The Effect of Peri-operative Fluid Therapy on Haematocrit in Spinal Fusion Surgery

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Peri-operative fluid therapy

- Institutional trend noted wherein patients experience **significant** drop in haematocrit and haemoglobin seemingly in **excess** of expected

- Study to evaluate the **cause** and potential **management** thereof

Anaemia in Post-Operative Period

- Major causes of haematocrit variance:
  - Blood loss
  - Drain loss
  - **Haemodilution**

- Anaemia can have severe consequences
  - Poor delivery of oxygen
  - Increased post-operative **infection** rates *
  - **Prolonged** hospital stay **

* Spahn DR. Anemia and patient blood management in hip and knee surgery: a systematic review of the literature. Anesthesiology. 2010;113:482-495.

** Purvis, T., Goodwin, C., Molina, C., Frank, S. and Sciubba, D. (2018). Percentage change in hemoglobin level and morbidity in spine surgery patients. *Journal of Neurosurgery: Spine*, 28(3), pp.345-351.

Intraoperative blood loss

- Surgeon and anaesthesiologist should **recognize** ongoing losses
- Severe losses deserve **rapid** response
- Rothermel et al*:
  - Large losses typically **underestimated**
  - Small losses **overestimated**

* Rothermel, L. and Lipman, J. (2016). Estimation of blood loss is inaccurate and unreliable. *Surgery*, 160(4), pp.946-953.

Drain loss

- Grant et al*:
  - Theorized potential **concealed losses**
  - Drain and wound primary suspects
  - **Not confirmed** in literature

- Zhou et al**:
  - **Minimal evidence** of ongoing losses in spinal surgery
  - Drain use inconsistent and potentially **unnecessary**

* Grant, M., Whitman, G., Savage, W., Ness, P. and Frank, S. (2013). Clinical predictors of postoperative hemoglobin drift. *Transfusion*, 54(6), pp.1460-1468

**Zou, H., Li, Z., Sheng, H., Tan, M., Yang, F., Liang, L. and Zhao, J. (2015). Intraoperative blood loss, postoperative drainage, and recovery in patients undergoing lumbar spinal surgery. *BMC Surgery*, 15(1).

Peri-Operative Fluid Therapy

- Primary goal to maintain **euvolemia**
  - Hypertensive patient estimated **20% intravascularly depleted**

- Predictors of greater post-operative haematocrit drift
  - Greater intraoperative blood loss
  - Positive peri-operative fluid balance
  - Spinal Surgery

BLOOD MANAGEMENT

Clinical predictors of postoperative hemoglobin drift

Michael C. Grant,[1] Glen J. Whitman,[2] Will J. Savage,[3] Paul M. Ness,[4] and Steven M. Frank[1]

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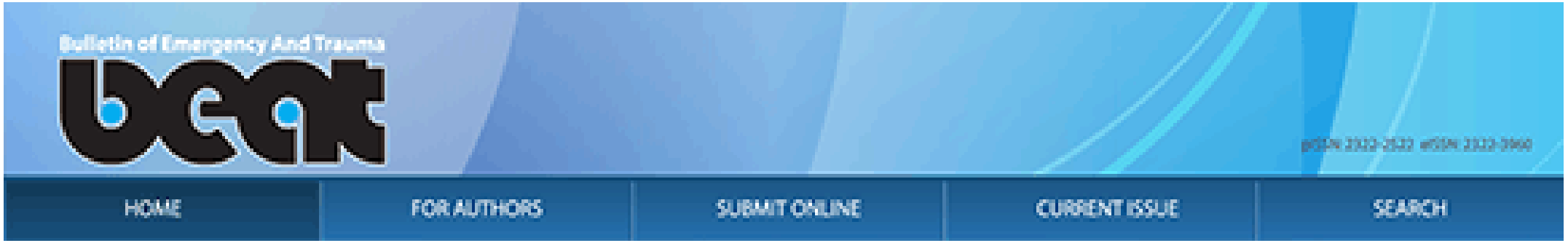
Effect of Intravenous Fluid on Haematocrit

- ASA I and II patients undergoing elective minor surgeries with negligible blood loss

- Significant decrease in haemoglobin and haematocrit



The Effect of Routine Maintenance Intravenous Therapy on Hemoglobin Concentration and Hematocrit during Anesthesia in Adults

