
MANUAL BLOOD VOLUME CALCULATION VERSUS NADLER'S FORMULA FOR PEDIATRIC THERAPEUTIC APHERESIS PROCEDURES

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Background

- Determination of total blood volume (TBV) is difficult
- TBV calculation
 - Manual calculation
 - COBE Spectra's autocalculation based on Nadler's formula

Manual TBV Calculation

Gilcher's Rule of Fives

Patient	Blood Volume (mL/kg of Body Weight)			
	Fat	Thin	Normal	Muscular
Male	60	65	70	75
Female	55	60	65	70
Infant/Child	–	–	80/70	–

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Manual TBV Calculation

Table 2. Circulating Blood Volume From *The Harriet Lane Handbook*³⁸

	Circulating Blood Volume, mL/kg
Age group	
Preterm infants	90–105
Full-term newborns	78–86
1–12 mo	73–78
1–3 yr	74–82
4–6 yr	80–86
7–18 yr	83–90
Adults	68–88

Manual TBV Calculation

Table 1. Comprehensive Meta-Analysis Results

Age Group	No. of Studies	Estimated Mean Circulating Blood Volume, mL/kg (95% CI)	Test of Homogeneity*	
			Q Statistic	<i>p</i>
All subjects	21	80.0 (77.4–82.5)	46.53	0.16
Premature newborns 0–30 d	3	91.5 (77.3–105.7)	0.18	0.91
Full-term newborns 0–24 h	16	87.7 (83.2–92.3)	11.69	0.70
Full-term newborns 1–7 d	6	91.7 (84.0–99.4)	2.40	0.79
Full-term newborns 7–30 d	2	86.0 (75.6–96.4)	0.09	0.76
Children 1–6 mo	6	84.0 (77.2–90.7)	2.68	0.75
Children 6–24 mo	9	75.4 (68.5–82.3)	8.74	0.36
Children 2–5 yr	6	75.7 (70.7–80.7)	7.26	0.20
Children 5–12 yr	4	74.9 (67.3–82.6)	2.98	0.39
Children 12–18 yr	4	71.4 (66.2–76.5)	1.90	0.59

This compilation was obtained using study-level data from all studies.

* $p > 0.05$ indicates that results of the included studies are homogeneous and can be combined.

Nadler's Formula

- Designed primarily for the adult population

TBV Male $(0.006012 \times H^3) + (14.6 \times \text{weight}) + 604$

TBV Female $(0.005835 \times H^3) + (15 \times \text{weight}) + 183$

Height in inches

Weight in pounds

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Background

- Nadler formula may produce erroneous estimates of TBV for pediatric patients
 - Especially for boys < 10 years or < 30 kg
 - Mean percent difference
 - Greater than 17% males
 - Discrepancy greater in prepubertal boys
 - Ranging from 10% at 10 years to 40% at 2 years
 - Less than 1% in females
- In prepubertal boys, Spectra may be more accurate if “female” is entered as gender instead of “male”

Clough L et al. *J Clin Apheresis* 1998; 13:81

Kim HC. *J Clin Apheresis* 2000; 15:129-157

Objective

- Validation study
 - Compare the difference between the manual (70 mL/kg) and Nadler's calculation of total blood volume in our pediatric population

Methods

- Retrospective study at Texas Children's Hospital
 - Any patient receiving therapeutic apheresis
 - January 2008 to November 2010
- 66 charts were reviewed
 - TBV was calculated using both formulas
 - Percent error of the manual calculations versus the machine calculations was determined for the patients based on weight

