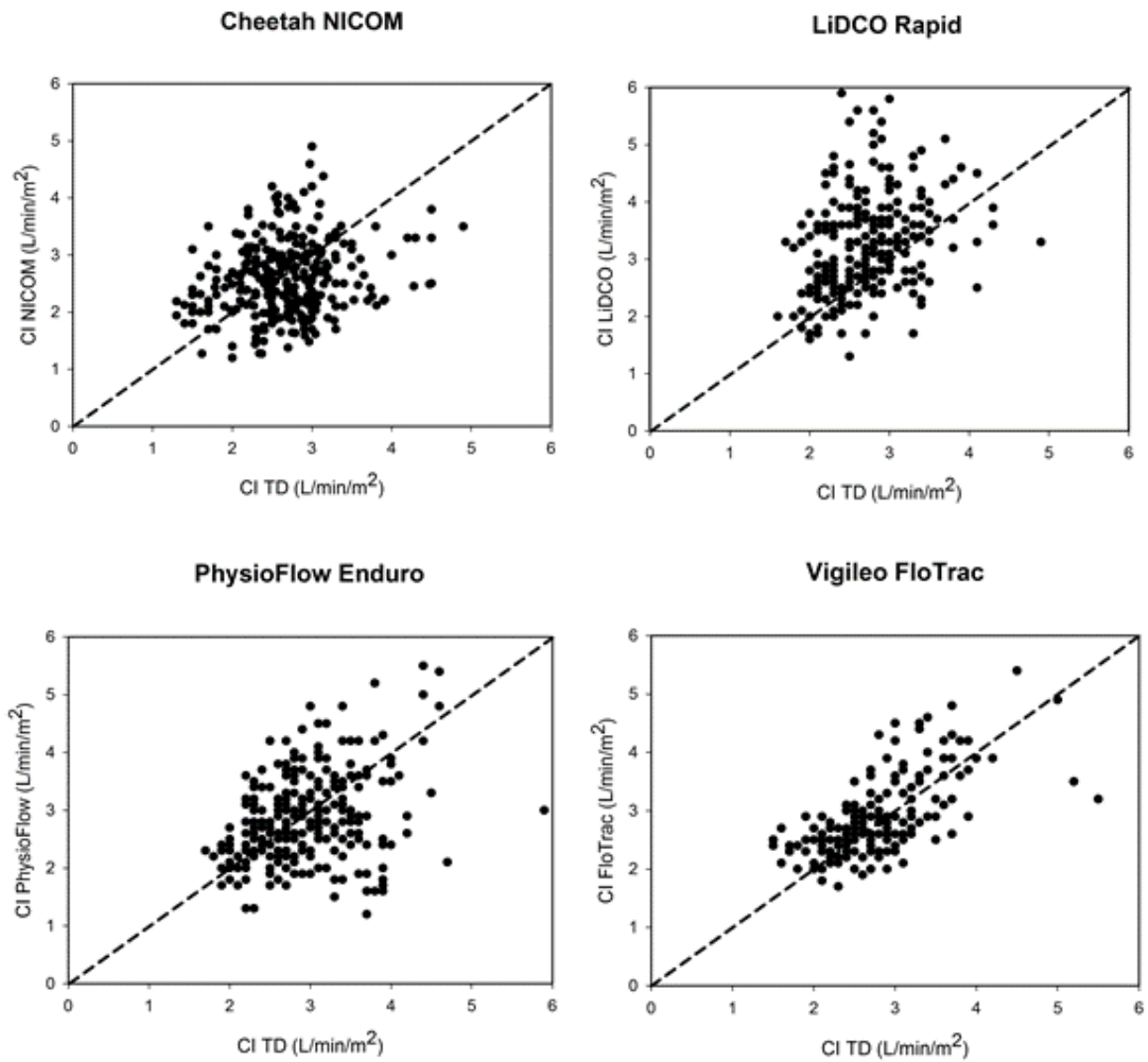


Figure 1. Cardiac index measurements from TD and the non-invasive devices. Dashed line represents line of perfect agreement. CI – cardiac index, TD – thermodilution.

