Cardiac Update
2016-2017

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I have no financial disclosures or affiliations

Learning Objectives

- Pharmacology for cardiac procedures
- TAVR: What's the latest?
- New procedures you may be doing
- Atrial Fibrillation- Is it rate or rhythm?
- Blood transfusion- What's the limit? What can we add?
- Grab Bag of info

Pharmacology

- Cardiac Anesthesia
  - Definition of polypharmacy
  - Neurocognitive outcomes
  - Aging population
  - Fast track patients
- Do we make a difference?
  - CPB times
  - Embolic CVA
  - Transfusions

Dexmedetomidine Use

- Several prior studies showing improved outcomes in cardiac surgery
  - Mortality: In house, 30d, 1 yr
  - Neurologic : Delirium
  - Renal outcomes
- Recent publications in non-cardiac surgery
  - Reduced delirium post op in elderly patients
  - Safety in sedation of elderly with cognitive impairments

Dexmedetomidine *versus* Propofol Sedation Reduces Delirium after Cardiac Surgery

A Randomized Controlled Trial

George Djaiani, M.D., F.R.C.A., F.R.C.P.C., Natalie Silverton, M.D., Ludwik Fedorko, M.D., Ph.D., F.R.C.P.C., Jo Carroll, B.H.A., Rima Styra, M.D., F.R.C.P.C., Vivek Rao, M.D., Ph.D., F.R.C.P.C., Rita Katznelson, M.D.

ANESTHESIOLOGY 2016; 124:362-8

- Prospective, randomized, controlled trial of Dex vs Propofol
- Addressed heterogeneity of data on delirium
  - Delirium as primary outcome
- 185 patients randomized

Study Methods

- Patients > 60 yo with elective complex surgery
- Patients >70 yo with CABG or single valve surgery
- Standardized anesthetic
  - Midazolam limited to 0.05 mg/kg max
- Sedation initiated on ICU arrival
  - Dex bolus + infusion – not DC'ed on extubation
- Ventilation > 24 hrs: Dex converted to propofol
- Multimodal analgesia

Results

Table 2. Onset and Duration of Delirium and the Length of Stay in Patients with Delirium

	Dexmedetomidine Group (n = 16)	Propofol Group (n = 29)	*P* Value
Onset of delirium, d, median (range)	2 (1–4)	1 (1–4)	0.027
Duration of delirium, d, median (range)	2 (1–4)	3 (1–5)	0.04
Extubation time, h, median (range)	5.5 (3.5–14.2)	7.6 (3.8–202.2)	0.0007
Intensive care unit length of stay, h, median (range)	67.8 (20–214)	76.5 (17.8–956.5)	0.38
Hospital length of stay, d, median (range)	7.5 (5–32)	10 (6–74)	0.054

Table 4. Delirium, Sedation, and Pain Scores and Requirements for Analgesia and Antipsychotics in Dexmedetomidine and Propofol Groups

	Dexmedetomidine Group (n = 91)	Propofol Group (n = 92)	*P* Value
Delirium frequency, n (%)	16 (17.5)	29 (31.5)	0.028
Haloperidol, n (%)	12 (13)	24 (26)	0.04
Quetiapine, n (%)	3 (3.3)	5 (5.4)	0.72
Sedation Agitation Scale scores, 24 h	4 (1–7)	4 (1–7)	0.13

Summary

- Post Op Delirium (POD)
  - Dex 17.5% vs Prop 31.5%
- Duration of delirium (median days)
  - Dex 2d vs Prop 3d
- Hospital LOS (median days)
  - Dex 7.5 vs Prop 10
- Delirium related hours
  - 450 vs 1200 (ICU) and 532 vs 888 (floor) for Dex vs Prop

The Effect of Dexmedetomidine on Outcomes of Cardiac Surgery in Elderly Patients

Hao Cheng, MD,*† Zhongmin Li, PhD,‡ Nilas Young, MD,§ Douglas Boyd, MD,§ Zane Atkins, MD,§ Fuhai Ji, MD,* and Hong Liu, MD†

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 6 (December), 2016: pp 1502–1508

- Retrospective, single center
- 505 patients
- Authors reviewed 5 years of data for elderly patients
- CABG or Valve/CABG > 65 years old
- Dexmedetomidine vs Non-Dex groups

Methodology

- Univariate and multivariate regression analysis
  - Demographic, therapeutic, and clinical outcome variables
- Propensity score
  - Likelihood of a patient receiving Dex
- Dex group : More CRF, CHF, lipid lowering agents
  - Less urgent surgery, CVD and lower BMI
  - Shorter CPB, X-clamp times, less IABP use

Take Away Message

- Data consistent with prior studies
  - Same dataset as previously published work
- Improved in hospital and 30d mortality benefit
  - 1 year mortality benefit did not persist in elderly
- Decreased stroke risk
- Decreased delirium
  - Very low rates of delirium reported in this study

Sevoflurane Versus Total Intravenous Anesthesia for Isolated Coronary Artery Bypass Surgery With Cardiopulmonary Bypass: A Randomized Trial

Valery V. Likhvantsev, MD,* Giovanni Landoni, MD,† Dmitry I. Levikov, PhD,‡ Oleg A. Grebenchikov, PhD,* Yuri V. Skripkin, MD,* and Rostislav A. Cherpakov, MD§

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 5 (October), 2016: pp 1221-1227

- Randomized controlled trial, 2 hospitals
- Isolated CABG in native chest
- TIVA vs volatile anesthetic maintenance
- 900 patients randomized 2012-2014

Details

- Volatile group
  - Allowed for propofol during induction (38% without propofol)
  - Fentanyl, sevoflurane, cisatricurium intermittent bolus
- TIVA group
  - Propofol gtt, fentanyl intermittent, and cisatricurium
- No benzodiazepines or etomidate use reported in either

Table 2. Cardiac Biomarkers and Length of Hospital Stay in Patients Randomly Assigned to Receive Propofol-Based Total Intravenous Anesthesia or Sevoflurane

	TIVA Group (n = 431)	Sevoflurane Group (n = 437)	p Value
Troponin T after 24 h, ng/mL	0.57 (0.12-0.91)	0.18 (0.12-0.35)	<0.001
NT-proBNP after 24 h, pg/mL	878 (561-1,825)	633 (452-1,105)	<0.001
NT-proBNP after 48 h, pg/mL	1,036 (692-2,496)	482 (240-684)	<0.001
Hospital stay, days	14 (10-16)	10 (9-11)	<0.001
Hospital stay in survivors, days	14 (11-16)	10 (9-11)	<0.001

NOTE. Data are presented as median (interquartile range).
Abbreviations: NT-proBNP, N-terminal pro-brain natriuretic peptide; TIVA, total intravenous anesthesia.

Subgroup	7-day Mortality	1-month Mortality	1-year Mortality	Hospital Stay	Troponin T After 24 h, ng/mL	NT-proBNP After 24 h, pg/mL	NT-proBNP After 48 h, pg/mL
With propofol, n = 700	2.0%	4.7%	22.7%	11 (10-14)	0.36 (0.13-0.78)	807 (535-1,574)	711 (514-1,542)
Without propofol, n = 168	0%	2.4%	16.5%	10 (9-10)	0.18 (0.11-0.30)	547 (393-880)	432 (228-668)
p value	0.085	0.21	0.15	<0.01	<0.01	<0.01	<0.01

NOTE. Data are presented as percentages or as median (interquartile range).
Abbreviation: NT-proBNP, N-terminal pro-brain natriuretic peptide.