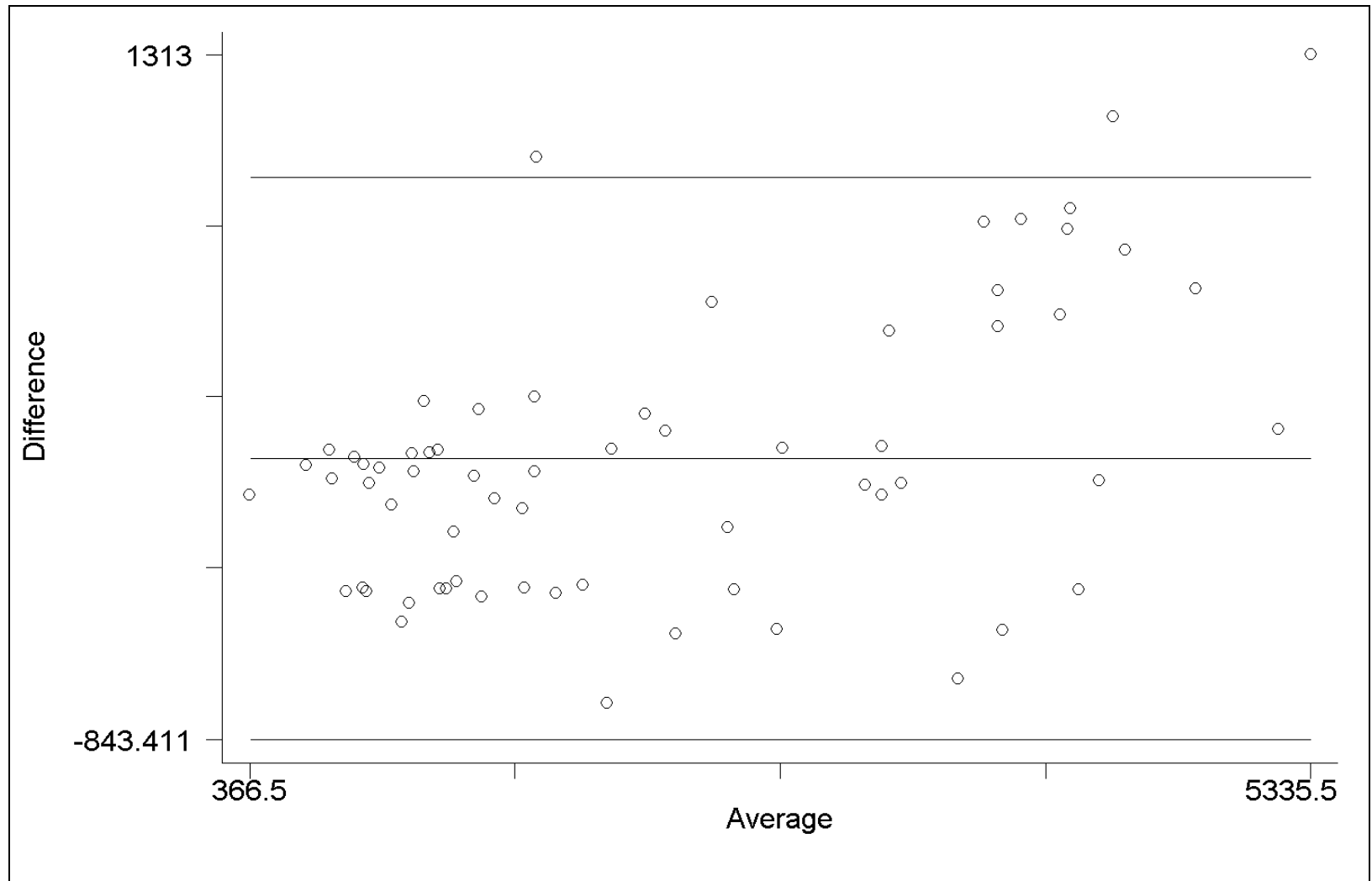
Methods

- Bland Altman plot to compare manual versus machine
- Box & Whisker Plots for the two groups based on weight
 - < 20 kg vs. > 20 kg
 - < 35 kg vs. > 35 kg