Seyed Masoud Lahsaee, Sina Ghaffaripour, and Hossein Hejr*

Blood Loss Calculation

- **Nadler (1962)**
  - Calculates Total Blood Volume

- **Gross (1983)**
  - Calculates blood loss using haematocrit fluctuance

$$BL = \frac{CBV\left(i - f\right)}{\left(i + f\right)/2}$$

Methods

- Prospective study

- 38 consecutive **first** operation **single level** fusion procedures

- Data collected:
  - Patient height, weight, body composition (fat, muscle, bone, water)
  - Complete fluid input and output data collected for 24 hours (theatre, ICU)
  - Intraoperative bloodloss and drain output
  - Hct pre-op, post-induction, post operative for 10 time points

Results

- Total loss = 709.61 ml
- Post-operative drain loss = 221.45 ml
- Proportional blood loss = 18.99%
- Observed blood loss = **501.35 ml**
- Calculated blood loss = **696.81 ml**

Results

- Mean volume of fluid received = **42%** of unique total blood volume
- Wide range of fluid received from **19%** to **71%** of blood volume
- Significant **inverse relationship** of BMI to proportional fluid volume
- Everyone seemingly receiving a **fixed fluid volume** regardless of phenotype

Results

- Mean fluid received peri-operatively = 1260.9ml
- Mean duration of surgery = 138.7 minutes
- Fluid administration = **545.45ml per hour**
- **3.45%** drop in haematocrit per hour