Conclusions

- Largest randomized trial of volatile vs TIV anesthetic
- Decreased post-op TroponinT
- Decreased proBNP
- Decreased hospital LOS
- Increased biomarkers and LOS if propofol was used during induction in
  - Trend towards mortality benefit at all points

Can J Anesth/J Can Anesth (2016) 63:1128-1139
DOI 10.1007/s12630-016-0706-y

REPORTS OF ORIGINAL INVESTIGATIONS

Comparison of isoflurane and sevoflurane in cardiac surgery: a randomized non-inferiority comparative effectiveness trial

Philip M. Jones, MD · Daniel Bainbridge, MD · Michael W. A. Chu, MD · Philip S. Fernandes, BA · Stephanie A. Fox, BA · Ivan Iglesias, MD · Bob Kiaii, MD · Ronit Lavi, MD · John M. Murkin, MD

- Pragmatic randomized, non-inferiority study
- CABG or single valve study, 464 patients
- 2011-2014
- Single center

Simple Answer

- There was no difference!
- Primary Outcome: Prolonged ICU stay or 30d mortality
  - Trend towards Sevo better for prolonged ICU stay
- Clinically irrelevant cTnT and Cr elevation with Sevo
- Cost Analysis:
  - Sevo: $41 (Canadian $)
  - Iso: $5

Etomidate

- The story continues….
- Known adrenocortical insufficiency with single doses
  - Clinically relevant?
- Periop concerns for hemodynamic instability and infection
- Potential modulation of inflammation
  - Increased IL-6 and without commensatory anti-inflammation
- Authors question relationship for atrial fibrillation
  - A Fib admittedly multifactorial

Etomidate and the Risk of Complications After Cardiac Surgery: A Retrospective Cohort Analysis

Ryu Komatsu, MD,* Natalya Makarova, MS,†‡ Jing You, MS,†‡ Daniel I. Sessler, MD,‡ David G. Anthony, MD,§ Yusuke Kasuya, MD,‖ Edward G. Soltesz, MD, MPH,¶ and Alparslan Turan, MD‡

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 6 (December), 2016: pp 1516–1522

- Retrospective cohort study with propensity matching
- 8,978 patients undergoing CABG or CABG/valve
- Etomidate: Other induction agents in 2:1 matched study
- Primary outcome: Rates of A Fib, LOS
- Secondary Outcomes: Bleeding and major complications

Table 2. Results for the Primary Outcomes

Primary Outcome	Etomidate (n = 4,094)	Non-etomidate (n = 2,524)	Estimated (98.3% CI)[*,†] (OR4 or HR§)	P[‡]
Postoperative atrial arrhythmia, yes (%)	33.4	31.5	1.07 (0.92, 1.23)[§]	0.29
Length of ICU stay (hours)	28.0 [23.4, 55.1]	27.4 [23.5, 50.1]	1.00 (0.94, 1.06)[‖]	0.98
Length of hospital stay (days)	7.3 [5.3, 11.5]	7.2 [5.3, 11.0]	1.00 (0.94, 1.06)[‖]	0.98

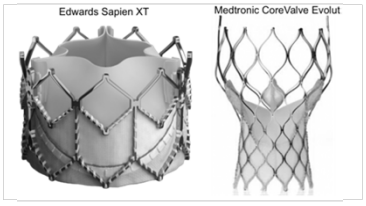
Table 3. Results for the Secondary Outcomes

Secondary Outcomes (%)	Etomidate (n = 4,094)	Non-etomidate (n = 2,524)	Odds Ratio (99.6% CI)[*,†]	P[‡]
Packed red cells	20.1	16.4	1.32 (1.02, 1.70)	0.002
Fresh frozen plasma	4.2	2.9	1.44 (0.91, 2.27)	0.02
Platelets	9.8	7.6	1.29 (0.97, 1.73)	0.01
Cryoprecipitate	0.5	0.5	0.84 (0.25, 2.82)	0.67
Postoperative complications				
Cardiovascular[§]	2.1	2.0	0.96 (0.57, 1.61)	0.80
Reoperation	4.7	5.8	0.76 (0.55, 1.06)	0.02
Infectious	2.0	1.8	1.08 (0.63, 1.86)	0.68
Neurologic	1.5	1.4	1.06 (0.57, 1.97)	0.78
Pulmonary	10.1	9.6	0.99 (0.77, 1.29)	0.94
Renal	3.5	3.6	0.90 (0.60, 1.35)	0.45
Hematologic	0.8	0.6	1.30 (0.53, 3.21)	0.40
Gastrointestin	2.4	1.7	1.32 (0.77, 2.25)	0.14

Conclusions

- Atrial fibrillation rates no different
- ICU and hospital LOS also the same
- Secondary outcomes
  - Increased RBC use with etomidate
  - Trend towards increased FFP and platelets
- Limitations
  - Observational trial
  - Selection bias

TAVR: What's the latest?



TAVR – Long term followup

- TAVR implanation > 5 yrs ago (5-14 yrs) in 2002-2011
- 2 centers
- Cribier Edwards, Edwards SAPIEN, SAPIEN XT valves
- 704 TAVI cases, 378 with long term followup
- Degeneration
  - Mean gradient ≥ 20mmHg without endocarditis
  - Moderate AI

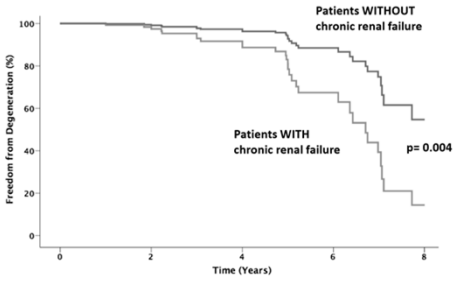
Dvir D. First look at long-term durability of transcatheter heart valves: Assessment of valve function up to 10 years after implantation. EuroPCR 2016; May 17, 2016; Paris, France

2016 euro PCR

TAVR followup

- Valve types
  - C-E: 14.3%, Edwards Sapien 49.7%, Sapien XT 36%
- Access Route
  - Transfemoral 68.5%, Transapical 28.7%
- Median Survival Time: 51 months (4 yrs, 3 mo)
- Approximately 50% degeneration at 8 years
  - CRF strongest correlation with degeneration
  - About 2/3 AI and 1/3 AS

Long Term TAVR follow up



Original Article

Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients

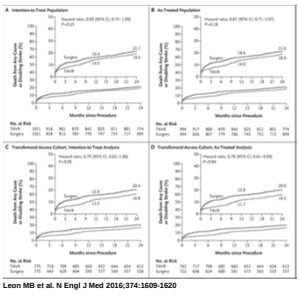
Martin B. Leon, M.D., Craig R. Smith, *et al.* for the PARTNER 2 Investigators

N Engl J Med
Volume 374(17):1609-1620
April 28, 2016

In a randomized trial involving more than 2000 patients, transcatheter aortic-valve replacement was noninferior to surgical replacement in the primary end point of death from any cause or disabling stroke at 2 years.

The NEW ENGLAND JOURNAL of MEDICINE

Time-to-Event Curves for the Primary Composite End Point.