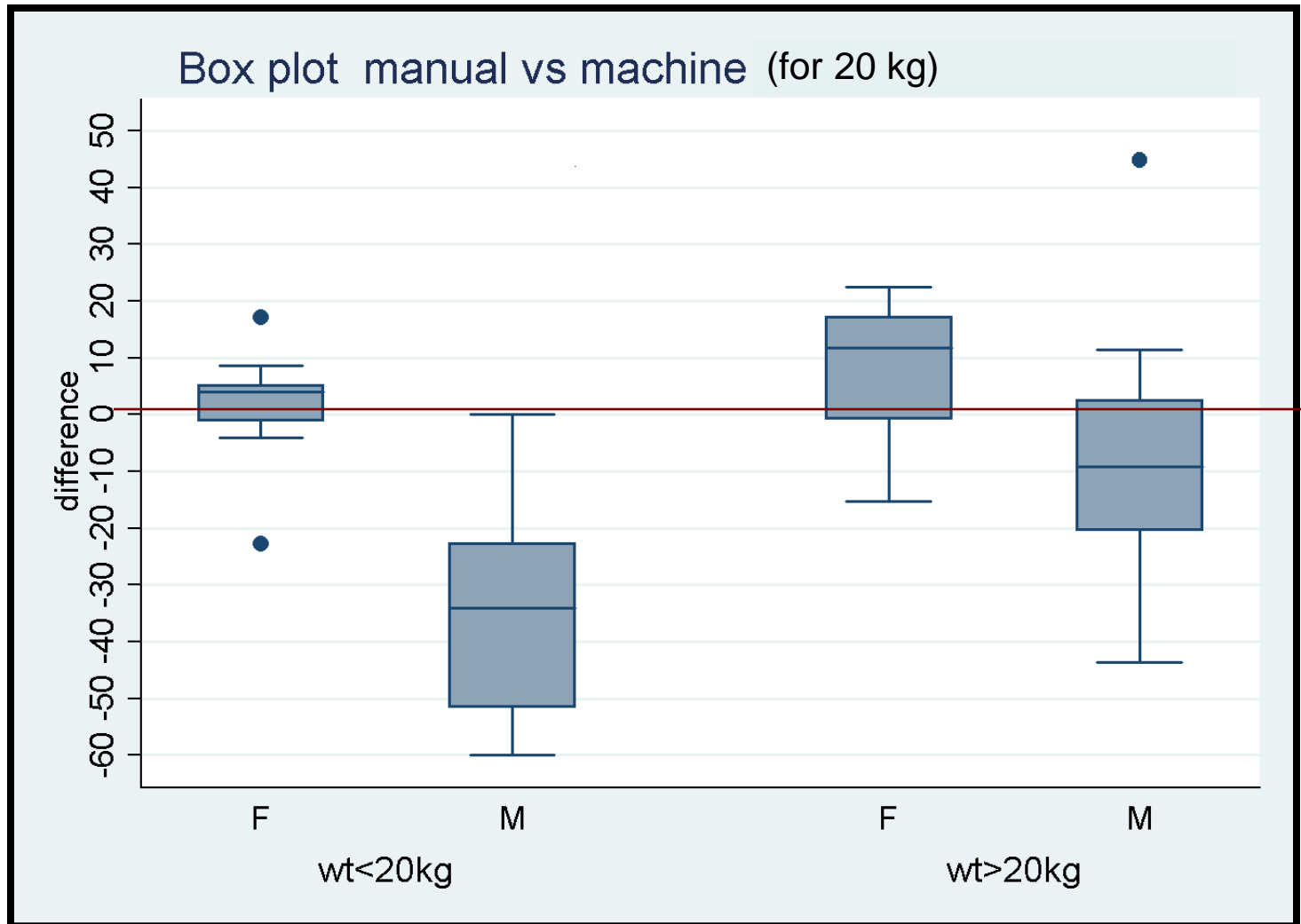
Results -- Demographics

- 66 charts were reviewed
 - 45% male
 - Mean weight was 34.34 ± 22.4 kg
 - Forty one patients were less than 35 kg (22 female, 19 male)

