The Effect of a Comprehensive Blood Management Protocol on Decreasing Transfusion Rates Following Primary Total Joint Arthroplasty

Charles A. Hope, II, MD[1], Robert W. Eberle[2] , Constance B. Squibb, RN, BSN, MPA[2]

(1) Optim Orthopedics, Savannah, GA
(2) Medtronic Advanced Energy, LLC, Portsmouth, NH

Presented at the *AABB Annual Meeting and CTTXPO 2012*
October 6-9, 2012, Boston, MA

Disclosures

- Stryker
  - Consultant and Speaker on Hip and Knee Arthroplasty surgical techniques and instrumentation.
- Medtronic Advanced Energy
  - Consultant and Speaker

INTRODUCTION

- Primary total joint arthroplasty (TJA) is generally an elective procedure and is associated with significant blood loss.
- Considerable variations exists in transfusion practices and in strategies for the management of blood loss from primary TJA which include;
  - Pre-donation of autologous blood
  - Salvage and re-infusion of intraoperative and post-operative shed blood
  - The pre-operative use of erythropoietin for the stimulation of red blood cell production and volume.

Prevalence of Anemia in Surgery

Type of Surgery	Study	N	Prevalence of Anemia (%)
Hip and knee replacements only	Gruson et al (2003)	395	45.6
	Andrews et al (1997)	100	18
	Myers et al (1991)	27,370	10.8
	Bonnet et al (1997)	90	41.1
	Haljamae et al (1982)	204	19
General ortho (hip/knee + other)	Goodnough et al (1994)	263	25
	Goodnough et al (1993)	385	30
	Bierbaum (1999)	8561	35
	Halm et al (2004)	550	40.4
Noncardiac	Dunne et al (2002)	6301	33.9
Lung carcinoma	Dougenis et al (2001)	198	24.7
Colorectal	M'Koma et al (1994)	32	22
	Cappell, Goldberg (1992)	315	Dukes A: 39.1 Dukes B & C: 56.8 Dukes D: 75.8

Modified from Shander et al. *Am J Med*. 2004;116(Suppl 7A):58S-695.

Anemia and Risk of Perioperative Transfusion

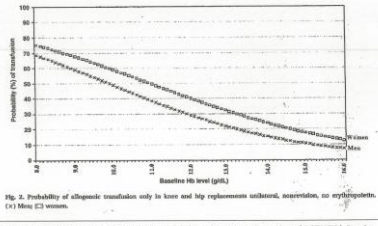


Fig. 2. Probability of allogeneic transfusion only in knee and hip replacements unilateral, noncreation, no erythropoietin. (+) Men; (□) women.

Orthopedic Surgery Transfusion Hemoglobin European Overview (OSTHEO) Study

Transfusion 2003; 43: 459-69

Landscape is Changing . . .

- Medicare no longer paying for the first three units of blood product
- Headlines are stating,
  "Hospitals are Overspending on Blood Transfusions"
  October 9, 2012 *Health Leaders Media*
- One report estimates that $65 M could be saved if readmission after hip and knee replacement were avoided

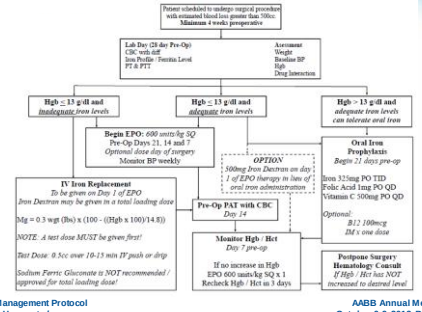
PURPOSE

- The purpose of our study was to evaluate the influence of a comprehensive surgical and clinical blood management protocol on the post-operative transfusion rate in patients undergoing primary TJA.