Leon MB et al. N Engl J Med 2016;374:1609-1620

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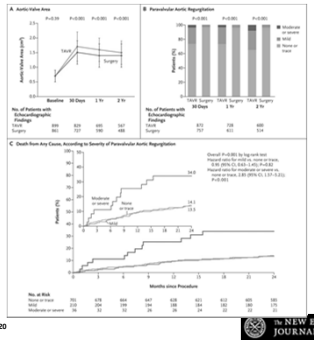
Echocardiographic Findings.



Leon MB et al. N Engl J Med 2016;374:1609-1620

The NEW ENGLAND JOURNAL of MEDICINE

Take Away Points

- TAVR non-inferior to surgery in intermediate risk patients
- Valve gradients were lower in TAVR than SAVR
- Paravalvular leaks greater with TAVR than SAVR
  - Moderate-Severe PVL with Hazard Ratio 2.85
- TAVR had lower bleeding risks, atrial fibrillation, AKI
- Length of Stay
  - ICU 2 vs 4 days – favoring TAVR
  - Hospital 6 vs 9 days – favoring TAVR

Have you ever seen a passive CT surgeon?
They will not go away quietly

Sutureless Valve Technology

Figure 1 Commercially available sutureless aortic valves. (A) 3F Enable (Medtronic, Minneapolis, USA); (B) Perceval S (Sorin, Saluggia, Italy); (C) Intuity Elite (Edward Lifesciences, Irvine, USA).

- Pericardial biologic prostheses that require less than 3 sutures
- Still requires Aortic x-clamp and CPB
- Diseased valve removed and prosthesis implants under direct vision
- CPB and X-clamp times reported are approximately half of STS averages
- Reduced PVL vs TAVR

Ann Cardiothorac Surg 2015;4(2):123-130

SUAVR Data

- SUAVR vs Convential AVR (C-AVR)
  - Outcomes differences yet to be reported
  - Consistently significant CPB and X-clamp times across studies
  - Shorter LOS and potential cost benefit
- 1 randomized trial of SUAVR vs C-AVR
  - Shorter x-clamp times, similar CPB
  - No differences in early outcomes
  - Improved mean gradient in SUAVR

Ann Cardiothorac Surg 2015;4(2):123-130

TAVI vs SUAVR

Original Article

Transcatheter aortic valve implantation (TAVI) versus sutureless aortic valve replacement (SUAVR) for aortic stenosis: a systematic review and meta-analysis of matched studies

Nelson Wang[1], Yi-Chin Tsai[2], Natasha Niles[2], Vakhtang Tchantchaleishvili[3], Marco Di Eusanio[4], Tristan D. Yan[2], Kevin Phan[1,2]

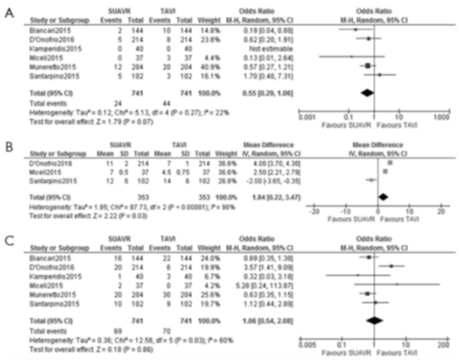
J Thorac Dis 2016;8(11):3283-3293

- Meta-analysis of TAVI vs SUAVR
- Primary outcomes paravalvular leak, short, and intermediate mortality
- 6 studies met inclusion criteria
- Compared TAVI to SUAVR via propensity score matching

Mortality

Hospital LOS

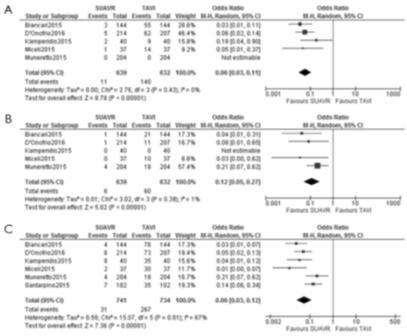
Pacemaker



Mild PVL

Moderate-Severe

Any PVL



TAVR Anesthetic Implications and safety

- General anesthesia initially preferred choice
  - Airway management
  - Immobility during deployment
  - TEE guidance
  - Duration of initial procedures
  - Learning curve for the room
- Safety, cost containment, neurological outcomes
  - MAC as an alternative

Outcome After General Anesthesia Versus Monitored Anesthesia Care in Transfemoral Transcatheter Aortic Valve Replacement

Paola D'Errigo, MStat,* Marco Ranucci, MD,† Remo Daniel Covello, MD,‡ Fausto Biancari, MD, PhD,§ Stefano Rosato, MStat,* Marco Barbanti, MD,‖ Francesco Onorati, MD, PhD,¶ Corrado Tamburino, MD, PhD,‖ Gennaro Santoro, MD,# Claudio Grossi, MD,** Francesco Santini, MD,†† Katia Bontempi, MStat,‡‡ Danilo Fusco, MStat,‡‡ and Fulvia Seccareccia, MSc**, on behalf of the OBSERVANT Research Group

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 5 (October), 2016: pp 1238–1243

- Secondary analysis from observational and prospective OBSERVANT trial
- Multicenter trial in Italy 2010-2012
- 1494 patients undergoing transfemoral TAVR
- Propensity score matching 310 pairs of MAC vs GA

Methods

- Sapien XT (Edwards Life-Science, Irvine, CA)
- CoreValve (Medtronic, Minneapolis, MN)
- Primary Endpoint: All cause mortality
- Secondary Endpoint: Adverse events
- Propensity score matching
- MAC 1137 (76.1%) vs GA 357 (23.9%)

Table 3. Early Outcomes in Propensity-Score–Matched Pairs of Patients Undergoing Transcatheter Aortic Valve Replacement Under MAC Versus GA

Variable	MAC (n = 310)	GA (n = 310)	p Value
30-day mortality	12 (3.9)	15 (4.8)	0.564
Stroke	4 (1.3)	2 (0.7)	0.414
Valve migration	5 (1.6)	6 (1.9)	0.739
Cardiogenic shock	5 (1.6)	9 (3.0)	0.285
Cardiac tamponade	12 (3.9)	7 (2.3)	0.251
Permanent pacemaker	58 (19.1)	45 (14.8)	0.168
Major vascular damage	26 (8.6)	24 (7.9)	0.758
Infection	19 (6.4)	24 (8.1)	0.411
Emergency percutaneous coronary intervention	1 (0.3)	2 (0.7)	0.564
Severe bleeding*	95 (31.8)	114 (38.1)	0.102
Paravalvular regurgitation			
Mild	121 (41.3)	134 (45.7)	0.858
Moderate	22 (7.5)	33 (11.3)	
Severe	2 (0.7)	0	
Acute kidney injury*	81 (28.3)	72 (25.2)	0.397
Acute Kidney Injury Network stages			
Stage 1*	51 (17.8)	47 (16.4)	0.669
Stage 2*	12 (4.2)	7 (2.4)	
Stage 3*	18 (6.3)	18 (6.3)	
De novo dialysis†	13 (4.4)	16 (5.4)	0.578
Mean transvalvular gradient (mmHg)	9.7 ± 5.6	9.7 ± 4.2	0.965
Peak transvalvular gradient (mmHg)	18.3 ± 10.1	18.5 ± 8.0	0.635
Intensive care unit stay (days)	2.9 ± 4.7	3.5 ± 4.5	0.086

