# Improvements in blood usage in hip/knee replacement over 20 years

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# Question

- Is it possible to have a zero transfusion rate for primary hip and knee replacements?

# Hip/Knee replacements in 1988

- Maintain Hb at pre-op level
- Transfuse TKR during op
  - Torniquet

# Solcotrans

- Reinfusion device for TKR
- Post-operative blood salvage

# Transfusion rates in THR

- 1992/1993
- Bridge of Earn hospital
- Hypotensive anaesthetic
- No cell salvage
- 30% transfusion rate

# Methods of blood conservation

- Pre-operative autologous donation
- Acute normovolaemic haemodilution
- Autologous reinfusion (Cell salvage)

# Pre-operative Autologous Donation

- Advantages
  - Can provide up to 4 units of blood
  - Risk of viral transfusion & immunologically mediated transfusion reaction eliminated
  - No immune modulation

# Pre-operative Autologous Donation

- Disadvantages
  - Difficult logistics with high risk of clerical error
  - Difficult to collect blood if surgery scheduled at short notice
  - Some patients may not be able to tolerate donation

# Acute normovolaemic haemodilution

- Advantages
  - Inexpensive
  - Blood always with patients so fewer clerical errors
  - Produces whole blood with platelets & clotting factors
  - Lower haematocrit so dilute blood lost

# Acute normovolaemic haemodilution

- Disadvantages
  - Acute & significant drop in haematocrit
  - Physiological effects of acute haemodilution

# Cell salvage

- Involves collection of blood from surgical field
- Can be carried out intra-operatively or post-operatively
- Salvaged blood either filtered or washed and processed for transfusion back to patient

# Cell salvage

- Advantages
  - ↓ risk of infection
  - ↓ risk of transfusion reaction
  - Safer in patients with rare blood groups & multiple antibodies
  - No immunosuppression
  - ? Acceptable to Jehovah's Witnesses
  - ↓ demand for allogenic blood products

# Cell salvage

- Disadvantages
  - ↑ cost- setup cost including staff training
  - Unused blood wasted
  - ↑ risk of bacterial contamination

# Cell salvage

- 3 main techniques
  - Blood collected into from suction into reservoir canisters. Processed in batches of 1000ml producing blood for reinfusion. Repeated when enough blood collected
  - Semi-continuous system where blood is simultaneously scavenged, anticoagulated & washed. Smaller quantities can be processed
  - Single use reservoir bags, attached to surgical drains to collect blood after operation

# Other Methods

- Transfusion trigger
- Hb limit?
- Ferritin limit?
- Pre-operative oral iron
- Total body iron transfusion
- Erythropoietin
- Tranexamic acid

# Transfusion trigger

- 8g/dl
- Education of junior doctors and nurses

# Hb limit

- Higher Hb less likely to be transfused
- General Practitioner's don't assess patients adequately
- Short waiting list
- Time between pre-assessment and surgery
- Patient cancelled after going on waiting list

# Ferritin

- Don’t operate on patients with ferritin <100?
- Chesterfield 1 month audit of 52 patients
- 65% of THR/TKR had ferritin <100

# Pre-op iron

- All patients given ferrous sulphate at pre-assessment
- No pre/post audit done
- Short time from pre-assessment to surgery
- Give it in clinic?

