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Data Driven Methods for Predicting Blood Transfusion Needs in Elective Surgery

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Content

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 - What is patient blood management
 - How are transfusion needs currently predicted
- Methods
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 - Predictive modelling pipeline
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 - Transfused erythrocyte volume
- Discussion

Blood Transfusion – Pros and Cons

 lifesaving procedure

 various indications

■ surgical procedures, etc.

 Substant

 Severe a

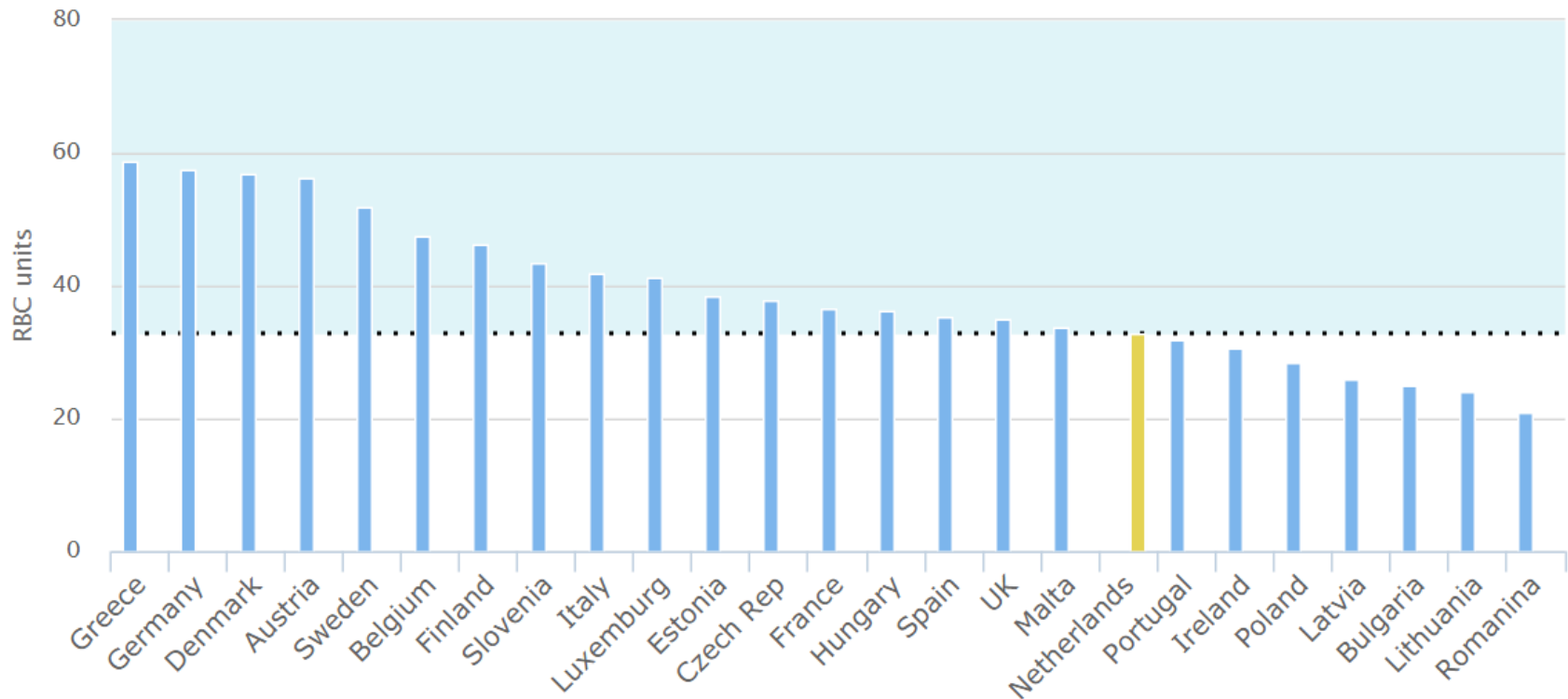
■ infections, immunologic reactions, etc.

Anthes E.
 Evidence-based medicine:
Save blood, save lives.
 Nature. 2015 Apr 2;520(7545):24-6.

➔ transfusions should be limited to the necessary volume

Blood Transfusion in Europe

RBC consumption per 1000 population

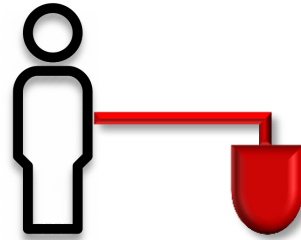


RBC....red blood cells

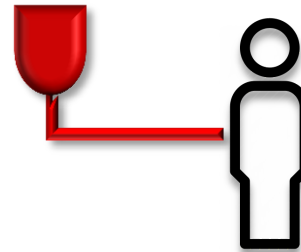
European Commission, "An EU-wide overview of the market of blood, blood components and plasma derivatives focusing on their availability for patients," April 2015. [Online]. Available: http://ec.europa.eu/health/blood_tissues_organs. [Accessed March 2016].

