

# Post-operative anaemia and the risk of cardiac complications following elective knee or hip surgery


*Ullah N, Barry PJ, Molloy A, Ali G, Grimes L, O'Leary G, Harrington P, McGarry K*


Department of Medicine, Regional Orthopaedic Unit, Nursing & Haemovigilance Service, Department of Anaesthesia, Our Lady's Hospital, Navan, Co. Meath



# Introduction

- The avoidance of post and peri-operative complications is one of the most important considerations in elective surgical procedures.
- Many risk factors for post-operative complications have been identified but the effect of anaemia, particularly in orthopaedic patients undergoing elective surgery remains in debate.
- There has been much discussion regarding universal trigger points for blood transfusion with the majority of the literature advocating a tailored approach to the individual patient.

- 
- This seems to make physiological sense as it is often observed in medical practice that some subjects can tolerate lower Hb levels than others without any obvious adverse complications.
  - The utilisation of a certain level of haemoglobin (Hb) as requiring transfusion may therefore be misleading to the possible contribution of low Hb levels to post-operative complications.
  - For example, early reports from the multicentre FOCUS trial did not establish any difference in ischaemic cardiovascular complications when comparing a liberal transfusion policy (receiving transfusion when Hb <10g/dl) to a more restrictive policy (Hb < 8g/dl).

- 
- The utilisation of transfusion policies as a guidance to the safety or otherwise of pre- and peri-operative Hb levels is in itself fundamentally flawed as we are not isolating the sole effects of low Hb levels.
  - Transfusion itself has been associated with many complications in cardiac surgery patients. Thus there appears to be a complex interaction between anaemia and blood transfusion, which likely has led to many confounding factors in some of the previously published literature.

# Aims

- To examine whether;
  1. Pre-operative Hb
  2. Post-operative Hb
  3. Absolute Hb drop

are predictive of post-operative cardiac complications in elective orthopaedic joint arthroplasty.



# Population and Data Collection


- A retrospective analysis of all patients undergoing elective hip or knee arthroplasty between June 2009 to June 2010.
- Identified by the Hospital In-patient Enquiry system (HIPE).
- Charts were reviewed for;
  - Basic demographic details
  - Cardiac complications peri-operatively
  - Pre-operative Hb
  - Nadir Hb post-operatively

## *Sub-division of Population*

- Patient were divided into two groups;
  - 1) those who experienced cardiac complications post-operatively
  - 2) those who did not experience cardiac complications
- Cardiac complications were classified as;
  - Myocardial infarction
  - Unstable angina
  - Congestive cardiac failure
  - Pulmonary oedema
  - Arrhythmias
  - Sudden death

# Statistical Analysis

- All data was entered into a computerised spreadsheet. Data is reported as mean  $\pm$  SD.
- T-testing used where appropriate.
- Complications was taken as a dichotomous variable, with subjects experiencing 2 or more complications being regarded equivalently to those that had one.
- All recorded predictors of cardiac complications were entered in a univariate logistic regression model.
- Each variable with a p value  $< 0.1$  was entered into a backward logistic regression model.

- 
- Multicollinearity;
    - Absolute Hb drop and % Hb drop
    - Absolute Hb drop and Nadir Hb
  - If 2 variables had high correlation and were felt to represent similar data, the variable attached to the model with lowest AIC was included.
  - Statistical significance was determined at a level of  $p < 0.05$ .



# RESULTS

# Study Population

	<b>TOTAL</b>
<b>No: (male)</b>	404 (210)
<b>AGE (yrs)</b>	67.21 (21 – 90)
<b>PRE OP HB (g/dl)</b>	13.61 (9 – 18)
<b>NADIR HB (g/dl)</b>	10.23 (5.4 – 15.1)
<b>HB DROP (g/dl)</b>	3.4 (-0.5 – 8.9)
<b>HB DROP INTERVAL (days)</b>	2.91 (<1 – 25)
<b>LOS (days)</b>	10.76 (3 – 55)
<b>OPERATION</b>	
<i>THR</i>	203
<i>REV THR</i>	23
<i>HIP RESURFACING</i>	17
<i>B/L THR</i>	2
<i>TKR</i>	156
<i>REV TKR</i>	2
<i>B/L TKR</i>	1

## Surgery Type

	<b>TOTAL</b>	<b>COMPLICATIONS</b>	<b>NO COMPLICATIONS</b>
<b>No: (male)</b>	404 (210)	27 (15)	377 (195)
<b>AGE (yrs)</b>	67.21 (21 – 90)	72.11 (53 – 84)	66.86 (21 – 90)
<b>OPERATION</b>			
<i>THR</i>	203	13	190
<i>REV THR</i>	23	4	19
<i>HIP RESURFACING</i>	17	1	16
<i>B/L THR</i>	2	0	2
<i>TKR</i>	156	9	147
<i>REV TKR</i>	2	0	2
<i>B/L TKR</i>	1	0	1