# Total body iron transfusion

- Increase iron stores pre-op
- Doesn't appear to have rapid effect on Hb

# Erythropoietin

- Expensive

# TRANEXAMIC ACID PROVIDES SIGNIFICANT COST BENEFIT AND REDUCED BLOOD LOSS IN PRIMARY HIP AND KNEE ARTHROPLASTY

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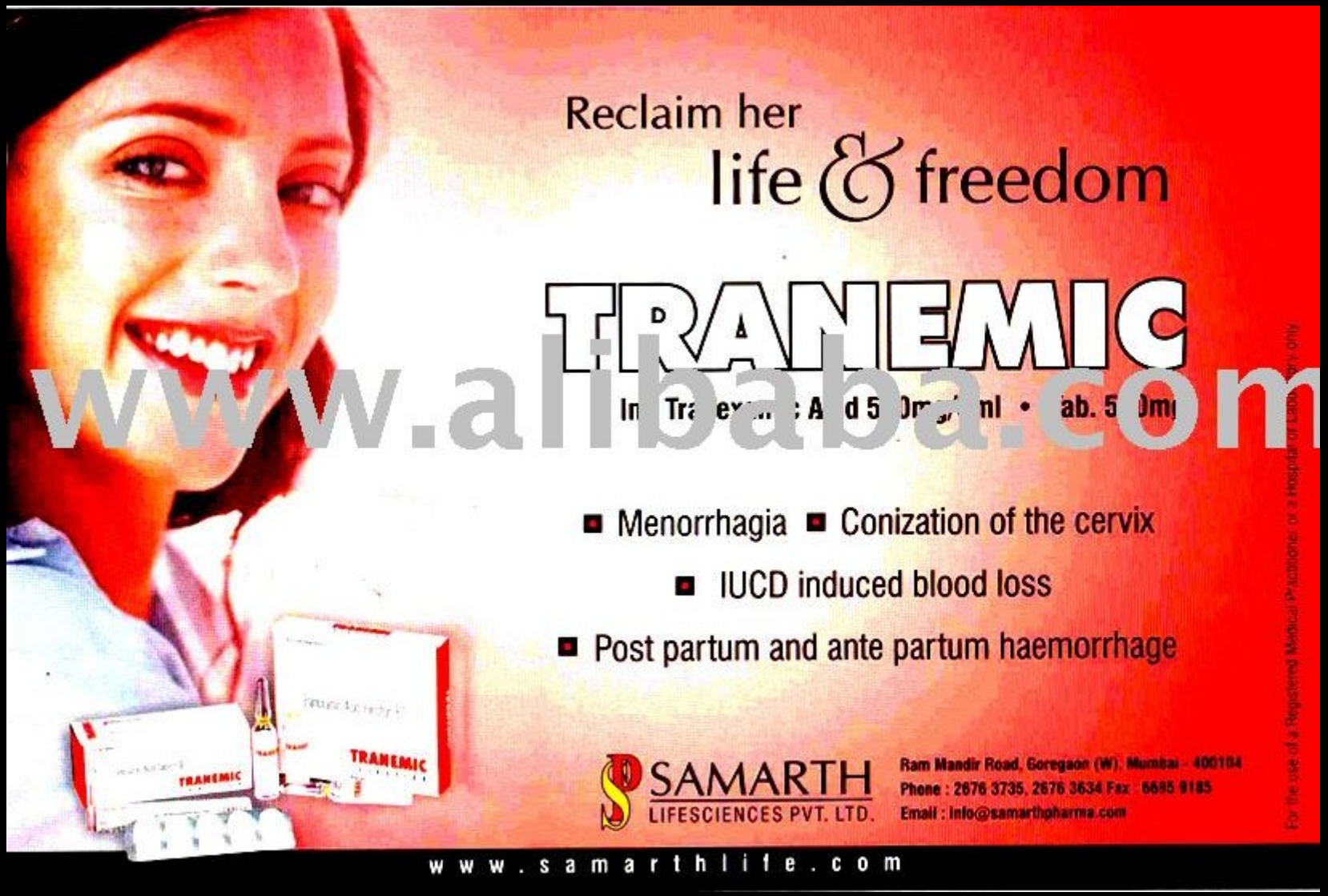
No experience