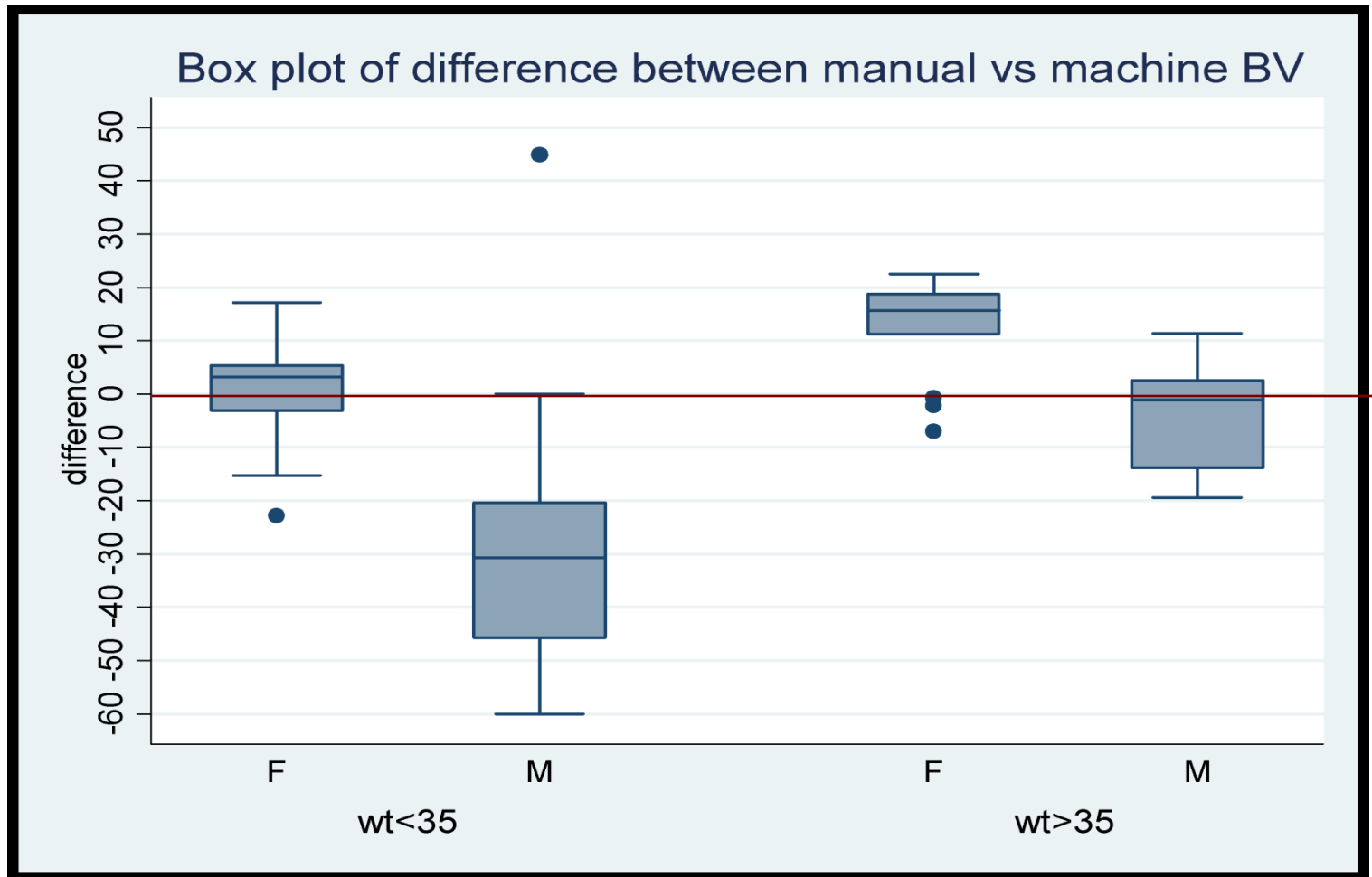
Results – Bland Altman Plot



Results – Box & Whisker Plot (< or > 20 kg)



Results – Box & Whisker Plot (< or > 35 kg)



Conclusions

- Large variability in TBV between manual vs machine in patients < 35 kg, especially in males
 - Findings were similar to Clough et al
- In females > 35 kg, manual calculation tends to overestimate the TBV as compared to machine

Conclusions

- It is more effective from a blood product cost resource to manually calculate the total blood volume using 70 mL/kg for all pediatric patients whose weight is less than 35 kg.
- In addition, using the manual calculation for this subset of patients will provide a more accurate calculation of replacement volumes for apheresis therapies such as therapeutic plasma exchange and red cell exchange.