Results

- No primary end point differences
- Severe paravalvular leak in 2 MAC patients, 0 in GA
- 3 year survival the same
- No methodology for MAC
- No commentary on intra-procedure adverse events

Comparison of sedation and general anaesthesia for transcatheter aortic valve implantation on cerebral oxygen saturation and neurocognitive outcome†

N. P. Mayr[1,*], A. Hapfelmeier[2], K. Martin[3], A. Kurz[3], P. van der Starre[4], B. Babik[5], D. Mazzitelli[6], R. Lange[6], G. Wiesner[1] and P. Tassani-Prell[1]

British Journal of Anaesthesia, 116 (1): 90–9 (2016)

doi: 10.1093/bja/aev294

- INSERT Trial – single center, balanced randomization
- Transfemoral Medtronic CoreValve™ in 66 patients
- Evaluated cerebral desaturations in sedation vs GA - NIRS
- Secondary look at neurocognitive outcomes

Anesthetic plan

- TAVI-GA
  - Oral midazolam
  - Propofol 3mg/kg/hr (50 mcg/kg/min)
  - Remifentanil 0.2 mcg/kg/min
- TAVI-S
  - Oral midazolam
  - Propofol 1 mg/kg/hr (16.7 mcg/kg/min)
  - Remifentanil 0.03 mcg/kg/min

Results

	TAVI-GA n=31	TAVI-S n=31	P-value
rSO_2 values			
rSO_2 at room air baseline (%)	60 (53/66)	57 (54/67)	0.916
rSO_2 interhemispheric difference (%)	0 (–3/3)	0 (–5/3)	0.789
rSO2 with oxygen after induction (%)	65 (58/70)	68 (63/78)	0.111
rSO_2 before RVP (%)	68 (60/71)	70 (64/79)	0.107
rSO_2 minimal value during RVP (%)	58 (51/64)	60 (56/67)	0.323
rSO_2 before valve implantation (%)	68 (58/72)	69 (64/78)	0.161
rSO_2 minimal value during valve impl. (%)	60 (51/66)	62 (54/71)	0.430
rSO_2 120 S after extubation (%)	73 (62/78)	72 (66/76)	0.921
Adverse events			
Unrest/Pain n (%)	0	19 (61)	<0.001*
Bradypnoea n (%)	n.a.	16 (52)	n.a.
SpO_2<90% n (%)	0	5 (16)	0.053
Jaw-Thrust/nasopharyngeal airway n (%)	n.a.	11 (36)	n.a.
Bag-Mask Ventilation n (%)	n.a.	6 (19)	n.a.
Difficult tracheal intubation n (%)	3 (10)	n.a.	n.a.
Bronchospasm n (%)	0	1 (3)	1.000
Difficult central venous catheter n (%)	1 (3)	3 (10)	0.612
Defibrillation n (%)	0	1 (3)	1.000
Perioperative Stroke n (%)	0	1 (3)	1.000
Cumulative no. of patients with adverse events n (%)	4 (13)	29 (94)	<0.001*

Blood Gas Analysis

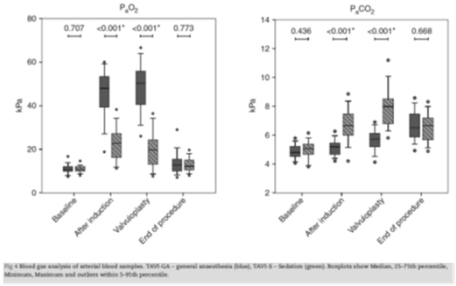


Fig 4 Blood gas analysis of arterial blood samples. TAVI-GA – general anaesthesia (blue), TAVI-S – Sedation (green). Boxplots show Median, 25–75th percentile, Minimum, Maximum and outliers within 5–95th percentile.

Discussion

- No statistical difference in cerebral desaturation
- No differences in neurocognitive testing
- High rate of adverse events
  - Primarily respiratory ~ 20% required BMV
  - Hypercarbia/respiratory acidosis – during procedure
  - Hypoxia
- No obvious safety concerns related to anesthetic choice

Monitored Anesthesia Care Versus General Anesthesia: Experience With the Medtronic CoreValve

Christopher Palermo, DO, MPH,* Meredith Degnan, MD,* Keith Candiotti, MD,* Tomas Salerno, MD,† Eduardo de Marchena, MD,* and Yiliam Rodriguez-Blanco, MD*

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 5 (October), 2016: pp 1234–1237

- Retrospective, case controlled study- single health system
- 65 patients undergoing TAVR with Medtronic CoreValve™
- GA (n=21) or MAC (n=44) was utilized
- Hospital LOS, morbidity and mortality data reviewed

Anesthetic Plan

- MAC
  - Dexmedetomidine load: 1mcg/kg over 10-15 min
    - Infusion 0.2-0.7 mcg/kg/hr
  - Fentanyl 25 mcg bolus PRN
  - 1% lidocaine at catheter site
- GA
  - Etomidate 0.2-0.6 mg/kg
  - NMB
  - Sevoflurane

Table 2. Surgical Characteristics/Complications

	GA (n = 21)	MAC (n = 44)	p Value
Postop mean AV gradient	8.8 ± 4.3	11.6 ± 5.9	0.054
Procedure time	260.0 ± 50.5	256.1 ± 50.7	0.771
Conversion to open	0.0%	0.0%	N/A
Pulmonary embolism	9.5%	2.3%	0.193
Pneumonia	4.8%	0.0%	0.145
Coagulopathy	0.0%	0.0%	N/A
CVA	0.0%	2.3%	0.486
Cardiac arrest	0.0%	0.0%	N/A
Intraoperative mortality	0.0%	0.0%	N/A
1-month mortality	0.0%	2.3%	0.486
Sepsis	0.0%	2.3%	0.486
Pericardial tamponade	0.0%	0.0%	N/A
ICU readmission	4.8%	0.0%	0.145
Contrast nephropathy	0.0%	4.5%	0.321
Postoperative AKI	0.0%	9.1%	0.154
Postoperative permanent PCM insertion	28.6%	38.6%	0.427
Hematoma	14.3%	9.1%	0.527
ICU stay (days)	3.8 ± 2.9	4.5 ± 4.2	0.473
Hospital stay (days)	5.7 ± 2.5	6.3 ± 3.7	0.514
Intraoperative PRBC	0.43 ± 1.0	0.09 ± 0.29	0.047
Intraoperative FFP	0.19 ± 0.6	0	0.038
Intraoperative cryoprecipitate	0	0	N/A
Intraoperative platelets	0.10 ± 0.4	0	0.149
Postoperative PRBC	0.24 ± 0.6	0.50 ± 1.0	0.285
Postoperative FFP	0	0	N/A
Postoperative cryoprecipitate	0	0	N/A
Postoperative platelets	0	0	N/A

NOTE: Values are for percentage for listed technique, mean ± SD.