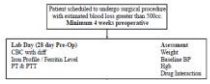
MATERIALS AND METHODS

- Study
  - Prospective, continuous series
  - 505 primary TJA procedures
  - Intra- and peri-operative blood management protocol
- Control
  - Retrospective continuous series
  - 1,092 control primary TJA procedures
  - Performed prior to blood management protocol implementation
- Single surgeon
  - Similar MIS/Tissue Sparing surgical techniques and TJR implants

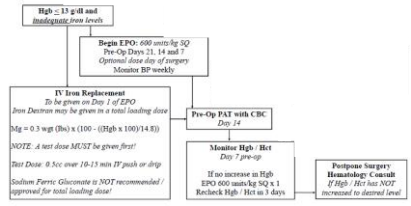
MATERIALS AND METHODS
Pre-Operative Blood Management Protocol



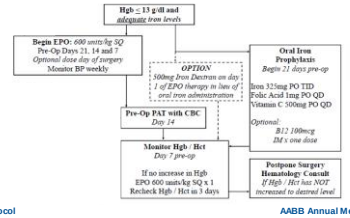
MATERIALS AND METHODS
Initial Screening



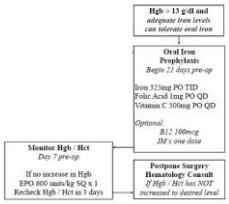
MATERIALS AND METHODS
Hgb ≤ 13 g/dl and inadequate Iron Levels



MATERIALS AND METHODS
Hgb ≤ 13 g/dl and adequate Iron Levels



MATERIALS AND METHODS
Hgb> 13 g/dl and adequate iron levels and can tolerate oral iron

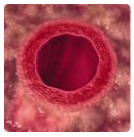


MATERIALS AND METHODS
Intra-Operative

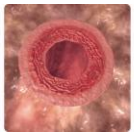
- For the study group, the intra-operative blood management protocol utilized the Aquamantys® (AQM) bipolar sealing technology to achieve and maintain wound hemostasis.

MATERIALS AND METHODS
Intra-Operative

The Aquamantys® System with Transcollation technology combines radiofrequency (RF) energy and saline for haemostatic sealing and coagulation of soft tissue and bone at the surgical site.



RF energy and saline are applied to tissue



Heat induced shrinkage occurs

Vessels <1mm may be occluded, reducing bleeding

Results

- There was no significant difference in demographics between study groups.
- Of the 505 treatment TJA cases, there were 4 (< 1.0%) cases in which post-operative allogenic blood transfusion was necessary.
- In the control group (n=1,092), there were 57 (5.3%) cases requiring allogeneic blood transfusions.
- This proportional difference was statistically significant ($p < 0.0001$).

Surgeon Response

- In subsequent patients
  - Post-operative reinfusion drains were eliminated for Total Knee Arthroplasty.
  - The use of cell saver and reinfusion drains were eliminated in Total Hip Arthroplasty.

Conclusions

- Our findings show a significant decrease in allogeneic transfusion rates following primary TJA when a total intra- and peri-operative blood management protocol was implemented featuring pre-operative anemia control and active intra-operative hemostasis control.

CONCLUSIONS

Clinical Value Continuum of Combined Protocols

CLINICAL BENEFITS	ECONOMIC BENEFITS	PATIENT BENEFITS
- Reduces transfusion rates by minimizing intra-operative blood loss[1-4] - May help improve visibility in the surgical field[5] - Reducing allogeneic blood transfusions may result in reduced post-operative complications[6,7]	- May reduce the need for other blood management products during or after the procedure[1,2] - Significantly reduces post-operative drainage[3] - Reduces transfusion rates, which in turn may lower costs to the hospital[1-3,6,8]	- Helps to maintain hemoglobin levels[3] - Reduces transfusion rates by minimizing intra-operative blood loss[1-4] - Reduced transfusion rates may prevent related post-operative complications, thus reducing hospital length of stay[8]

CONCLUSIONS

TABLE 1

Average costs with and without a transfusion[1]

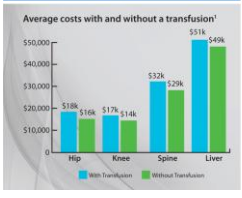
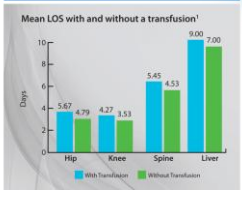


TABLE 2

Mean LOS with and without a transfusion[1]



Covance report; 2008 MedPAR database based on ICD-9-CM Codes for 100% of Medicare beneficiaries.