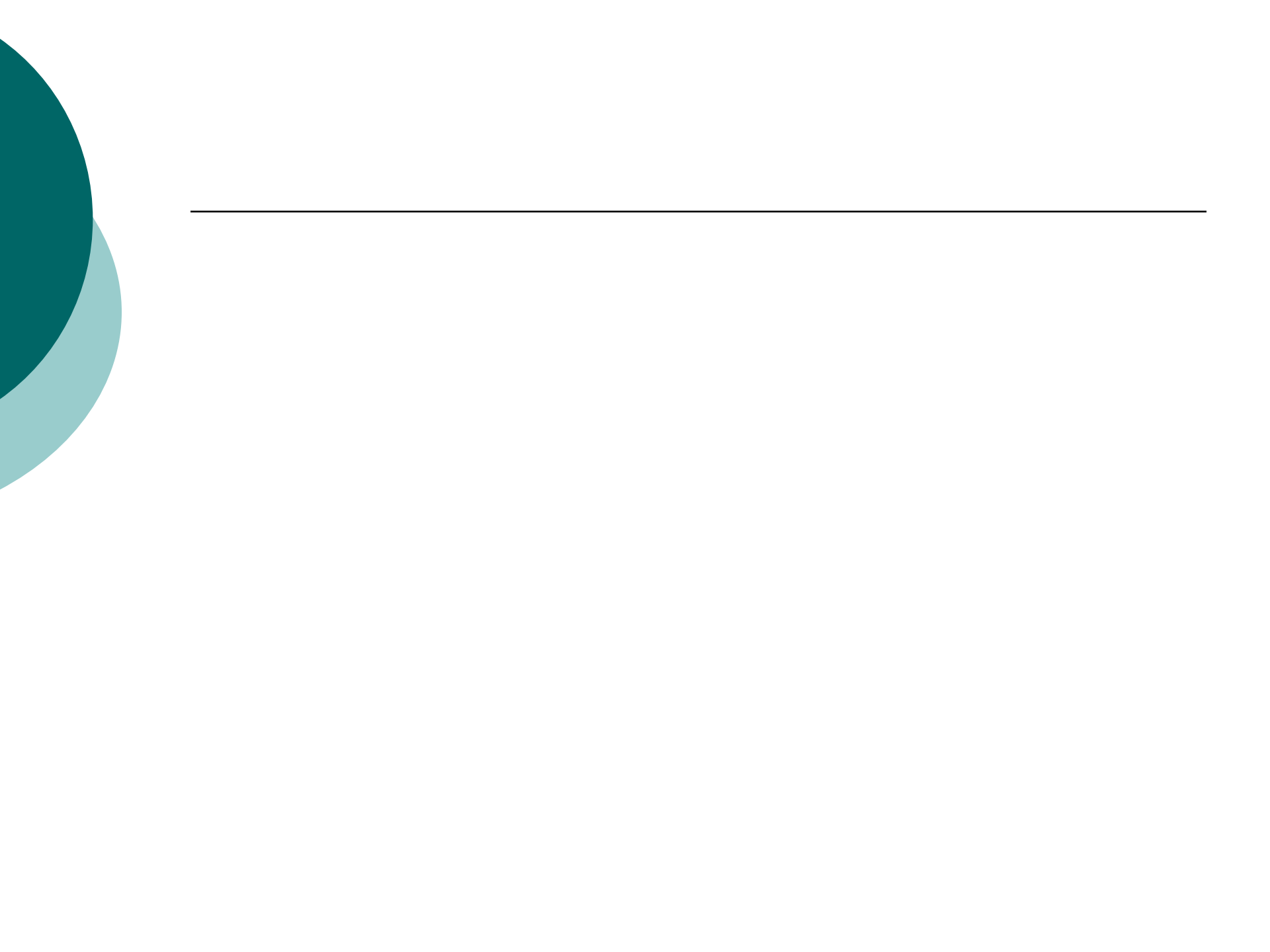
Limitations

- Retrospective study
- No gold standard for TBV calculation
- No outcome measures
- Didn't evaluate age as a factor

