

The efficacy of Acute Normovolemic Hemodilution compared to Cell Salvage as a Blood Transfusion alternative

Julia Yu, PA-S

Faculty Advisor: Shannon Diallo, MMS, PA-C, CAQ-HM

Department of Medical Science



Abstract

Blood transfusions are currently the treatment of choice for significant blood loss. However, there are a variety of reasons for which they cannot be utilized. Current alternatives are acute normovolemic hemodilution (ANH) and cell salvage.¹ This study analyzes whether ANH or cell salvage is more effective in minimizing blood loss in perioperative or trauma patients. Multiple different studies involving either ANH or cell salvage were compared to each other. However, due to the lack of research conducted in either method, results obtained were largely inconclusive.

Introduction

Why:

- Jehovah's Witnesses, Allo- and Auto-antibodies, Lack of supply

Cell Salvage²:

- Performed with machine, suctions up blood that is lost
- Blood is washed, filtered, and mixed with anticoagulant
- Reinfusion of filtered blood

Acute Normovolemic Hemodilution³:

- Certain volume of blood is collected from patient and replaced with colloid or crystalloid fluid
- Pt loses fluid rather than blood cells

Methods

- Resources: Pubmed and Academic Search Ultimate
- Search Terms: Cell salvage, Cell saver, Acute normovolemic hemodilution, Surgery, Blood loss
- Inclusion Criteria
 - Adult or elderly population
 - Studies within past 10 years
- Exclusion Criteria
 - Pediatric Population
 - Paywall
 - Case reports and systematic reviews
 - Lack of relevancy

Results

The six studies selected were either case controls or randomized control trials. As seen in Table 1, the studies were vastly different in terms of patient procedures, sample sizes, and demographics. However, their results were measured using similar parameters, such as pre and post-op hemoglobin, amount of blood loss, and complication rate. They also all involved comparing the efficacy of the treatment method to that of blood transfusions. The validity of the studies can be seen in Table 2, where the ANH studies had the lowest sample sizes with possible or likely bias involved. The cell salvage studies had larger sample sizes with varying amounts of bias. All but one study was adequately randomized. All studies used proper data analyses.

Table 1

Study	Design	Total N	Demographics	Procedure	Treatment	Outcome Measurements
Zacharias et al	Case Control	96	Mean ages (years): 63-66 Females: 29 Males: 67	Right or Repeat Hepatectomy	Cell Salvage	Blood loss, Length of hospital stay, Complication rate, Units transfused, Hgb at discharge
Young et al	Case Control	80	Mean ages (years): 60-64 Females: 30 Males: 50	PD	ANH	Blood loss, Transfused volume, Complication rate, Pre vs post-op hgb, Speed of bowel movement recovery
Rai et al	RCT	60	Mean ages (years): 37-39 Females: 29 Males: 31	General surgery, Orthopedic surgery, Otolaryngeal surgery	ANH	Hgb and hct at max blood loss and post-transfusion, blood loss, blood used, MAP
Huang et al	Case Control	225	Mean ages (years): 30-32 Females: 225 Males: 0	Ruptured ectopic pregnancy	Cell Salvage	Post-op hgb, Length of hospital stay, blood loss, Blood transfused, Hgb at discharge, Blood products used, Complications
Khan et al	RCT	23,028	Mean ages (years): 31 Females: 23,028 Males: 0	Cesarean Section	Cell Salvage	Fetomaternal hemorrhage, Rate of donor blood usage, Units of blood used, Length of hospital stay, Pre and Post-op hgb, Complications
Liang et al	RCT	110	Mean ages (years): 15-16 Females: 85 Males: 25	Posterior spinal fusion	Cell Salvage	Hgb pre-op, post-op, and at discharge, Blood transfusion rate, Blood loss, Complications

Key: ANH (acute normovolemic hemodilution), PD (pancreaticoduodenectomy), Hgb (hemoglobin), RCT (randomized control trial), Hct (hematocrit), MAP (mean arterial pressure)

Table 2

Study	Sample Size	Randomization	Sample Exclusion Criteria	Data Analysis	Bias
Zacharias et al	M (>50 samples)	I*	A (Few exclusions)	A	M (Bias possible)
Young et al	M (>50 samples)	A	A (Few exclusions)	A	M (Bias possible)
Rai et al	M (>50 samples)	A	I (Many exclusions)	A	I (Bias likely)
Huang et al	A (>100 samples)	A	M (Moderate exclusions)	A	A (Bias unlikely)
Khan et al	A (>100 samples)	A	M (Moderate exclusions)	A	A (Bias unlikely)
Liang et al	A (>100 samples)	A	I (Many exclusions)	A	I (Bias likely)

Key: A (Adequate), M (Marginal), I (Inadequate)
*Samples could not be randomized per author

Table 3

Study	Decrease in amount of blood loss	Hgb Post-op or at Discharge	Incidence of Complications	Decrease in Length of Hospital Stay	Decrease in amount of homologous blood transfused
Zacharias et al	NS	NS	NS	S	S
Young et al	NS	S*	S	NS	S
Rai et al	NS	S*	N/A	N/A	S
Huang et al	NS	S	NS	S	S
Khan et al	N/A	NS	S!	NS	NS
Liang et al	S	S	NS	N/A	S

Key: S (Statistically Significant), NS (Not Significant), N/A (Not Available)
*Treatment group had the lower hgb
!Treatment group had increased complications

Discussion

Due to the major differences among the studies, it was difficult to directly compare studies using ANH against the studies using cell salvage. Based on Table 3:

Amount of blood loss

- Both ANH and cell salvage showed no significant difference in amount of blood lost compared to utilizing blood transfusions.
- Liang et al's study displayed a lower amount of blood lost using cell salvage, but this study involved more exclusion criteria when selecting samples.
- All but one study lead to fewer blood products being required in emergency cases

Post-op Hgb

- ANH patients had lower post-op hgbs compared to cell salvage

Complications

- One study using ANH had a lower complication rate
- One study using cell salvage had a higher complication rate
- Rest of studies showed no difference in complication rates compared to transfusions

Length of Hospitalization

- Half of the cell salvage studies resulted in a decrease in length of hospital stay, the other half showed no difference or did not measure it
- One ANH study showed no difference in length of stay, the other study did not measure it.

Conclusion

- Cell salvage yields a higher post-op hgb and faster recovery time
- ANH leads to less complication rates
- Results questionable and overall inconclusive due to the vast variation in study designs and validities
- Overall lack of research into both cell salvage and ANH individually
- Limitations
 - More studies with cell salvage than ANH
 - Small sample sizes (<100) in half of the studies
- Both ANH and cell salvage are valid alternatives to blood transfusion