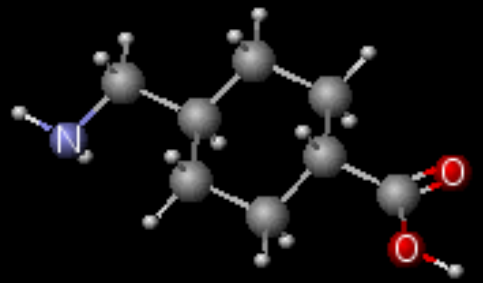


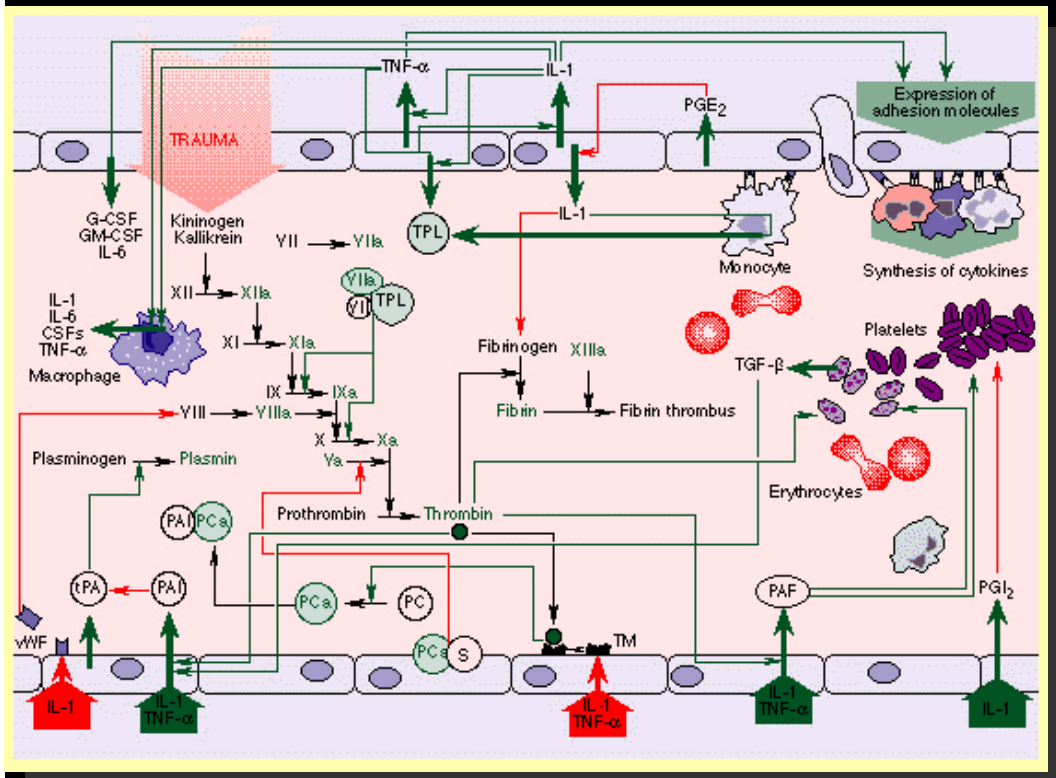
# Methods

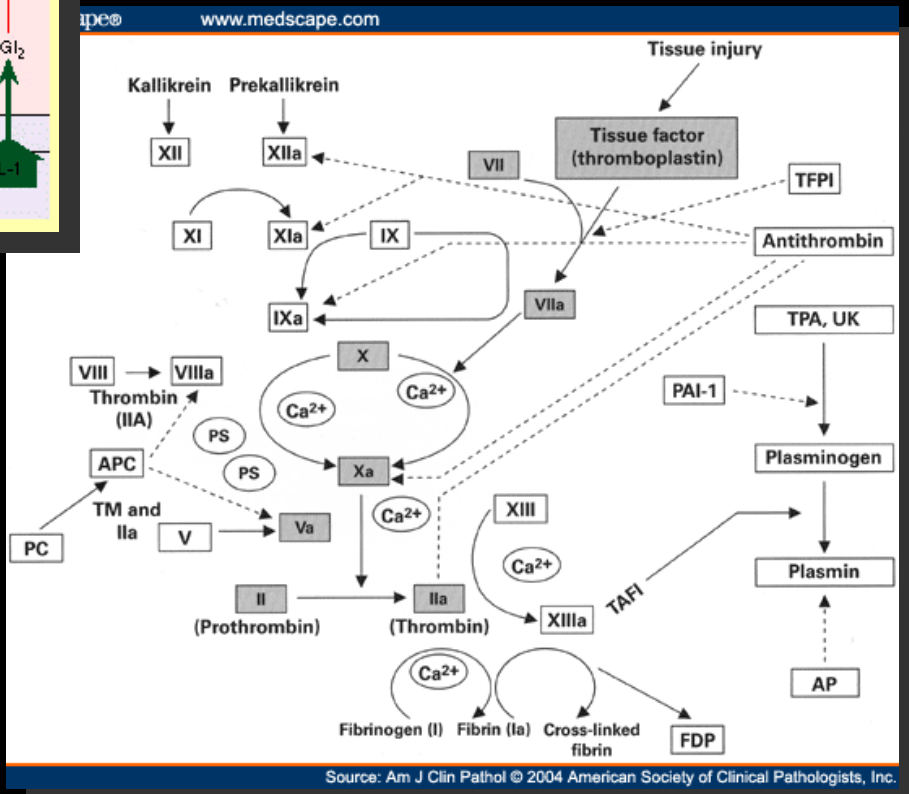
- 100 patients
- All primary arthroplasy
- Single Consultant
- All knees computer navigated
  - PFC Sigma cemented Knee - Depuy
  - Knee drains – autologous transfusion drains
- Hips - cemented Charnley