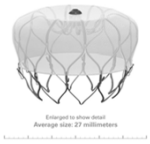
Conclusions

- No significant outcomes differences
- Underpowered to detect significant differences
- During learning curve phase of institution
- Comorbid CAD more likely to get GA
  - Also more likely to get transfusions
- No risks or benefits between anesthetic choice

New Devices coming to you

- Atrial Fibrillation Occlusion devices
- Only 30-50% of Atrial fibrillation patients treated with AC
  - 5 fold increased risk of CVA with Afib
  - AC reduces risk only 60% with 1-3% increased bleeding
  - Left Atrial Appendage – site of thrombus in 90% in AF
- Left Atrial Appendage Occlusion Devices
  - Catheter based delivery system with self expanding occluder
  - Trans-septal Puncture required

WATCHMAN Device



- Boston Scientific, Marlborough, MA
- Only device with FDA approval in the US
- Central Nickel-titanium with 10 fixation anchors
- European Society of Cardiology Guidelines
  - 2012 - Class IIb (LOE B) recommendation for patients at high risk of stroke but contraindication to AC
- Indications for AC currently based on CHA_2DS_2-VASc

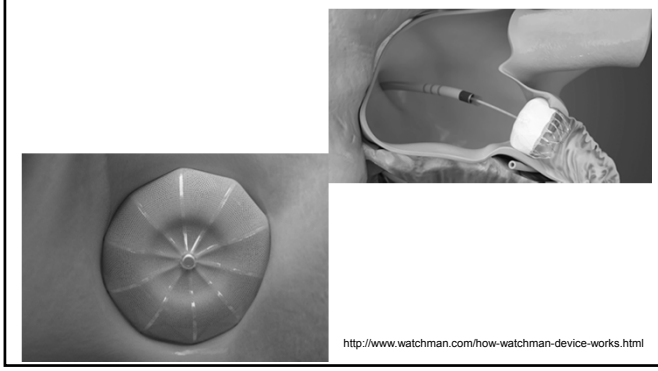
Contraindications

- Presence of ASD or PFO closure device
- Inability to tolerate warfarin, ASA, or clopidogrel
  - ASA/warfarin used for 45 days post procedure
  - 45 d – 6 mo: ASA/clopidogrel
  - 6 mo+ ASA Monotherapy
  - Endocarditis prophylaxis initial 6 mos

Outcomes Data

- PROTECT AF
  - Efficacy endpoint of stroke, CV death, embolic event
    - 2.3/100 vs 3.8/100 events compared to warfarin
- PREVAIL
  - Endpoint of ischemic stroke prevention
    - Non-inferior to warfarin therapy

Homes DR Jr. J Am Coll Cardiol 64:1-12, 2014
Fountain RB Am Heart J 151:956-961, 2006.



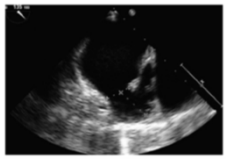
http://www.watchman.com/how-watchman-device-works.html

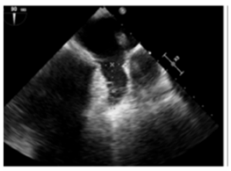
TEE guided procedure

- Identify contraindications to procedure
- Aid fluoro guided direction of device
- Identify size, morphology, # of lobes relative to ostium
- Rapid recognition of procedural complications
  - Pericardial effusions

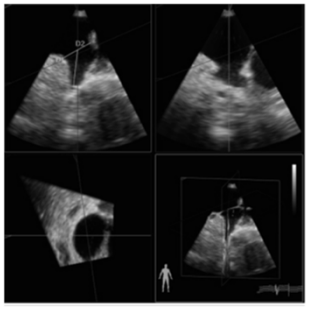
TEE Assessment

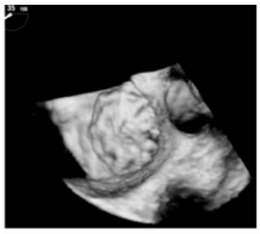
- LAA measured ostium, depth
  - ME 4C: 0-20°, 45-60°, ME 2C: 90°, ME LAX: 120-135°
- 0° and 135° may show largest ostial diameter





Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 6 (December), 2016: pp 1685–1692





Atrial Fibrillation

- 20-50% incidence post cardiac surgery
- Increased rates of
  - Death
  - Complications
  - Cost of hospitalization
- Non-surgical Patients: AFFIRM trial*
  - No advantage to rhythm control vs rate control

*NEJM 2002;347:1825-33.

Rate Control versus Rhythm Control for Atrial Fibrillation after Cardiac Surgery

A.M. Gillinov, E. Bagiella, A.J. Moskowitz, J.M. Raiten, M.A. Groh, M.E. Bowdish, G. Ailawadi, K.A. Kirkwood, L.P. Perrault, M.K. Parides, R.L. Smith II, J.A. Kern, G. Dussault, A.E. Hackmann, N.O. Jeffries, M.A. Miller, W.C. Taddei-Peters, E.A. Rose, R.D. Weisel, D.L. Williams, R.F. Mangusan, M. Argenziano, E.G. Moquete, K.L. O'Sullivan, M. Pellerin, K.J. Shah, J.S. Gammie, M.L. Mayer, P. Voisine, A.C. Gelijns, P.T. O'Gara, and M.J. Mack, for the CTSN*

- Cardiothoracic Surgical Trials Network (CTSN), 23 sites
- CABG, Valve repair, bioprosthetic valve replacement
- 2109 patients enrolled
- 695 (33%) developed atrial fibrillation

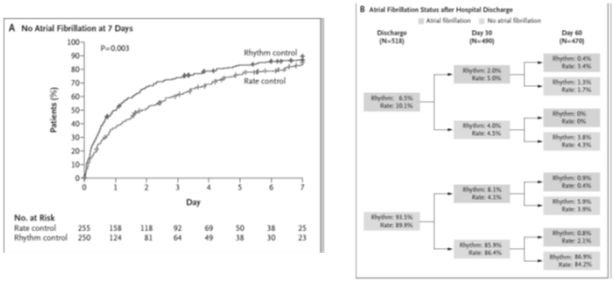
Methodology

- Rate Control Group (n=255)
  - Medications to control HR <100
  - Could be converted if provider thought necessary for hemodynamics or symptoms
- Rhythm Control (n=250)
  - Amiodarone +/- rate controls agents for 24-48 hrs
  - DCCV recommended at that time for failure to convert
  - Amiodarone continued for 60 days unless side effects
- Pts DC'ed home in rate control or after amio load

Outcomes

- Primary
  - Total hospital days within 60 days of randomization
- Secondary
  - Days to DC from randomization
  - Need for readmission
  - Need for PPM
  - Other adverse events

Atrial Fibrillation Results



Discussion

- 10x size of previous trials
- ~25% non-adherence to trial outline
  - Multiple crossovers reflecting clinical practice
- No primary end point differences – hospital days
  - Readmission rate still 28% - 1/5 for Atrial Fib issues
- Rhythm control achieved more SR faster
- Overall in total study participants
  - 85% in SR by discharge
  - 95% by 6 mo

Take Home Points

- No measurable differences
- Rate control avoids toxic side effects of amio
  - At a cost of slower onset to rhythm control
    - More Anti-coagulation
- Most deviations from rhythm control group were amio toxicity side effects
- Continue to practice clinical bedside medicine


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Effect of Short-Term vs. Long-Term Blood Storage on Mortality after Transfusion

N.M. Heddle, R.J. Cook, D.M. Arnold, Y. Liu, R. Barty, M.A. Crowther, P.J. Devereaux, J. Hirsh, T.E. Warkentin, K.E. Webert, D. Roxby, M. Sobieraj-Teague, A. Kurz, D.I. Sessler, P. Figueroa, M. Ellis, and J.W. Eikelboom