## *Cardiac Complications*

<b><u>CARDIAC COMPLICATIONS (total)</u></b>	<b>35</b>
<b>Angina</b>	<b>2</b>
<b>Myocardial Infarction</b>	<b>6</b>
<b>Arrhythmias</b>	<b>21</b>
<i>A. Fibrillation</i>	<i>17</i>
<i>SVT</i>	<i>3</i>
<i>2 AV Block</i>	<i>1</i>
<b>CCF/Pulmonary oedema</b>	<b>6</b>

## *Pre-operative Hb levels*

- Average pre-operative Hb level was 13.6 g/dl.
- Pre-operative anaemia was noted if Male Hb < 13.0 g/dl, Female Hb < 12.0 g/dl;
  - Total 72 patients
  - 34 Males
  - 38 Females
- The lowest pre-operative HB was 9.0 g/dl.

## *Complications vs No Complications*

Variable	Total	Complication	No Complication	p value
<b>Pre-op Hb (g/dl)</b>	13.6 ± 1.4	13.5 ± 1.6	13.6 ± 1.4	0.545
<b>Nadir Hb (g/dl)</b>	10.2 ± 1.7	9.3 ± 1.6	10.3 ± 1.6	<b>0.002</b>
<b>Hb Drop (g/dl)</b>	3.4 ± 1.3	4.2 ± 1.6	3.3 ± 1.3	<b>0.002</b>
<b>Hb Drop Interval</b>	2.9 ± 2.8	4.2 ± 3.2	2.8 ± 2.8	<b>0.027</b>
<b>Length of Stay</b>	10.8 ± 5.9	18.1 ± 12.6	10.2 ± 4.8	<b>0.0001</b>



## *Transfusion Effects*

- In total 59 subjects had a blood transfusion.
- 6 patients experienced a cardiac complication following transfusion;
  - 4 of these patients had an arrhythmia
  - 2 subjects experienced an episode of CCF following blood transfusion

## *Univariate Analysis*

- Length of stay was not included in analysis;
  - Felt to be consequence rather than cause

<b>Characteristics</b>	<b>OR</b>	<b>CI</b>	<b>P value</b>
<b>Age</b>	1.002	1.0003546 - 1.004562	<b>0.0225</b>
<b>Gender</b>	0.9905	0.9432475 - 1.040062	0.7011
<b>Pre-op Hb (g/dl)</b>	1.002	0.9772481 - 1.012223	0.5451
<b>Nadir Hb (g/dl)</b>	0.9780	0.9641753 - 0.9920805	<b>0.0024</b>
<b>Hb Drop (g/dl)</b>	1.0291	1.0108487 - 1.047721	<b>0.0018</b>
<b>% Hb. Drop</b>	1.0043	1.0017412 - 1.006850	<b>0.0011</b>
<b>Time to nadir (days)</b>	1.0098	1.001121 - 1.018548	<b>0.0274</b>

## *Multi-variate Analysis*

<b>Characteristics</b>	<b>OR</b>	<b>CI</b>	<b>P value</b>
<b>Age</b>	1.002	0.9998514 - 1.0040643	0.0693
<b>Nadir Hb (g/dl)</b>	<b>Excluded due to possible multicollinearity as per methods</b>		
<b>Hb Drop (g/dl)</b>	1.023	1.0041481 - 1.0426592	<b>0.0173</b>
<b>Time to nadir (days)</b>	1.006	0.9966245 - 1.0146846	0.2224


## *Summary - results*


- This study reveals that;
  1. Serious complication rates are low in elective lower limb joint arthroplasty
  2. Cardiac complications do not appear to be related to pre-operative haemoglobin levels
  3. Neither time to nadir haemoglobin nor age was predictive of adverse clinical outcomes in our study
  4. Cardiac complications do appear to be related to the absolute drop in Hb seen post-operatively
  5. These complications have clinical consequences and contribute to increased length of stay




# Discussion

- This study has important clinical implications.
- It would appear that pre-operative Hb levels are perhaps not as important as previously suggested.
- Furthermore, it appears that absolute Hb drop is an important factor in the development of post-operative complications.
- It is unclear why this association has not been emphasised previously.

- 
- Previous research has often focused on transfusion trigger points.
  - Utilising a universal trigger point may in fact falsely increase the risks of cardiac complications in the liberally transfused groups due to the noted relationships between cardiac complications and transfusion.
  - In addition, many trials focused on end points of myocardial infarction or death, whereas our data also included cardiac arrhythmias, which may capture more cardiovascular complications.