# What is it

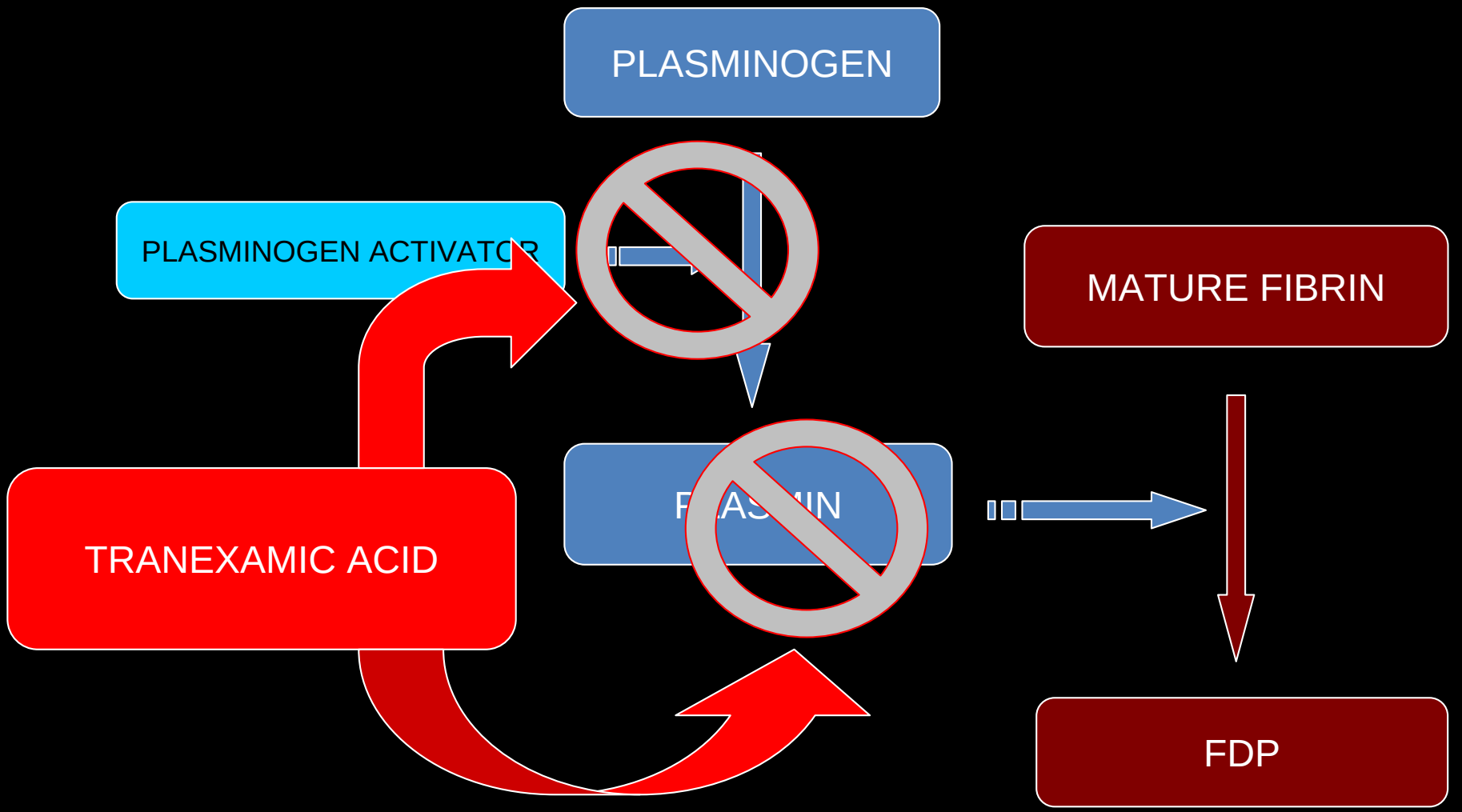
- Fibrinolytic inhibitor
- Inhibits plasminogen activation
  - Inhibits plasmin directly in high doses
- No effect on primary coagulation