N ENGL J MED 375;20 NEJM.ORG NOVEMBER 17, 2016

- INFORM trial
- All hospitalized patients receiving RBC transfusion
- Patients randomized to receive freshest vs oldest unit in blood bank
- Blood type A or O only in primary analysis, all types in secondary
- 24,736 patients studied at 6 institutions

Results

- Circulatory d/o, trauma, neoplasm, GI bleed
  - 67% of all patients
- Average of 2 units RBC per patient
- Mortality 9.1% vs 8.7% in new vs old blood units
- Sub-group analysis of high risk patients with no difference
  - Includes CT surgery – 1 institution excluded

JAMA | Special Communication

Clinical Practice Guidelines From the AABB
Red Blood Cell Transfusion Thresholds and Storage

Jeffrey L. Carson, MD; Gordon Guyatt, MD; Nancy M. Heddle, MSc; Brenda J. Grossman, MD, MPH; Claudia S. Cohn, MD, PhD; Mark K. Fung, MD, PhD; Terry Gernsheimer, MD; John B. Holcomb, MD; Lewis J. Kaplan, MD; Louis M. Katz, MD; Nikki Peterson, BA; Glenn Ramsey, MD; Sunil V. Rao, MD; John D. Roback, MD, PhD; Aryeh Shander, MD; Aaron A. R. Tobian, MD, PhD

JAMA. 2016;316(19):2025-2035. doi:10.1001/jama.2016.9185
Published online October 12, 2016.

- Literature review to establish guidelines on blood transfusion
- Reviewed transfusion threshold and storage age guidelines
- RBC transfusion threshold – 31 RCTs
- RBC transfusion storage – 13 RCTs

Practice Guidelines

- Recommendation 1
  - Threshold of 7 g/dL for hospitalized adult patients
  - 8 g/dL for those undergoing orthopedic or cardiac surgery
    - Or those with pre-existing cardiac conditions
- Recommendation 2
  - Patients should receive any unit of RBC within standard issue dates
  - There is no benefit to fresher blood

Future Research

Transfusion Requirements in Cardiac Surgery III (TRICS-III)

This study is currently recruiting participants. **(see Contacts and Locations)**
Verified December 2016 by St. Michael's Hospital, Toronto

Sponsor:
St. Michael's Hospital, Toronto

Information provided by (Responsible Party):
St. Michael's Hospital, Toronto

ClinicalTrials.gov Identifier:
NCT02042898

First received: January 17, 2014
Last updated: December 9, 2016
Last verified: December 2016
History of Changes

Red Cell Storage Duration and Outcomes in Cardiac Surgery

This study is currently recruiting participants. **(see Contacts and Locations)**
Verified January 2017 by The Cleveland Clinic

Sponsor:
The Cleveland Clinic

Information provided by (Responsible Party):
d sessler, Outcomes Research Consortium

ClinicalTrials.gov Identifier:
NCT00458783

First received: April 9, 2007
Last updated: January 19, 2017
Last verified: January 2017
History of Changes

Comparison of Two Different Red Blood Cell Transfusion Thresholds on Short-Term Clinical Outcomes of Patients Undergoing Aortic Surgery With Deep Hypothermic Circulatory Arrest

Yongyuan Wang, BA, and Hongwen Ji, MD

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 5 (October), 2016: pp 1163–1166

- Single center retrospective analysis
- 2 surgical teams with different thresholds for transfusion
  - Restrictive < 8 g/dL or Liberal < 10g/dL
- 74 patients studied over 1 year undergoing aortic surgery with DHCA

Table 4. Postoperative Mortality and Complications Compared Between the 2 Groups of Patients

Variable	Liberal Group (n = 34)	Restrictive Group (n = 40)	p Value
Re-exploration for bleeding, n (%)	1 (2.9%)	0	0.459
Need for dialysis, n (%)	4 (11.8%)	4 (10%)	1.000
Pulmonary infection, n (%)	5 (14.7%)	3 (7.5%)	0.458
Incision infection, n (%)	2 (5.9%)	0	0.208
Stroke, n (%)	0	2 (5%)	0.496
30-day mortality, n (%)	2 (5.9%)	3 (7.5%)	1.000
Duration of mechanical ventilation, h	26 ± 20	40 ± 39	0.077
ICU length of stay, h	100 ± 18	61 ± 10	0.464
Postoperative length of stay, days	11.9 ± 4.5	11.7 ± 5.4	0.575
6-h drainage volume, mL	304 ± 141	309 ± 215	0.391
24-h drainage volume, mL	741 ± 302	682 ± 426	0.081
24-h urine output, mL	4,401 ± 1,265	3,793 ± 1,247	0.044

Abbreviation: ICU, intensive care unit.

- No significant differences in M&M between groups
- Restrictive group did receive more PCC
- Limitations
  - Retrospective
  - Small sample size

Review

Over 50 Years of Fibrinogen Concentrate

Rubens Costa-Filho, MD, FCCP[1], Gerald Hochleitner[2], Michael Wendt[3], Alexandre Teruya, MD[4], and Donat R. Spahn, MD, FRCA[5]

Clinical and Applied Thrombosis/Hemostasis
2016, Vol. 22(2) 109-114

- The first license granted for fibrinogen concentrate was in Brazil in March 1963
  - Was available prior in unregulated forms
- 1985 – Pasteurization step added for viral inactivation
  - 3 million grams have been used since
  - Available as Haemcomplettan® or RiaSTAP® (US version)

Fibrinogen Concentrate

- During major bleeding events, fibrinogen is the first clotting factor to reach critically low levels
- 1/23,300 cases of thrombotic events in post-marketing surveillance
- Purification of recombinant fibrinogen was completed in 1993
- Multiple clinical trials underway to investigate its use in major bleeding

REPLACE Trial

Randomized evaluation of fibrinogen *vs* placebo in complex cardiovascular surgery (REPLACE): a double-blind phase III study of haemostatic therapy

N. Rahe-Meyer[1,*], J. H. Levy[2], C. D. Mazer[3], A. Schramko[4], A. A. Klein[5], R. Brat[6], Y. Okita[7], Y. Ueda[8], D. S. Schmidt[9], R. Ranganath[10] and R. Gill[11]

British Journal of Anaesthesia, 117 (1): 41–51 (2016)

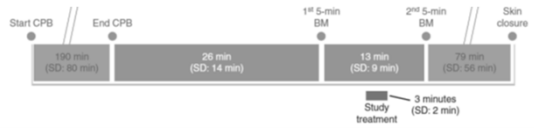
doi: 10.1093/bja/aew169

- Elective Aortic surgery randomized to fibrinogen concentrate (FCH) vs placebo

Methodology

- Phase III, multinational, multi-center, randomized, double blinded trial in 2012-2014
- Post heparin reversal bleeding 60-250 g in 5 minutes
- FCH concentrates given to target FIBTEM maximal clot firmness (MCF) of 22mm
- Standard trasnsfusion algorithm followed if bleeding continued
- 68% adherence rate in transfusion algorithm

Methodology



- 519 patients randomized
  - 367 did not meet bleeding criteria
  - 152 treated with FCH or placebo

Outcomes

- End Points: total allogenic units transfused in 24 hours
  - RBC, FFP, and platelets
- Secondary Endpoints
  - Inidividual unit types transfused
  - Need for reoperation
  - Mortality
  - Plasma fibrinogen (Clauss assay)
  - MCF – FIBTEM assay using ROTEM device