CONCLUSIONS

- The proposed blood management protocol was easy to implement and effective within the scope of our single surgeon study.
- Further study of this blood management protocol beyond a single surgeon's experience is warranted.

THANK YOU!

Tourniquetless TKA

VUMEDI

January 15, 2013

H. Del Schutte, Jr., M.D.
Medical Univ. of South Carolina

MUSC ORTHOPAEDIC SURGERY

Disclosure

- **Consultant / speaker**

- **Medtronic**
- **Stryker**
- **Depuy**

MUSC ORTHOPAEDIC SURGERY

Tourniquet Use

MUSC ORTHOPAEDIC SURGERY

Tourniquet Surgery

MUSC ORTHOPAEDIC SURGERY

MUSC ORTHOPAEDIC SURGERY

Tourniquetless tka

- Arterial calcification

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Arterial damage

J Perioper Pract. 2010 Feb;20(2):55-8.

Tourniquet failure during total knee replacement due to arterial calcification: case report and review of the literature.

Barr L, Iyer US, Sardesai A, Chitnavis J.

Department of Trauma & Orthopaedics, Addenbrooke's Hospital, Hills Road, Cambridge, CB2 0QQ. lynne.barr@nhs.net

case: caso, encajonar, asen… cajón, envoltura, maleta, est… vitrina, razón, causa, pleito

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Arterial damage

J Arthroplasty. 2008 Dec;23(8):1239.e1-6. Epub 2008 Apr 2.

Acute arterial thrombosis after bilateral total knee arthroplasty

Bayne CO, Bayne O, Peterson M, Cain E.

Harvard Medical School, Boston, Massachusetts, USA.

MUSC ORTHOPAEDIC SURGERY

Tourniquetless tka

- Obesity

MUSC ORTHOPAEDIC SURGERY

Tourniquetless tka

- Infection – antibiotic concentration, tissue oxygen perfusion
- Blood loss
- Vascular Effects
  - Arterial damage
    - Return to OR
  - DVT
- Multi-organ effects
  - Pulmonary, hepatic, splenic
- Cognitive function
- Pain
- Muscle function / Rehab

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Antibiotic concentration
  - SCIP guidelines
    - Vancomycin - 1hour
    - Ancef - 20 min

MUSC ORTHOPAEDIC SURGERY

Blood loss

Picture courtesy Fred Cushner

- Tka vs Hand surgery
- Transfusion rate
- Wound healing
  - Infection
  - Rehab
- Hematoma Rate
  - Anticoagulants
  - Pain
  - Decreased rom
  - Infection

MUSC ORTHOPAEDIC SURGERY

Tranfusion in TKA

Picture courtesy Fred Cushner

- 6 % - 42% incidence
- $200/unit - $1000 total cost
- LOS .5 to 1 day longer
- Per surgery costs in pts with transfusions –
  - $3000 knees
  - $2000 hips
- Medical risks - infection
- Decreased supply
- Increased demand

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- **Blood loss**
  - Blood loss after tka – effect of tourniquet release and cpm - Lotke et al JBJS 1991
    - Group 1 full tourniquet and splint
    - Group 2 full tourniquet and cpm
    - Group 3 tourniquet released and splint
      - –1400cc blood loss
    - Group 4 tourniquet released and cpm
      - –1800 cc blood loss

MUSC ORTHOPAEDIC SURGERY

Hematoma formation

MUSC ORTHOPAEDIC SURGERY

Minimizing Blood loss

Picture courtesy Fred Cushner

- Tissue Adhesives
- Tranxemic Acid
- Tourniquet use
- Transcollation®*

*A combination of radiofrequency (RF) and saline that provides hemostatic sealing of soft tissue and bone.