TRAUMA
TNF-α
IL-1
PGE2
Expression of adhesion molecules
G-CSF
GM-CSF
IL-6
Kininogen
Kallikrein
VII → VIIa
TPL
IL-1
Monocyte
Synthesis of cytokines
XII → XIIa
VIIa
VII
TPL
IL-1
IL-6
CSFs
TNF-α
Macrophage
XI → XIa
Fibrinogen
XIIIa
Platelets
TGF-β
IX → IXa
Fibrin
Fibrin thrombus
VIII → VIIIa
X → Xa
Va
Plasminogen → Plasmin
Prothrombin → Thrombin
Erythrocytes
PAI
PCa
tPA
PAI
PCa
PC
PAF
PGI2
vWF
PCa
S
TM
IL-1
IL-1
TNF-α
IL-1
TNF-α
IL-1


www.medscape.com
Tissue injury
Kallikrein
Prekallikrein
XII
XIIa
Tissue factor (thromboplastin)
VII
TFPI
XI
XIa
IX
Antithrombin
IXa
VIIa
TPA, UK
VIII
VIIIa
Thrombin (IIA)
X
Ca2+
Ca2+
PAI-1
PS
PS
APC
Xa
Plasminogen
TM and IIa
V
Va
Ca2+
XIII
PC
Ca2+
Plasmin
II
(Prothrombin)
IIa
(Thrombin)
XIIIa
TAFI
AP
Ca2+
Fibrinogen (I)
Fibrin (Ia)
Cross-linked fibrin
FDP
Source: Am J Clin Pathol © 2004 American Society of Clinical Pathologists, Inc.

# Fibrinolysis



# Background

- Good evidence for efficacy in TKR
  - 10x reduction in ‘transfusion risk’
- Weaker evidence in THR
  - Small RCT’s
- Dosing / timing of administration inconsistent
- Limited evidence focused on cost-benefit
- No evidence of increased thromboembolism

# Our Study

- Assess effectiveness in TKR and THR
  - Post op Hb
  - Tranfusion requirement
  - Reinfusion drainage in TKR
- Cost