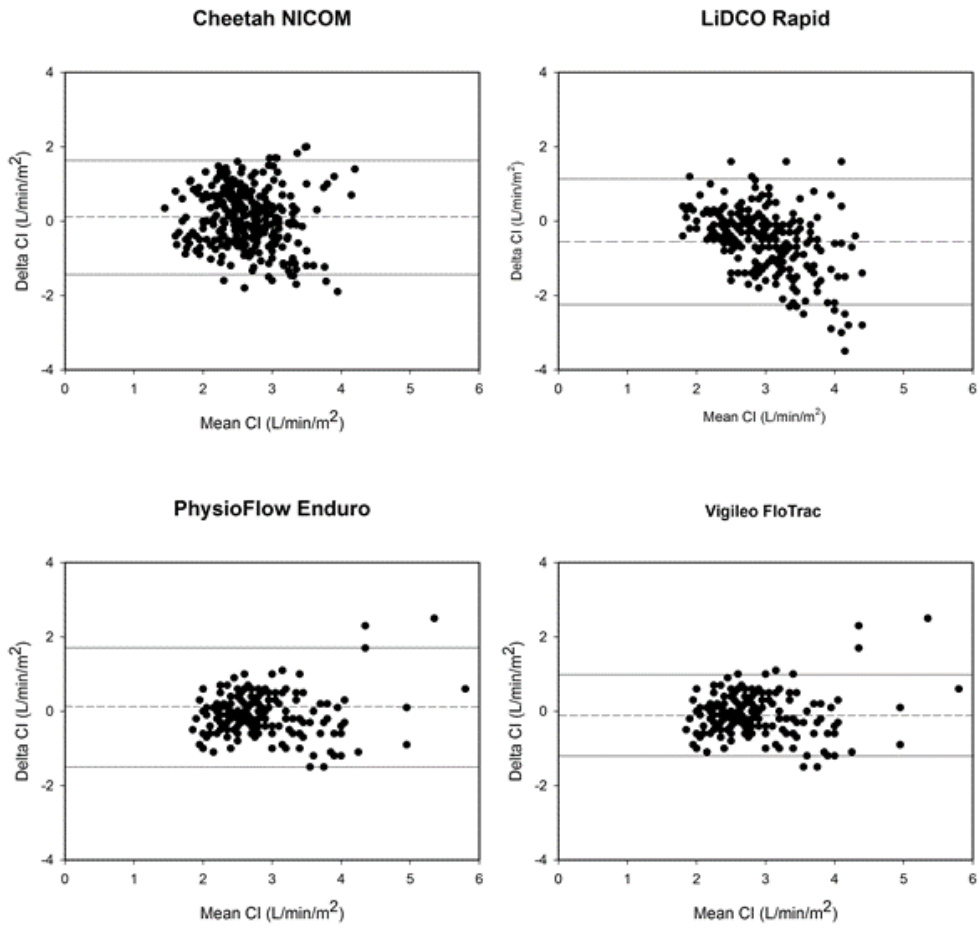


Figure 2. Bland Altman diagrams. Solid lines represent upper and lower limits of agreement, dashed line is mean bias. CI - Cardiac Index.

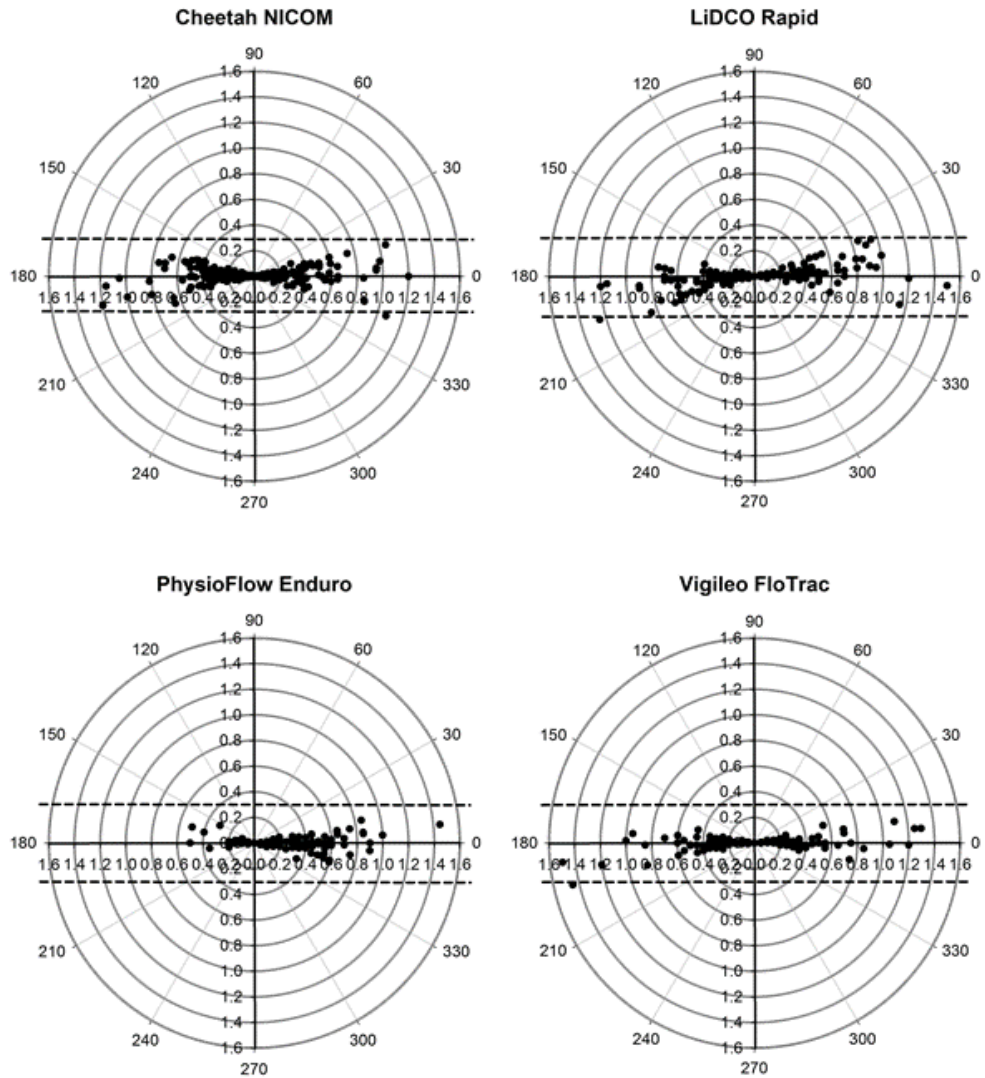


Figure 3. Polar plot analysis of trending performance. Distance from origin is mean difference in cardiac index, angle from 0° line is deviation from line of perfect agreement. Dashed lines correspond to the limits of agreement, 0.3 L/min/m² (10% of expected mean).