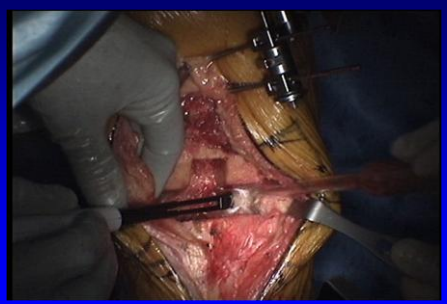
MUSC ORTHOPAEDIC SURGERY

Epinephrine Injection in TKA

- Injected along anticipated arthrotomy site
- Injected into fat pad

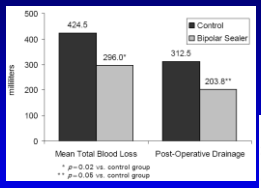
MUSC ORTHOPAEDIC SURGERY

Bipolar sealer technology in TKA



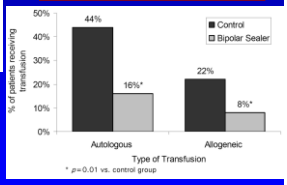
MUSC ORTHOPAEDIC SURGERY

Transcollation Technology in TKAs



Blood loss reduced by 30%*

Transfusions reduced by 64%**



-Marulanda GA, et al. *Surg Technol Int.* 2005;14:281-6.
** Weeden S. EFORT; 2007

MUSC ORTHOPAEDIC SURGERY

Comparison of Blood loss in Total Knee Arthroplasty with and without Tourniquet use: a retrospective study of 372 patients

Schutte Jr HD, Martin SM, Patrick M, Barfield W, Kavolous J.,.

MUSC ORTHOPAEDIC SURGERY

Calculated blood loss

- 172 TKAs with tourniquet 1,499.8
- 113 without tourniquet 1,538.5
- 87 w/o tourniquet and with Transcollation 1,368.5

MUSC ORTHOPAEDIC SURGERY

Transfusion rate

- 172 TKAs with tourniquet 29%
- 113 without tourniquet 17%
- 87 w/o tourniquet and with Transcollation 13%

MUSC ORTHOPAEDIC SURGERY

Drains - $50-250

MUSC ORTHOPAEDIC SURGERY

Tourniquetless TKA – OR time

Patient group	OR TIME
172 TKAs with tourniquet	62.7
113 without tourniquet	61.5
87 w/o tourniquet and with Transcollation	55.9

MUSC ORTHOPAEDIC SURGERY

Tourniquetless TKA – COST

Cost reductions in our series based on:

- **No tourniquet**
- **No drain**
- **6 minutes OR time**

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- **Arterial damage**

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- **Arterial damage**
  - **Often missed at surgery**
  - **.1% primary tka**
  - **.2% revision tka**
    - **50% lawsuit**

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Arterial damage
- Return to OR
  - Missed arterial injury
  - Hematomas

MUSC ORTHOPAEDIC SURGERY

Tourniquet use – DVT?

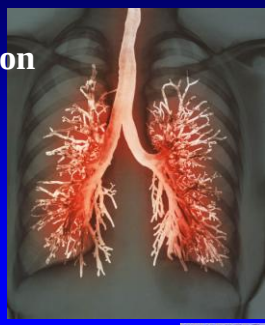
- PTE was detected in 6 patients (7.0%)
- 2 of 5 (40.0%) patients bilateral TKAs w T
- 3 of 42 (7.1%) bilateral TKAs w/o T
- 1 of 14 (7.1%) unilateral TKA w T
- PTE did not occur in patients who underwent unilateral TKA without tourniquet.
- median D-Dimer significantly higher in patients with tourniquet, both in unilateral TKA (p=0.003) and in bilateral TKAs (p=0.004).

Nishiguchia,et al 2005

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Pulmonary function
- Multi-organ function



MUSC ORTHOPAEDIC SURGERY

Tourniquet release

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- **Pulmonary function**
  - **"Tourniquet application within a safe limit may cause pulmonary gas exchange impairment several hours after tourniquet deflation"**

Orthopedics. 2010 Jun 9;33(6). doi: 10.3928/01477447-20100429-15.