- 
- We observed however that those patients with a more rapid drop in their haemoglobin did not have more cardiac complications.
  - Even when extrapolating data to g Hb drop per 24 hours, we did not see an increased complication rate in the acute group.
  - This suggests that it is in fact the drop in Hb as opposed to the timing, which is more important. This obviously only applies to the mild to moderate drops we witnessed in our study group.

- 
- The fact that age was not determined a significant factor on multivariate analysis was surprising in our study.
  - Our data suggests that whilst age appeared important in univariate analysis, it was less important than Hb drop in multi-variate analysis.
  - Age may be a marker of co-morbidities, which we did not account for in our study, which may have led to its identification as an important predictor of morbidity and mortality in previous studies.



## *Limitations*

- Numbers - 27 patients experienced complications during the course of the study.
- Multicollinearity.
- Non-examination of co-morbidities.
- Functional outcomes.



# Conclusion

- Peri-operative cardiac morbidity is related to absolute haemoglobin drop in the post-operative period in elective arthroplasty patients.
- Strategies at limiting the post-operative haemoglobin drop may be beneficial in reducing cardiac complication rates.



**THANK YOU**

## References

- Ouchterlony, J., Arvidsson, S., Sjöstedt, L. and Svärdsudd, K. Perioperative and immediate postoperative adverse events in patients undergoing elective general and orthopaedic surgery: The Gothenburg study of perioperative risk (PROPER). Part II. *Acta Anaesthesiologica Scandinavica* 1995;39: 643–652.
- Mantilla, C. B., Wass, C. T., Goodrich, K. A., Johanns, C. J., Kool, M. L., Zhu, X., Corredor, J. A., Warner, D. O., Joyner, M. J., Berry, D. J., Schroeder, D. R. and Sprung, J. Risk for perioperative myocardial infarction and mortality in patients undergoing hip or knee arthroplasty: the role of anemia. *Transfusion* 2011;51: 82–91.
- Greenburg AG. Benefits and risks of blood transfusion in surgical patients. *World J Surg.* 1996;20,1189–1193.
- Carson JL. Scientific Sessions. American Heart Association Conference. 2009 Orlando Fl
- Grover M, Talwalker S, Casbard A, Boralessa H, Contreras M, Brett S, Goldhill DR, Soni N. Silent myocardial ischaemia and haemoglobin concentration: a randomized controlled trial of transfusion strategy in lower limb arthroplasty. *Vox Sang* 2006 Feb; 90(2): 105-12
- Murphy GJ, Reeves BC, Rogers CA, Rizvi SI, Culliford L, Angelini GD. Increased mortality, postoperative morbidity, and cost after red blood cell transfusion in patients having cardiac surgery. *Circulation.* 2007;116: 2544 –2552.
- Wu WC, Schiffnert TL, Henderson WG, Eaton CB, Poses RM, Uttley G, Sharma SC, Vezeridis M, Khuri SF, Friedmann PD. Preoperative hematocrit levels and postoperative outcomes in older patients undergoing noncardiac surgery. *JAMA* 2007;297:2481-8.
- Carson JL, Terrin ML, Magaziner J, et al. Transfusion trigger trial for functional outcomes in cardiovascular patients undergoing surgical hip fracture repair (FOCUS). *Transfusion* 2006 Dec; 46(12): 2192-206
- Carson JL, Hill S, Carless P, et al. Transfusion triggers: a systematic review of the literature. *Transfus Med Rev.* 2002;16:187–199
- Foss NB, Kristensen MT, Jensen PS, et al. The effects of liberal versus restrictive transfusion thresholds on ambulation after hip fracture surgery. *Transfusion* 2009; 49:227.
- Pedersen, T., Eliassen, K. and Henriksen, E. A prospective study of risk factors and cardiopulmonary complications associated with anaesthesia and surgery: risk indicators of cardiopulmonary morbidity. *Acta Anaesthesiologica Scandinavica* 1990;34: 144–155.
- Foss NB, Kristensen MT, Kehlet H: Anaemia impedes functional mobility after hip fracture surgery. *Age Ageing* 2008; 37:173–8
- Myers E, O'Grady P, Dolan AM: The influence of preclinical anaemia on outcome following total hip replacement. *Arch Orthop Trauma Surg* 2004; 124:699–701
- Conlon NP, Bale EP, Herbison GP, McCarroll M: Postoperative anemia and quality of life after primary hip arthroplasty in patients over 65 years old. *Anesth Analg* 2008; 106:1056–6
- Spahn DR. Anemia and patient blood management in hip and knee surgery. A systematic review of the literature. *Anesthesiol* 2010;113:482-495.
- Husted H, Blond L, Sonne-Holm S, Holm G, Jacobsen TW, Gebuhr P: Tranexamic acid reduces blood loss and blood transfusions in primary total hip arthroplasty: a prospective randomized double-blind study in 40 patients. *Acta Orthop Scand* 2003, 74(6):665-9