Data

- Primary outcome
  - Increased RBC and FFP use with FCH
- Secondary outcomes
  - Increased fibrinogen levels and MCF target achieved
  - No differences in periop bleeding between groups
- Wide variability between centers

CARDIOVASCULAR

Preoperative supplementation with fibrinogen concentrate in cardiac surgery: A randomized controlled study

A. Jeppsson[1,2,*], K. Waldén[3], C. Roman-Emanuel[1], L. Thimour-Bergström[1] and M. Karlsson[4]

British Journal of Anaesthesia, 116 (2): 208–14 (2016)

doi: 10.1093/bja/aev367

- 304 assessed for eligibility
- 52 enrolled
- Double blind, randomized, placebo controlled trial
- Fibrinogen did not influence bleeding

Table 2 Haemostatic variables in the fibrinogen and placebo groups at five time points before, during and after CABG. Mean (SD). Key: CPB, cardiopulmonary bypass; APTT, activated partial thromboplastin time; INR, international normalized ratio. *P<0.05, * P<0.01, **P<0.001 vs the placebo group at the same timepoint

	After induction of anaesthesia	After fibrinogen or placebo	30 min after CPB	2 h after CPB	24 h after CPB	P-value
Fibrinogen (g litre^{-1})						Group 0.004
Fibrinogen	2.8 (0.3)	3.1 (0.4)***	2.3 (0.4)*	2.3 (0.4)**	3.9 (0.7)*	Time <0.001
Placebo	2.7 (0.5)	2.5 (0.4)	2.0 (0.4)	2.0 (0.3)	3.5 (0.8)	Group×Time 0.019
Haemoglobin (g litre^{-1})						Group 0.001
Fibrinogen	143 (7)***	135 (8)***	110 (11)	111 (13)	107 (11)	Time <0.001
Placebo	131 (9)	125 (9)	105 (9)	104 (15)	100 (12)	Group×Time 0.21
Platelet count (×10^9 litre^{-1})						Group 0.17
Fibrinogen	216 (53)	215 (54)	156 (57)	170 (74)	194 (68)	Time <0.001
Placebo	195 (49)	189 (45)	144 (40)	162 (44)	171 (42)	Group×Time 0.25
APTT (s)						Group 0.048
Fibrinogen	35.9 (2.5)	34.4 (2.6)	34.5 (3.3)	35.8 (2.7)*	35.5 (3.3)	Time <0.001
Placebo	35.0 (3.6)	34.9 (3.9)	36.0 (4.4)	36.1 (3.9)	37.5 (4.7)	Group×Time 0.12
INR						Group 0.12
Fibrinogen	1.09 (0.07)	1.12 (0.07)	1.32 (0.18)	1.26 (0.14)	1.35 (0.16)	Time <0.001
Placebo	1.14 (0.10)	1.17 (0.11)	1.31 (0.13)	1.29 (0.15)	1.42 (0.20)	Group×Time 0.36

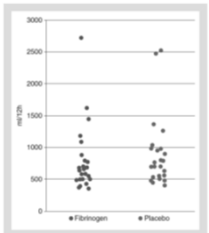


Fig 1 Postoperative blood loss volume in individual subjects. There was no significant difference in median volume between the fibrinogen and placebo groups, P=0.29.

Table 3 Bleeding and transfusions. Median (25th and 75th percentiles), mean (sd) or number (%)

	Fibrinogen (n=24)	Placebo (n=24)	P-value
Intraoperative blood loss (ml)			
Median	300 (200–400)	300 (200–500)	0.41
Mean	306 (110)	375 (203)	0.15
Postoperative blood loss (ml 12 h^{-1})			
Median	650 (500–835)	730 (543–980)	0.29
Mean	796 (523)	897 (553)	0.52
Total blood loss within 12 h (ml)			
Median	913 (815–1230)	1185 (930–1398)	0.18
Mean	1103 (518)	1272 (588)	0.30
Re-exploration for bleeding	1 (4.2%)	2 (8.4%)	0.55
Red blood cell transfusion			
Number of patients	6 (25.0%)	6 (25.0%)	1.00
Mean volume (units)	0.63 (1.17)	1.33 (3.11)	0.30
Median volume (units)	0 (0–1)	0 (0–1)	0.88
Plasma transfusion			
Number of patients	3 (12.5%)	6 (25.0%)	0.27
Mean volume (units)	0.25 (0.68)	0.58 (1.10)	0.19
Median volume (units)	0 (0–0)	0 (0–1)	0.45
Platelet transfusion			
Number of patients	2 (8.3%)	4 (16.6%)	0.38
Mean volume (units)	0.17 (0.48)	0.29 (0.70)	0.47
Median volume (units)	0 (0–0)	0 (0–0)	0.47
Any allogeneic transfusion			
Number of patients	8 (33.3%)	7 (29.2%)	0.76
Mean volume (units)	1.04 (2.1)	2.29 (4.47)	0.22
Median volume (units)	0 (0–2)	0 (0–3)	0.58

Efficacy and Safety of Fibrinogen Concentrate in Surgical Patients: A Meta-Analysis of Randomized Controlled Trials

Evgeny Fominskiy, MD, PhD,*† Valeriy A. Nepomniashchikh, MD, PhD,† Vladimir V. Lomivorotov, MD, PhD,† Fabrizio Monaco, MD,* Chiara Vitiello, MD,* Alberto Zangrillo, MD,*‡ and Giovanni Landoni, MD*‡

Journal of Cardiothoracic and Vascular Anesthesia, Vol 30, No 5 (October), 2016: pp 1196–1204

Objectives: To investigate the efficacy and safety of fibrinogen concentrate (FC) in surgical patients.

Design: Meta-analysis of randomized controlled studies (RCTs).

Setting: Perioperative.

Participants: Adult and pediatric surgical patients.

Interventions: A search of PubMed/Medline, Embase, Cochrane Central Register of Controlled Trials, Transfusion Evidence Library, Google Scholar, and the proceedings from major international anesthesiology meetings up to February 1, 2016 for RCTs that compared FC with placebo or other comparators.

Measurements and Main Results: The primary outcome was all-cause mortality. Pooled risk ratios and mean differences (MDs) were computed with either fixed-effects or random-effects models. The study included 14 RCTs comprising 1,035 patients; the majority of patients underwent cardiac surgery. All-cause mortality was lower in the fibrinogen group (4/432 [0.9%] v 15/430 [3.5%]; risk ratio 0.26; 95% confidence interval [CI] 0.09-0.78; $p = 0.02$; heterogeneity statistic $I2 = 0\%$). The use of FC was associated with reduced bleeding (MD −127 mL; 95% CI −207 to −47; $p = 0.002$; $I2 = 54\%$) and a lower number of red blood cells units transfused versus comparator (MD −0.9; 95% CI −1.3 to −0.5; $p < 0.001$; $I2 = 42\%$). There were no differences in the rates of thrombotic events and myocardial infarction.

Conclusions: In surgical patients, FC was associated with reduced bleeding and a lower number of red blood cell units transfused, and it also might reduce mortality. However, none of the analyzed trials was powered for estimation of survival and adverse events with FC use. Half of the included studies were of high or moderate risk of bias. The evidence primarily came from cardiac surgery settings.