Pulmonary gas exchange impairment following tourniquet deflation: a prospective, single-blind clin trial.

Lin L, Wang L, Bai Y, Zheng L, Zhao X, Xiong X, Jin L, Ji W, Wang W.

Anesth Analg. 2010 Aug;111(2):539-43. Epub 2010 Jul 7.

Ischemic preconditioning attenuates pulmonary dysfunction after unilateral thigh tourniquet-induc ischemia-reperfusion.

Lin LN, Wang LR, Wang WT, Jin LL, Zhao XY, Zheng LP, Jin LD, Jiang LM, Xiong XQ.

Department of Anesthesiology, The First Affiliated Hospital of Wenzhou Medical College, Wenzhou, China.

SC ORTHOPAEDIC SURGERY

Tourniquet use

- **Multi-organ function**

Am J Surg. 1992 Sep;164(3):248-53.

Liver and spleen phagocytic depression after peripheral ischemia and reperfusion.

Thompson PN, Cho E, Blumenstock FA, Shah DM, Saba TM.

Department of Physiology and Cell Biology, Albany Medical College, Union University, New York 12208.

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Cardiac function

J Int Med Res. 2010 Jul-Aug;38(4):1519-29.
Effect of high-dose vitamin C on oxygen free radical production and myocardial enzyme after tourniquet ischaemia-reperfusion injury during bilateral total knee replacement.
Lee JY, Kim CJ, Chung MY

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Cognitive function

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Cognitive function
  - Cognitive dysfunction after tka
    - Rodriguez et al, Jl. of Arthroplasty 2005
  - HITS (cerebral emboli) 22 of 37 pts.
  - Cognitive dysfunction
    - 41% at 1 week
    - 18% at 3 mos.
    - higher complication rate

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Pain

MUSC ORTHOPAEDIC SURGERY

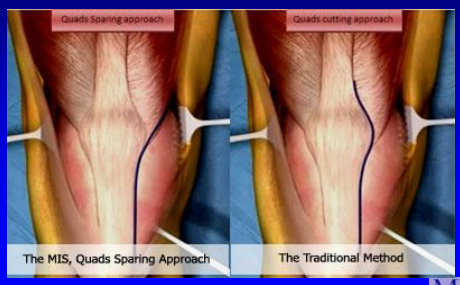
Tourniquet use

- Pain
  - Vandenbussche et al, International Orthopedics
    - Prospective randomized study with and without tourniquet Sig. decreased pain at 6 hours
    - Increased flexion at 5 days
  - Abdel-Salam, JBJS 77-B
    - 80 pts. – sig. degcreased pain without tourniquet
  - Barwell, JBJS 79-B
    - 88 pts. Sig. decreased pain with early release
  - Worland, Jl of Arthroplasty 1997
    - 28 bilat knees, sig. decreased pain without tourniquet

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Muscle function



MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Patellofemoral tracking
  - Husted, Jl. of Arthroplasty 2005
    - Tourniquet deflation improved patellar tracking
  - Lombardi, JBJS-B 87-B
    - Decreased need for lat. release if tourniquet released

MUSC ORTHOPAEDIC SURGERY

Tourniquet use

- Muscle function

Arthroscopy. 2001 Jul;17(6):603-7.
The effect on leg strength of tourniquet use during anterior cruciate ligament reconstruction: A prospective randomized study.
Nicholas SJ, Tyler TF, McHugh MP, Gleim GW.
CONCLUSIONS: Tourniquet use of less than 114 minutes during ACL reconstruction had no effect on the strength of the lower extremity after surgery

MUSC ORTHOPAEDIC SURGERY

Tourniquet Use

- Range of Motion
  - Ledin, Aspenberg, and Good. Acta Orthopaedica 2012; 83 (5): 499–503 499
    - Randomized RSA study with 50 patients
    - Found less postoperative pain and greater range of motion (11° more) in the non-tourniquet group (p = 0.001 at 2 years).