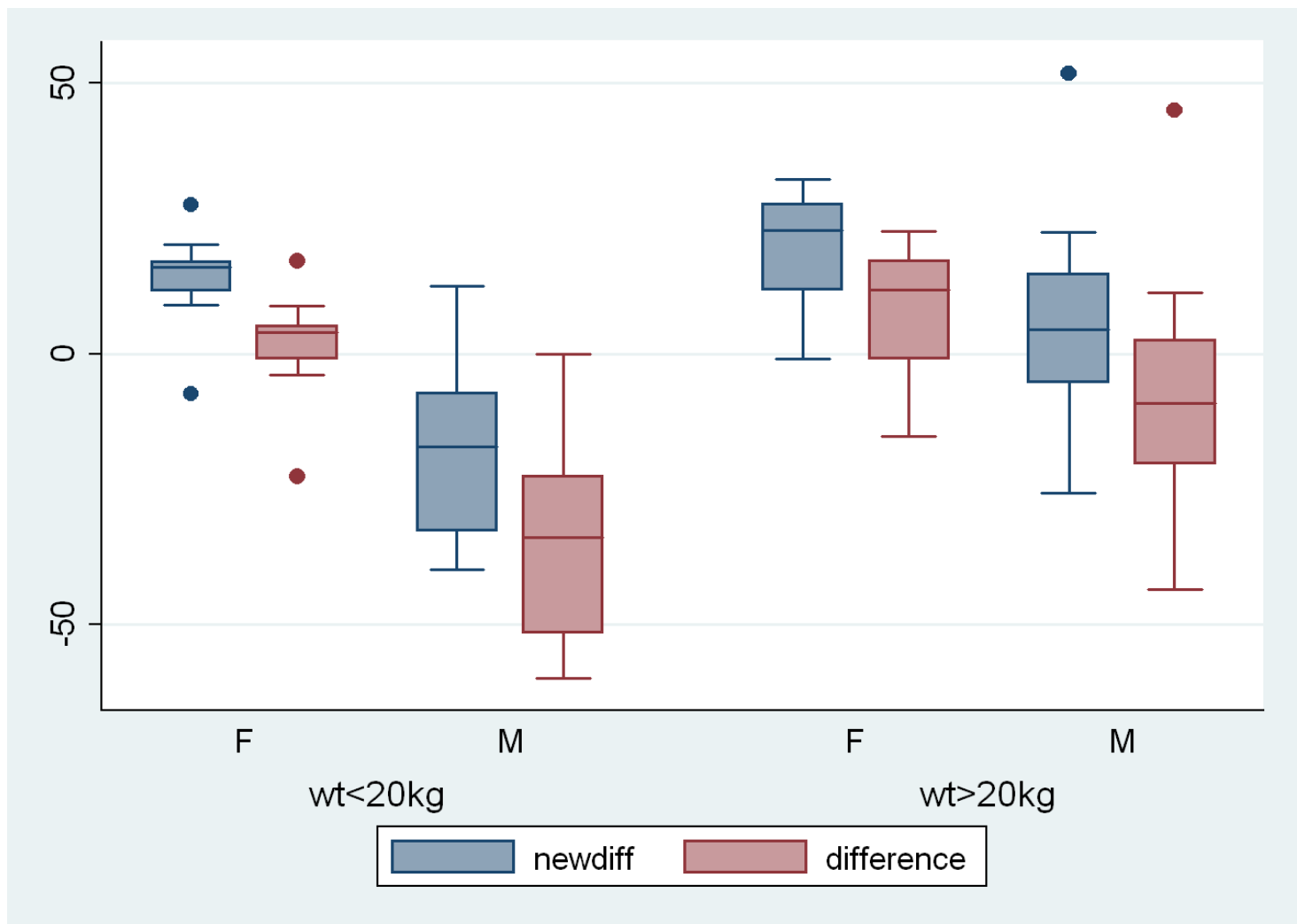


Future Plans

- Prospective study
- Look at outcome measures
 - Red Cell Exchange
 - End Hct
 - Post HbS
 - Amount of blood product used
 - Therapeutic Plasma Exchange
 - Amount of 5% albumin, FFP required



80 mL/kg vs. 70 mL/kg



80 mL/kg vs. 70 mL/kg