KEY WORDS: surgery, hemorrhage, fibrinogen, efficacy, safety

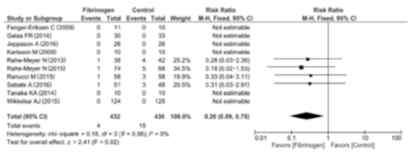


Fig 2. Forest plot for all-cause mortality. Mantel-Haenszel method (M-H).

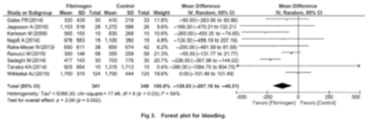


Fig 3. Forest plot for bleeding.

Immediate postoperative extubation in bilateral lung transplantation: predictive factors and outcomes†

M.-L. Felten[1,6], J.-D. Moyer[1,6], J.-F. Dreyfus[2], J.-Y. Marandon[1,6], E. Sage[3,6], A. Roux[4,6], F. Parquin[3,6], C. Cerf[5], B. Zuber[7], M. Le Guen[1,6] and M. Fischler[1,6,*], the Foch Lung Transplant Group

British Journal of Anaesthesia, 116 (6): 847–54 (2016)

doi: 10.1093/bja/aew119

- 89 Bilateral Lung Transplant (BLT) for patients with cystic fibrosis over 6 years
- Excluded pre-op ECMO, redo transplants, *ex vivo* lung reconditioning, and multiorgan transplants
- CPB was used if required

Table 1 Anaesthesia technique and local extubation guidelines. ECMO, extracorporeal membrane oxygenation; F_{IO_2}, fraction of inspired oxygen; ICU, intensive care unit; INO, inhaled nitric oxide; OR, operating room; Pa_{CO_2}, arterial partial pressure of carbon dioxide; Pa_{O_2}, arterial partial pressure of oxygen

Anaesthesia technique	Evaluation at the end of surgery	Evaluation at the end of the non-invasive ventilation attempt
Hot air warming blanket Epidural catheter: levobupivacaine 0.125% and sufentanil 0.25 μg ml^{-1} infusion at 5 ml h^{-1} Norepinephrine 0.2 μg kg^{-1} min^{-1} Propofol and remifentanil according to the bispectral index (target range 40–60); atracurium for neuromuscular block Bilateral and selective lung ventilation with a left-sided double-lumen tube positioned under bronchoscopic guidance Tidal volume of 6–8 ml kg^{-1} during double-lung ventilation and 4 ml kg^{-1} during one-lung ventilation; 15–20 breaths min^{-1}; F_{IO_2} adjusted to arterial blood gas results; systematic INO Broad-spectrum antibiotics according to the recipient cultures; immunosuppression Routine monitors, arterial catheter, oximetric pulmonary arterial catheter (Swan–Ganz CCO/Mixed venous oxygen saturation (Sv_{O_2}) catheter; Edwards Lifesciences Corp., Irvine, CA, USA), bispectral index monitoring (Aspect A-2000 XP, version 3.11; Aspect Medical Systems, Newton, MA, USA), transoesophageal echocardiography (Vivid 7; GE Healthcare, Fairfield, CT, USA)	Double-lumen tube changed to a single-lumen tube; fibreoptic bronchoscopy Tidal volume of 6–8 ml kg^{-1}; rate of ventilation according to Pa_{CO_2}; F_{IO_2} between 60 and 100% according to Arterial oxygen saturation (Sa_{O_2}) Arterial blood gas analysis: Pa_{O_2}/F_{IO_2} <13.3—ECMO; Pa_{O_2}/F_{IO_2} >13.3–40—continuation of mechanical ventilation; Pa_{O_2}/F_{IO_2} >40—extubation protocol if other requirements are fulfilled (no visible pulmonary oedema; no need for INO; Pa_{CO_2} <6.7 kPa; lactate <3 mmol litre^{-1}; Sv_{O_2} >65%; haemoglobin >10 g dl^{-1}; temperature >36°C; haemodynamic stability; low vasoactive drug needs; no coagulation issues; no significant bleeding seen in the chest tubes) No extubation in the OR in event of unfavourable evaluation (E-ICU group) Extubation protocol in event of favourable evaluation: antagonism of neuromuscular block; end of propofol and remifentanil; semi-sitting position; extubation; non-invasive ventilation in the operating room for 20 min using a face mask and a Respironics ventilator (Philips Healthcare, The Netherlands) with bi-level positive airway pressures: inspiratory and expiratory airway pressures of 8 and 4 cm H_2O, respectively, with an F_{IO_2} of 1	Success of the non-invasive ventilation attempt if the patient is well orientated, pain free, and with no clinical sign of acute respiratory distress, and if Pa_{O_2}/F_{IO_2} ratio >26.6 kPa and Pa_{CO_2}<6.7 kPa (arterial blood gas checked after 20 min)—patients transferred to ICU on a high-concentration oxygen face mask (E-OR group) Failure of the non-invasive ventilation attempt: reintubation and transfer to ICU (E-ICU group)

Table 3 Intraoperative data. Data are expressed as numbers (percentages) or medians [25th–75th percentile] and are compared using Fisher's exact test or the Mann–Whitney U-test. ECMO, extracorporeal membrane oxygenation; E-ICU, extubation in the intensive care unit; E-OR, extubation in the operating room; FFP, fresh frozen plasma; RBCs, red blood cells

		E-OR group (n=41)	E-ICU group (n=48)	P-value
Thoracic epidural [n (%)]		38 (92.7)	37 (77)	0.08
Anaesthetic induction complications [n (%)]		4 (9.7)	6 (12.5)	0.75
Anaesthetic maintenance complications before incision [n (%)]		9 (21.9)	12 (25)	0.81
First graft	Ventilation complications [n (%)]	9 (21.9)	19 (39.6)	0.11
	Pulmonary artery cross-clamping complications [n (%)]	13 (31.7)	20 (41.7)	0.38
	Pulmonary artery unclamping complications [n (%)]	10 (24.4)	15 (31.2)	0.49
	Ischaemic time (min)	240.0 [162.5–290.0]	240.0 [171.7–297.5]	0.54
Second graft	Ventilation complications [n (%)]	3 (7.3)	23 (47.9)	<0.001
	Pulmonary artery cross-clamping complications [n (%)]	4 (9.76)	19 (39.6)	0.001
	Pulmonary artery unclamping complications [n (%)]	9 (21.9)	18 (37.5)	0.17
	Ischaemic time (min)	345.0 [282.5–392.5]	360.0 [303.2–433.5]	0.17
End of surgery	Ventilation complications [n (%)]	3 (7)	33 (69)	<0.001
	ECMO [n (%)]	7 (17)	20 (42)	0.02
	RBCs (ml kg^{-1})	20.0 [13.5–29.5]	26.0 [20.0–38.7]	0.01
	FFP (ml kg^{-1})	18.0 [9.5–27.5]	21.0 [15.0–31.0]	0.23
	Colloid (ml kg^{-1})	30.0 [19.5–36.0]	35.0 [24.0–47.0]	0.01
	Crystalloid (ml kg^{-1})	26.0 [19.5–35.0]	27.0 [20.0–34.7]	0.90
	Patients receiving platelets [n (%)]	3 (7)	12 (25)	0.04
	Lactataemia (mmol litre^{-1})	2.3 [1.6–2.9]	2.8 [1.82–3.6]	0.03