MUSC ORTHOPAEDIC SURGERY

Range of Motion

MUSC ORTHOPAEDIC SURGERY

Range of Motion

MUSC ORTHOPAEDIC SURGERY

Tourniquet Use

- **Cement Interdigitation**

- Ledin, Aspenberg, and Good. Acta Orthopaedica 2012; 83 (5): 499–503 499
  - No statistically significant effect on prosthesis migration
- Vertullo CJ. Presented at the Australian Knee Society Annual Scientific Meeting 2009, Palm Cove; AOA Annual Science Meeting 2010, Adelaide; ISAKOS Meeting 2011, Rio De Janeiro.
  - Prospective, randomized trial of 40 patients, quantified cement penetration in tourniquet and tourniquetless arms.
  - Mean cement penetration and standard deviation (SD) were nearly identical in each group (2.98 mm with SD of 0.82 in the tourniquet group versus 3.10 with SD of 0.84 in the tourniquetless group).

MUSC ORTHOPAEDIC SURGERY

Tourniquetless TKA - Rehab

- Our series of 372 patients

Patient group	ROM at 8wks
172 TKAs w/ tourniquet	105.4
113 w/o tourniquet	109.5
87 w/o tourniquet and with Transcollation	114.6

MUSC ORTHOPAEDIC SURGERY

CMS - Applicable Conditions

- The FY 2012 final rule addressed the following applicable readmissions:
  1. Acute myocardial infarction
  2. Heart failure
  3. Pneumonia

Readmission for orthopaedic procedures is NOT currently covered; this may change…

47 Federal Register Volume 76, Number 87 (Thursday, May 5, 2011)

MUSC ORTHOPAEDIC SURGERY

Unplanned Readmissions after TKA - Poster #20 AAHKS 2012

Consideration	Metric
30 Day Readmission Rate	5.65%
Readmission associated with:	
Increased LOS	p < .001
Revision surgery	p < .001
Most common readmitting diagnoses:	
Post-op infection	.5% of pts
Unspecified prosthetic complication	.31% of pts
Hematoma	.28% of pts
PE	.22% of pts
Financial Impact:	
Avg profit – w/ reimbursement	$5,219
Re-admitted pts – w/ reimbursement	$2,583 less profitable (p=.001)
Net avg loss – w/o reimbursement	$5,326 per episode of care

48 Derman et al. Risk Factors, Causes, and the Financial Implications of Unplanned Readmissions after TKA. Poster #20, AAHKS 2012.

MUSC ORTHOPAEDIC SURGERY

Relationship between timing of TQ release and readmission

Rama et al, J Bone Joint Surg, 2007

Parameter	Early-TQ Release	Late-TQ Release	P Value
All regional complications	7.9%	14.8%	.006
Complications that required another operation*	.3%	3.1%	.04

**Wound dehiscence, hematomas, and infections that required drainage and / or debridement and knee stiffness that required manipulation with pt under anesthesia*

10x rate of reoperations due to post op complications in late versus early TQ release group!

Rama K, Apsingi S, Puovali S, Jetti A. Timing of tourniquet release in knee arthroplasty. J Bone Joint Surg am. 2007; 89:699-705.

MUSC ORTHOPAEDIC SURGERY

Tourniquetless TKA

- Infection – antibiotic concentration, tissue oxygen perfusion
- Blood loss
- Vascular Effects
  - Arterial damage
    - Return to OR
  - DVT
- Multi-organ effects
  - Pulmonary, hepatic, splenic
- Cognitive function
- Pain
- Muscle function / Rehab

MUSC ORTHOPAEDIC SURGERY

Tourniquetless TKA

- Intraoperative (real time) control of blood loss
- Decreased metabolic challenges
- Improved postoperative function

MUSC ORTHOPAEDIC SURGERY

Thank you

MUSC
ORTHOPAEDIC SURGERY