# Methods

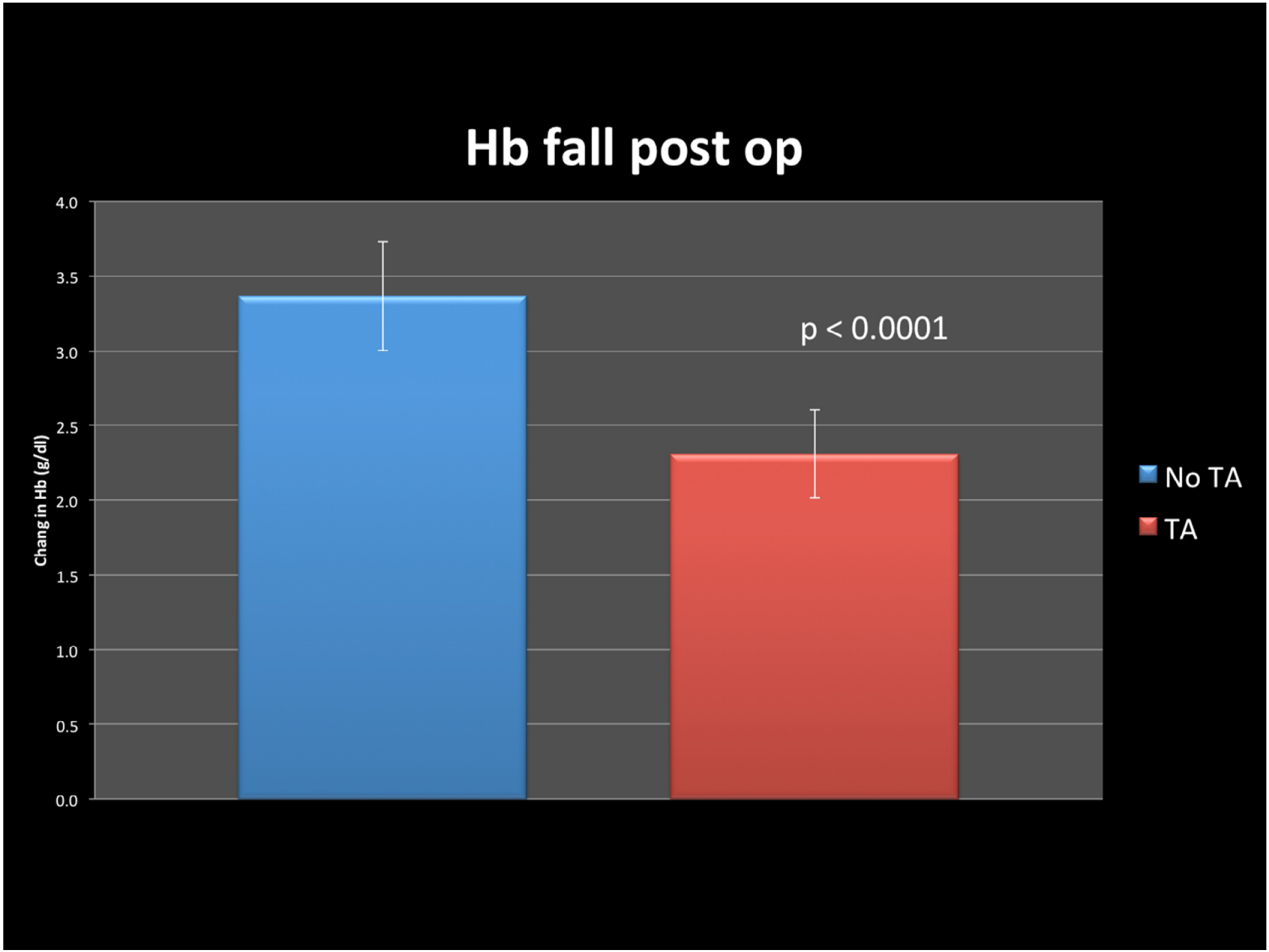
- Treatment group
  - Prospective cohort 50 consecutive TKR and THR
  - 1g IV Tranexamic – pre-op + 8 + 16hrs post op.
- Control group