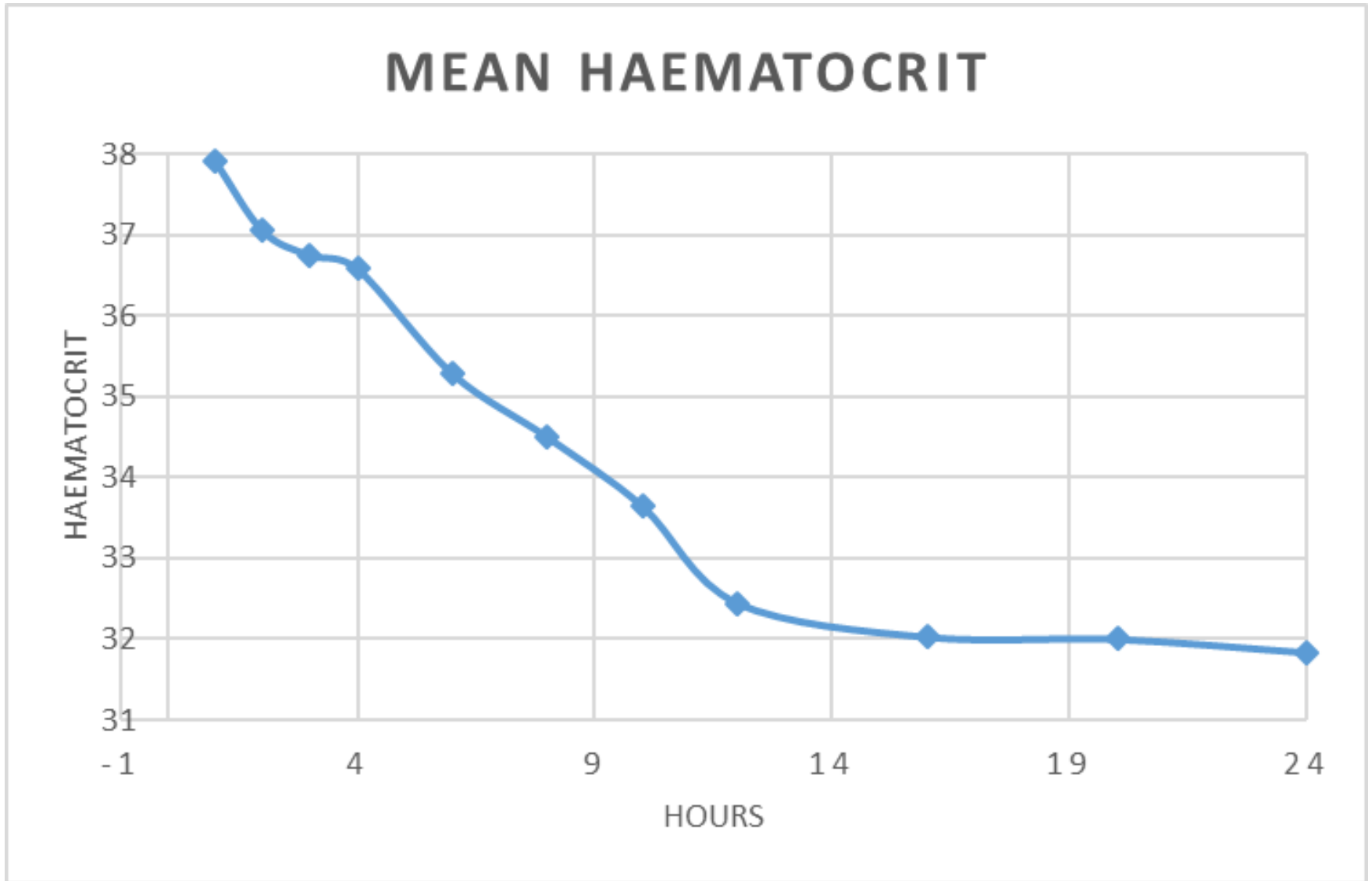
Results

- Pre-operative haematocrit mean = **42.33%**
- Post-induction haematocrit mean = **39.78%**
- Statistically significant with **P < 0.001**

Results

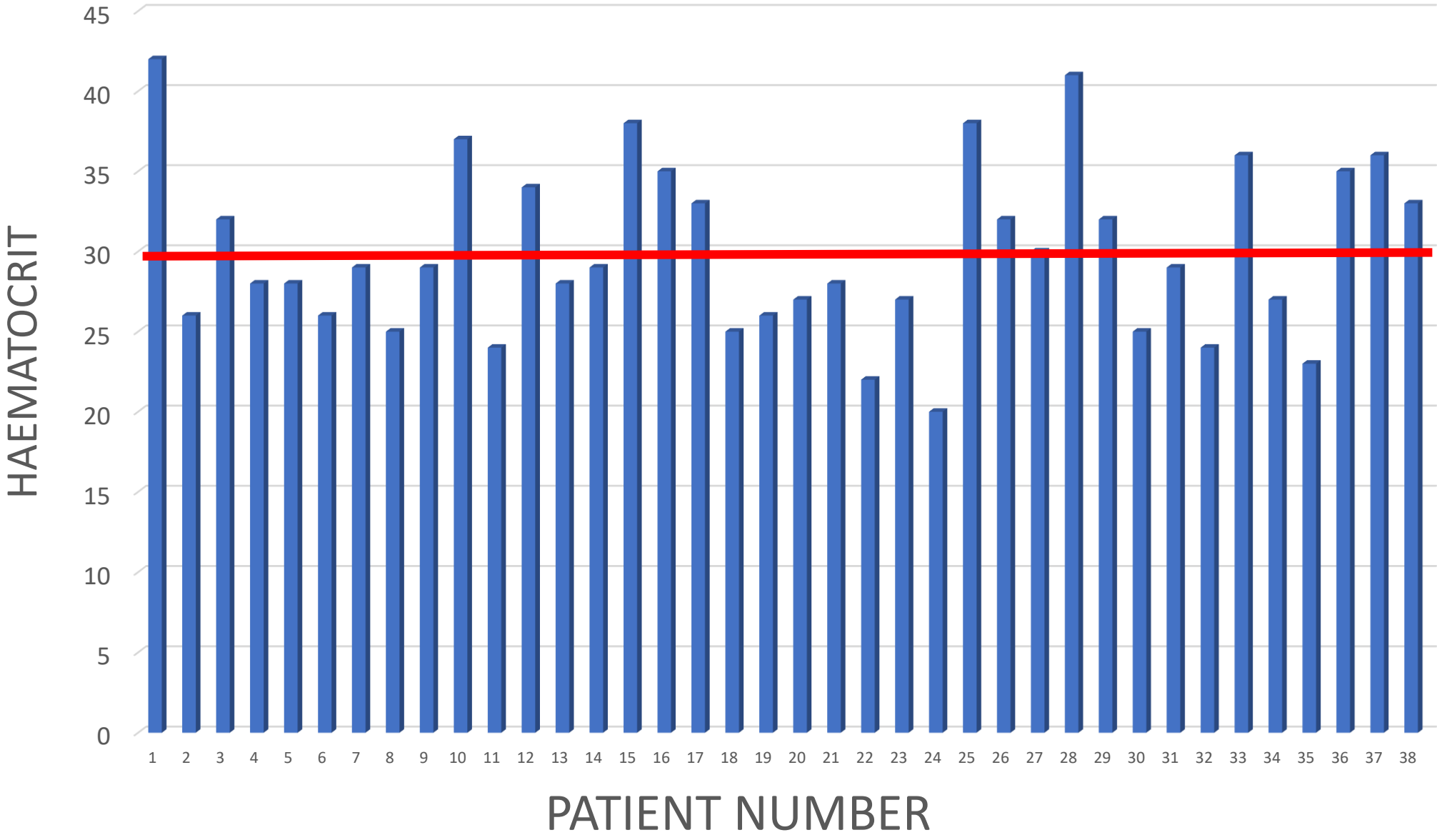
- Decline in mean haematocrit noted over 24 hours
- Turning point at 20 hours with stabilization
- Fluid excretion in urine compensates at this point

