Determining the validity of non-invasive hemoglobin testing to detect anemia in postpartum women stratified by pre-existing risk factors

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RESEARCH QUESTIONS

1. Can non-invasive hemoglobin monitors (Masimo Pronto Pulse CO-Oximeter and Rad 67 CO-Oximeter) be used to identify women with postpartum anemia?

2. Does a historical screening questionnaire accurately predict women who are high risk for postpartum anemia?

BACKGROUND

- Ziola et al[1] showed that 87% of pregnant woman in Regina are iron deficient, 8% are anemic in pregnancy, and 24% have postpartum anemia.
- World Health Authority defines postpartum anemia as <100 g/L which may result in:
  - Decreased milk supply
  - Increased maternal infection
  - Fatigue
  - Tachycardia[2]
- Major causes of postpartum anemia are:
  - Antepartum iron deficiency
  - Iron deficiency anemia
  - Excessive blood losses at delivery[3]

- Currently postpartum anemia is detected by invasive laboratory testing on postpartum day one
- Non-invasive hemoglobin analyzers measure oxygen saturation, pulse rate, perfusion index, and total hemoglobin by detecting the levels of oxygen and carbon monoxide bound to hemoglobin.
- The monitor is placed on the individual's finger, and a reading is obtained in seconds.

Masimo Rad-67 Pulse CO-Oximeter

Pronto Pulse CO-Oximeter

METHODS

- Prospective sample of postpartum day one women
- Potential risk factors for postpartum anemia were identified
  - antepartum anemia,
  - bleeding disorder,
  - postpartum hemorrhage
- Non-invasive hemoglobin values determined using Masimo Rad-67 and Pronto Pulse CO-Oximeters and compared to laboratory hemoglobin value
- Intraclass analysis determined device reliability
- Bland-Altman analysis assessed agreement between laboratory and non-invasive hemoglobin results
- Patients were grouped by presence or absence of anemia to determine the sensitivity and specificity of each CO-Oximeter and historical risk factors.
- Historical risk factors were evaluated by logistic regression analysis to determine which were predictors of postpartum anemia in this cohort.

RESULTS

Table 1: Study Demographics

Mean Age	30.76
Mean Gravity/Parity	2.46
Mean Parity	1.92
Mean BMI	30.06
Antepartum Anemia	106
Postpartum hemorrhage	35
Bleeding Disorder	6
Any High Risk Criteria	127
Mode of Delivery	
Vaginal	125
Vacuum	23
Forceps	4
Caesarean	87
Lab Hemoglobin result	
<110g/L	211
<100g/L	64
<90g/L	26
Total Participants	270

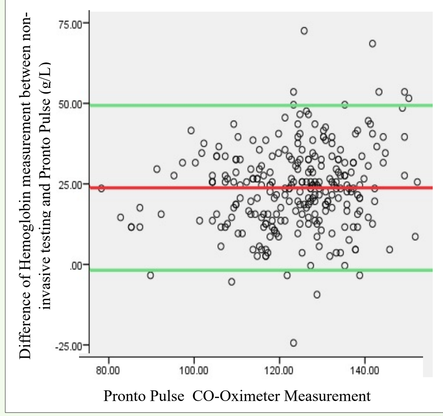
Table 2. Summary of Masimo Pronto Pulse and Rad-67 CO-Oximeters and screen questionnaire predictive value for postpartum anemia

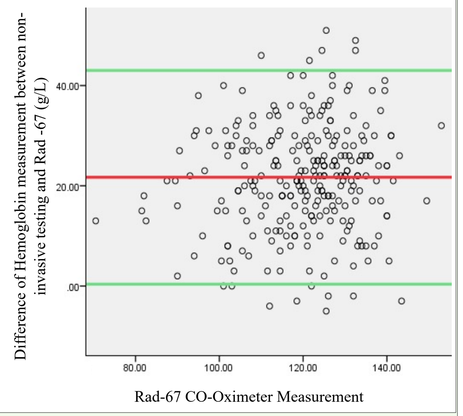
	Sensitivity	Specificity	Negative predictive value	Positive predictive value
Pronto Pulse	12.1%	100%	79.1%	100%
Pronto pulse adjusted for bias	14.07%	54.6%	83.5%	50.0%
Rad-67	13.6%	100%	76.2%	72.4%
Rad-67 adjusted for bias	20.0%	75.0%	82.3%	100%
Screening questionnaire	65.6%	58.7%		

Table 3. Summary of Interclass Correlations

Devices Compared	ICC
Pronto Pulse: Rad 67	0.70
Pronto Pulse: Lab Hb	0.26
Rad 67: Lab Hb	0.33

Figure 1. Summary of Difference Between Masimo Pronto Pulse and Rad-67 CO-Oximeters Hemoglobin Readings Compared to Non-Invasive Hemoglobin Testing





DISCUSSION

- 78.1% of participants had postpartum anemia
- Intraclass analysis showed low reliability when comparing the CO-Oximeters to laboratory hemoglobin
- Bland–Altman analysis showed that CO-Oximeters had a positive bias (overestimation) of 20g/L for the Rad-67 and 25g/L for the Pronto Pulse compared to laboratory hemoglobin
- The Rad-67 CO-Oximeter had a sensitivity of 13.6%, specificity 100%, PPV was 100% and NPV of 76.2% to predict anemia. When adjusted for the positive bias it was 20.0% specific. It is not adequate for screening.
- The Pronto Pulse had a sensitivity of 12.1%, specificity 100%, PPV was 100% and NPV of 79.1%. When adjusted for the positive bias it was 14.1% specific. It is not adequate for screening
- Potential risk factors were 65.6% sensitive which is not adequate for screening purposes
- Logistic regression identified elevated BMI, antepartum anemia, and postpartum hemorrhage as significant predictors of anemia
- Interclass correlation between CO-Oximeter devices was 0.70. Between Pronto Pulse and lab hemoglobin was 0.26, and between Rad-67 and lab hemoglobin was 0.33

CONCLUSION

- Both Masimo CO-Oximeters had positive bias over 20g/L compared to laboratory hemoglobin and may incorrectly identify patients as not being anemic when in fact they are and cannot be used as a sole screening tool for postpartum anemia
- Further refinement of the potential risk factor questionnaire may be developed to identify women at risk of postpartum anemia

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