  - 50 previous TKR and THR

# Contra-indications

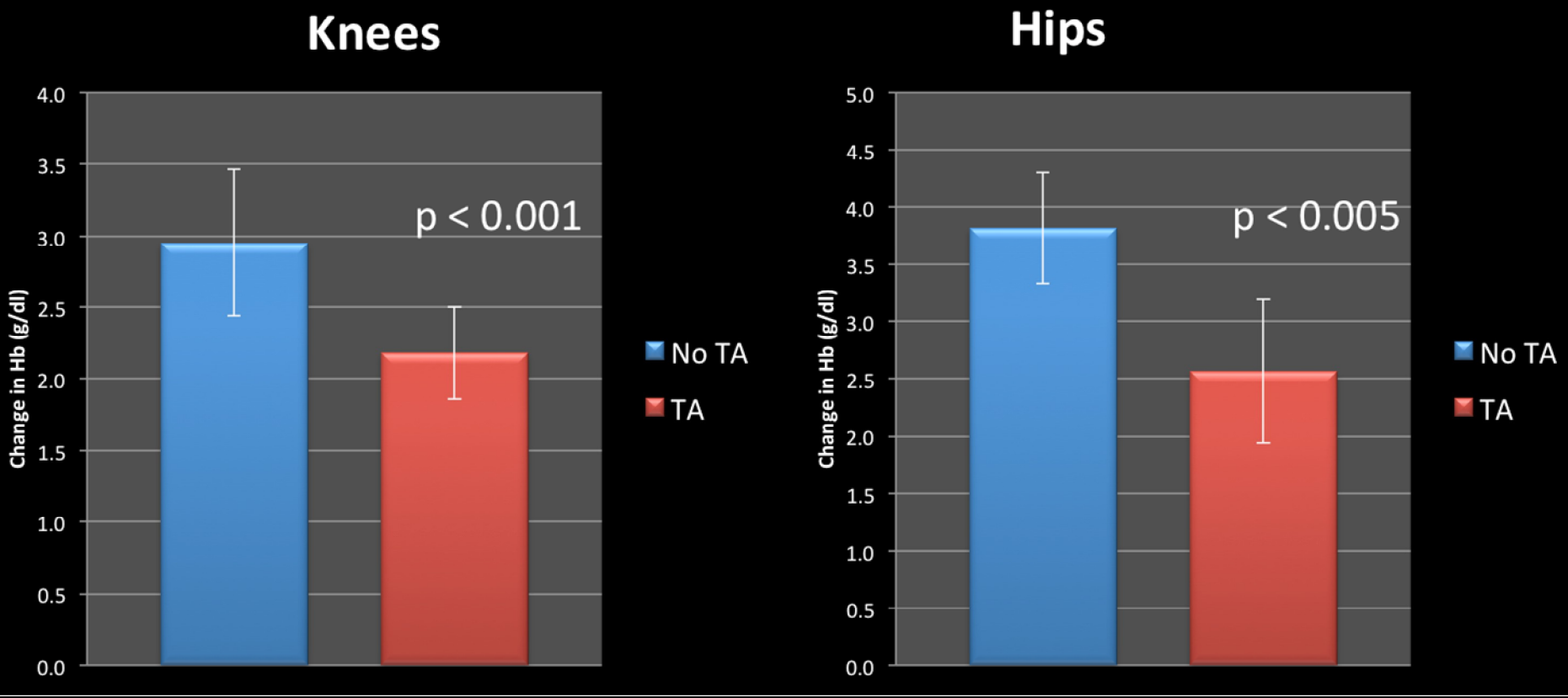
- Previous DVT/PE
- Previous CVA
  - TIA okay
  - Carotid stenosis
- Cardiac stent