Results


MEAN HAEMATOCRIT
HAEMATOCRIT
38
37
36
35
34
33
32
31
-1
4
9
14
19
24
HOURS

Results

- Hypertensive patients particularly at risk
- 22% dropping to below a haematocrit of 30% post-induction
- Not a single non-hypertensive followed this trend


HAEMATOCRIT
45
40
35
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
PATIENT NUMBER

The Fluid Budget

- Surgeon predicted blood loss
- Starting haematocrit
- Estimated total blood volume

$$f = \frac{i(2CBV - BL)}{(BL + 2CBV)}$$

$$BL = \frac{CBV(i-f)}{(i+f)/2}$$

$$BL \times \frac{(i+f)}{2} = CBV(i-f)$$

$$BL \times (i+f) = 2CBV(i-f)$$

$$BL \times i + BL \times f = 2CBV \times i - 2CBV \times f$$

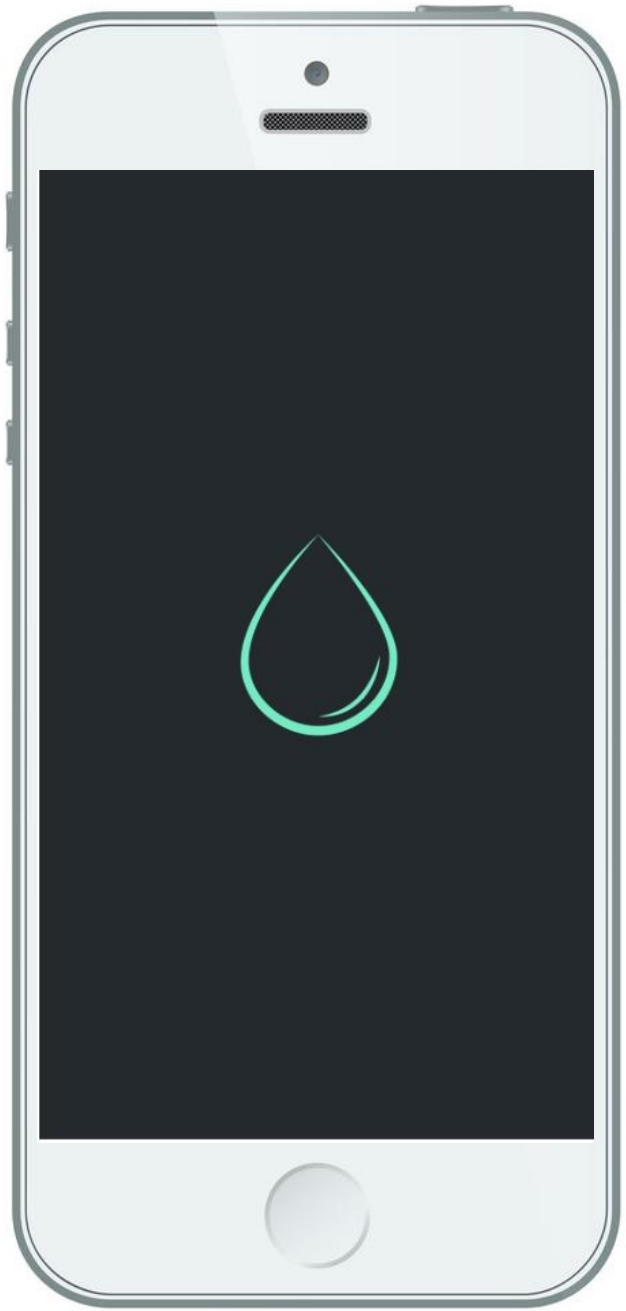
$$BLf + 2CBVf = 2CBVi - BLi$$

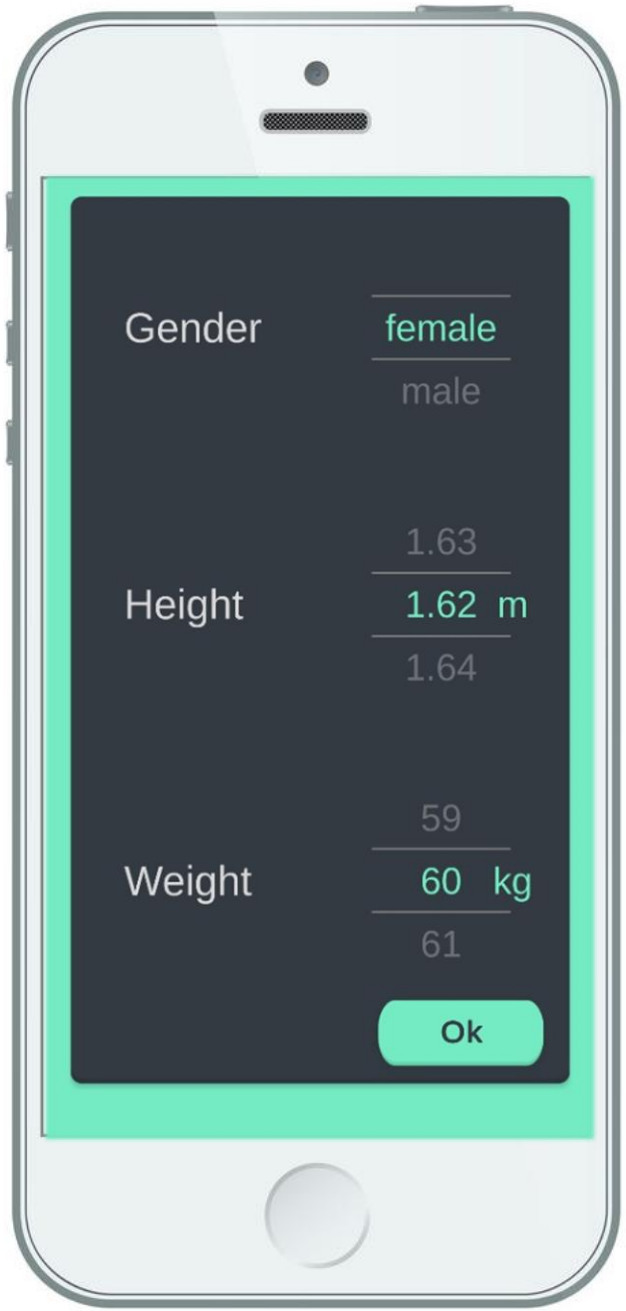
$$f(BL + 2CBV) = i(2CBV - BL)$$

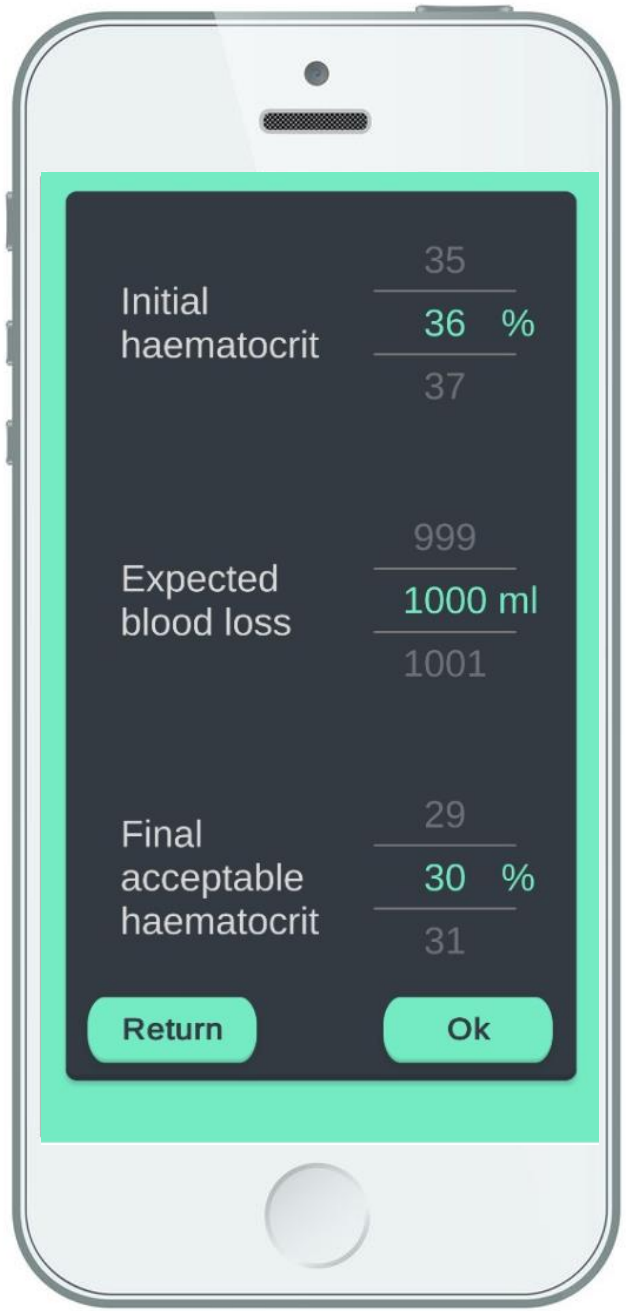
$$f = \frac{i(2CBV - BL)}{(BL + 2CBV)}$$

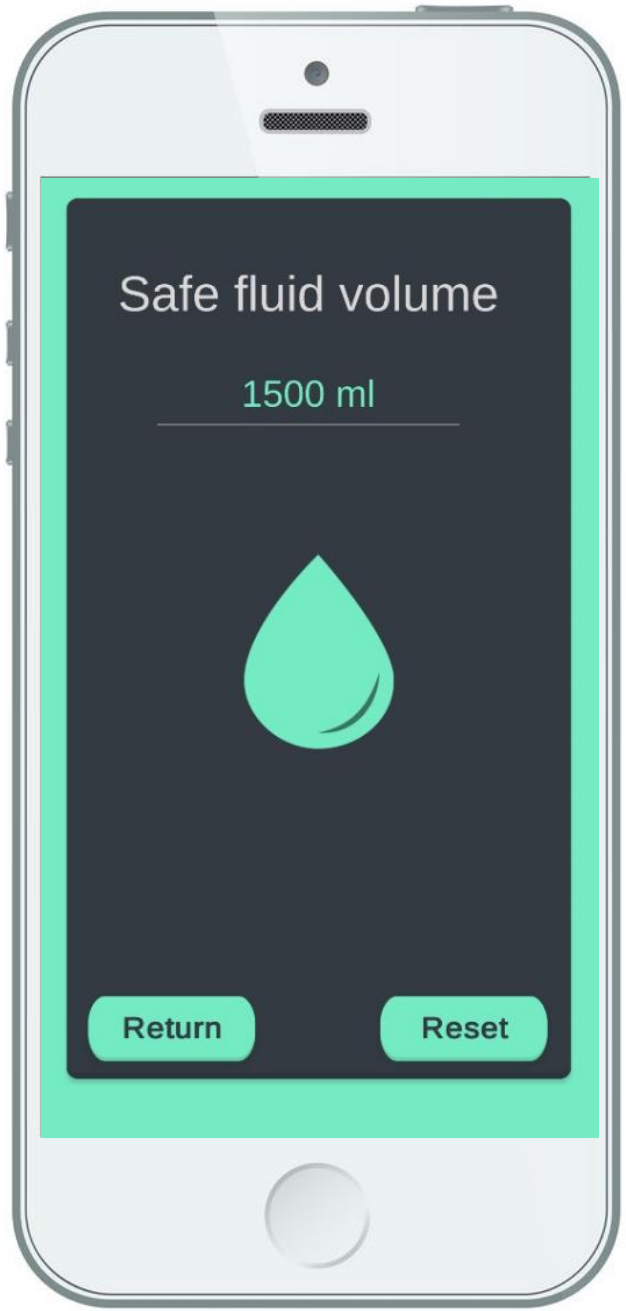
The Fluid Budget

- 158.1ml Normal saline results in 1% decrease in haematocrit
- Final acceptable haematocrit to be determined by the surgeon
- Estimated blood loss based on surgeon’s discretion




Gender
female
male
Height
1.63
1.62 m
1.64
Weight
59
60 kg
61
Ok


Initial haematocrit
35
36 %
37
Expected blood loss
999
1000 ml
1001
Final acceptable haematocrit
29
30 %
31
Return
Ok


Safe fluid volume
1500 ml
Return
Reset

Conclusion

- Underestimating the potential deleterious effects of fluid overload
- If a common target exists for both surgeon and anaesthetist to strive towards, significant haemodilution may be avoided

Thank you