# Results

| means | Control<br>24 hips / 26 knees | Treatment<br>17 hips / 33 knees |
|---|---|---|
| Age (p=0.72) | 71 | 72 |
| BMI (p=0.25) | 30 | 31 |
| ASA | 2 | 2 |
| Torniquet time (p=0.17) | 1hr19 | 1hr24 |
| Pre-op Hb (p=0.74) | 13.3 | 13.3 |
| Mean hospital stay (days) | 7 (3-16) | 7 (4-15) |

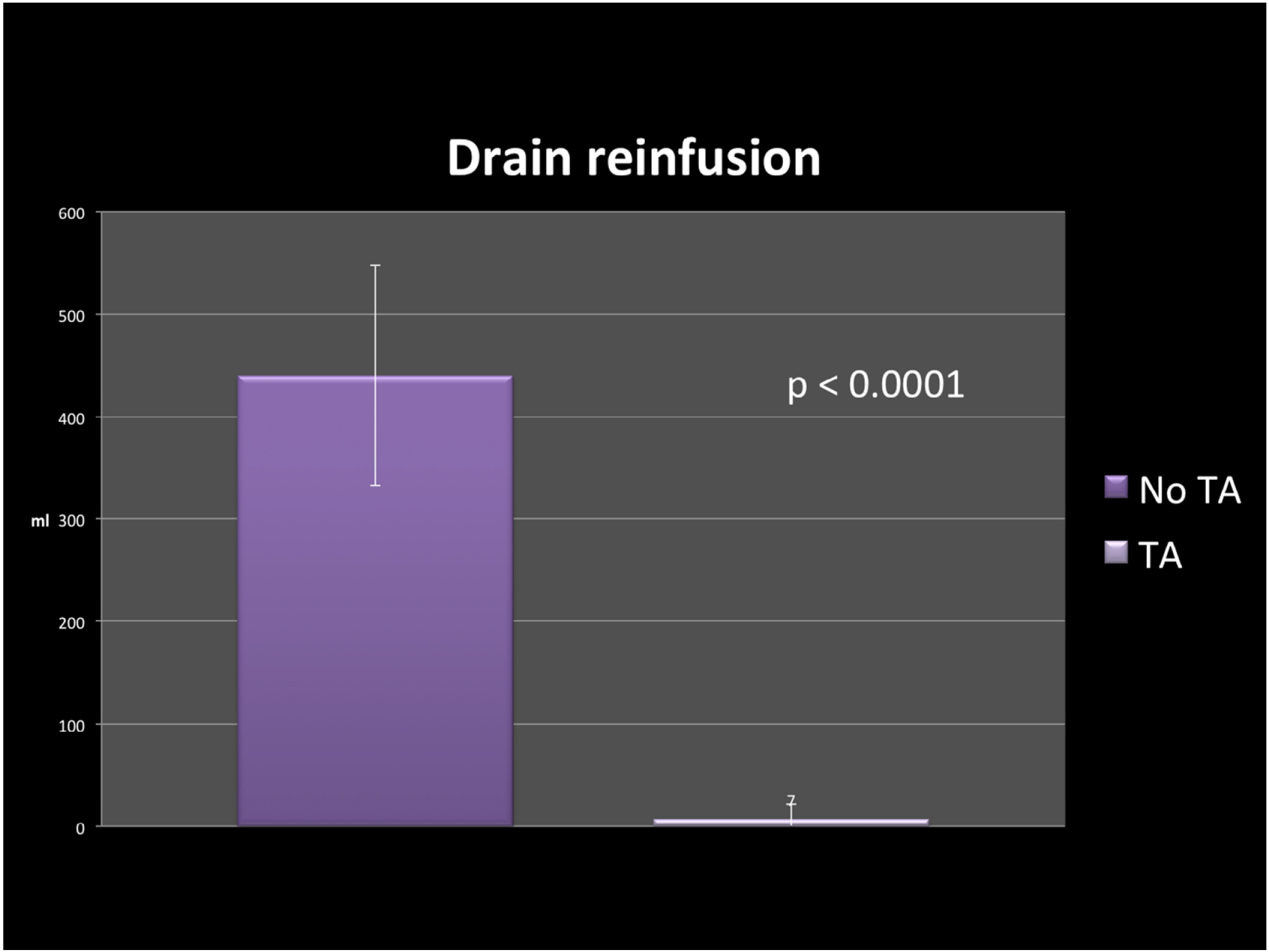

Hb fall post op
Chang in Hb (g/dl)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
p < 0.0001
No TA
TA

# HB Fall


Knees
Change in Hb (g/dl)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
p < 0.001
No TA
TA
Hips
Change in Hb (g/dl)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
p < 0.005
No TA
TA

# Post Op Transfusion

| | Control patients<br>14 units total | Tranexamic patients<br>5 units total |
|---|---|---|
| Overall | 14% (7) | 4% (2) |
| Knees | 8% | 0% |
| Hips | 21% | 12% |


Drain reinfusion
600
500
400
300
200
100
0
ml
p < 0.0001
No TA
TA

# Cost

- Saving £102.51/ patient

| | Control | Treatment |
|---|---|---|
| Tranexamic Acid | £0 | £9.25 |
| Blood | £37.80 | £13.50 |
| Reinfusion drains | £87.46 | £0 |
| TOTALS | £125.26 | £22.75 |
| | SAVING | £102.51 |

# Cost

- Saving €117.89/ patient

| | Control | Treatment |
|---|---|---|
| Tranexamic Acid | €0 | €10.64 |
| Blood | €43.47 | €15.52 |
| Reinfusion drains | €100.58 | €0 |
| TOTALS | €144.05 | €26.16 |
| | SAVING | €117.89 |

# Thromboembolism

- 1 DVT in Treatment group
  - 4 weeks post op
  - Despite tinzaparin

# Limitations

- Retrospective control group
- More knees in treatment group
- Drains comprise large proportion of cost saving
- Thromboembolism presenting elsewhere

# Conclusions

- Considerable Cost-Benefit
  - £102.51 per patient
- Significant improvement in post op Hb
  - Drop 3.4 vs 2.3 g/dl
- Reduced transfusion requirement
  - 14% vs 4%

# Conclusions

- Negates need for reinfusion drains
- No clear increase in thromboembolism
- Better evidence for dosing required

# Progress

- December 2009 international shortage of IV Tranexamic acid
- Post op doses oral
- Audit 75 patients with 1 dose IV, 2 doses oral
  - 1 patient transfused
- Now all doses oral

# Current practice

- Minimal General Practitioner assessment of fitness
- No tests when placed on waiting list
- Accept Hb>10g/dl at pre-assessment
- Oral iron at pre-assessment
- 3 oral doses tranexamic acid

# Question

- Is it possible to have a zero transfusion rate for primary hip and knee replacements?

- Not quite
- But a transfusion rate of 1-2% is very realistic