Patient Blood Management

- Donor blood management



- Patient blood management

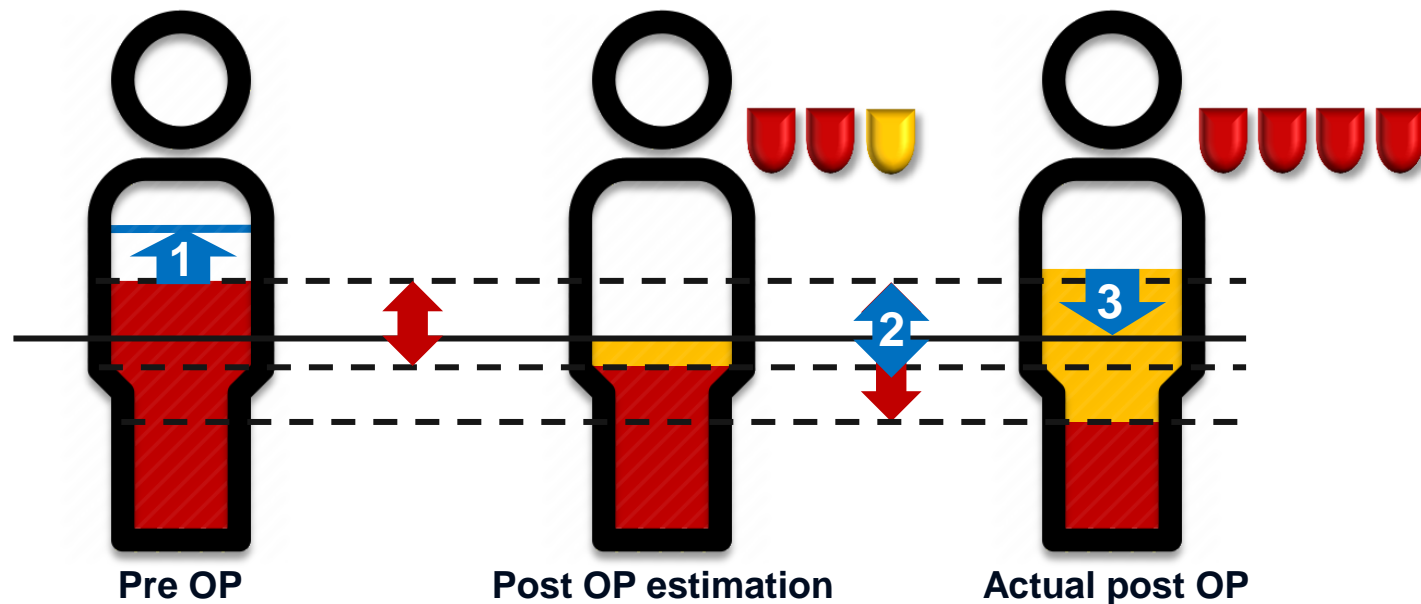


- Three pillars of patient blood management
 1. optimization of blood volume and red cell mass **prior** surgery
 2. minimization of blood loss **during** surgery
 3. optimization of the patient's tolerance of anemia **during** surgery



Prediction of Blood Transfusion Needs – Background

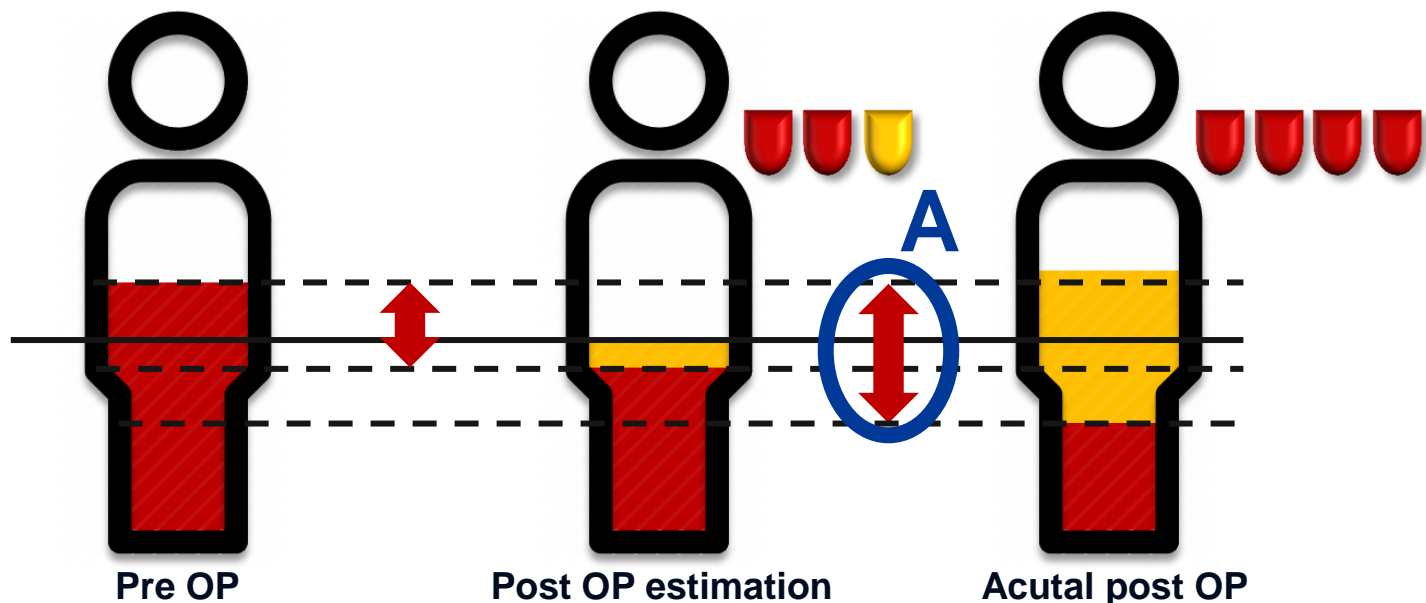
- Guidelines for blood component ordering prior surgery with expected high blood loss
 - Determine patient's actual erythrocyte volume
 - Determine average lost erythrocyte volume for planned surgery at your hospital
 - Define lower limit of tolerated erythrocyte volume for your patient
 - Determine the amount of erythrocyte volume to be ordered
- Post OP – Actual erythrocyte volume
 - ordered
 - lost
 - transfused



Research Question A

Individual prediction of erythrocyte volume lost

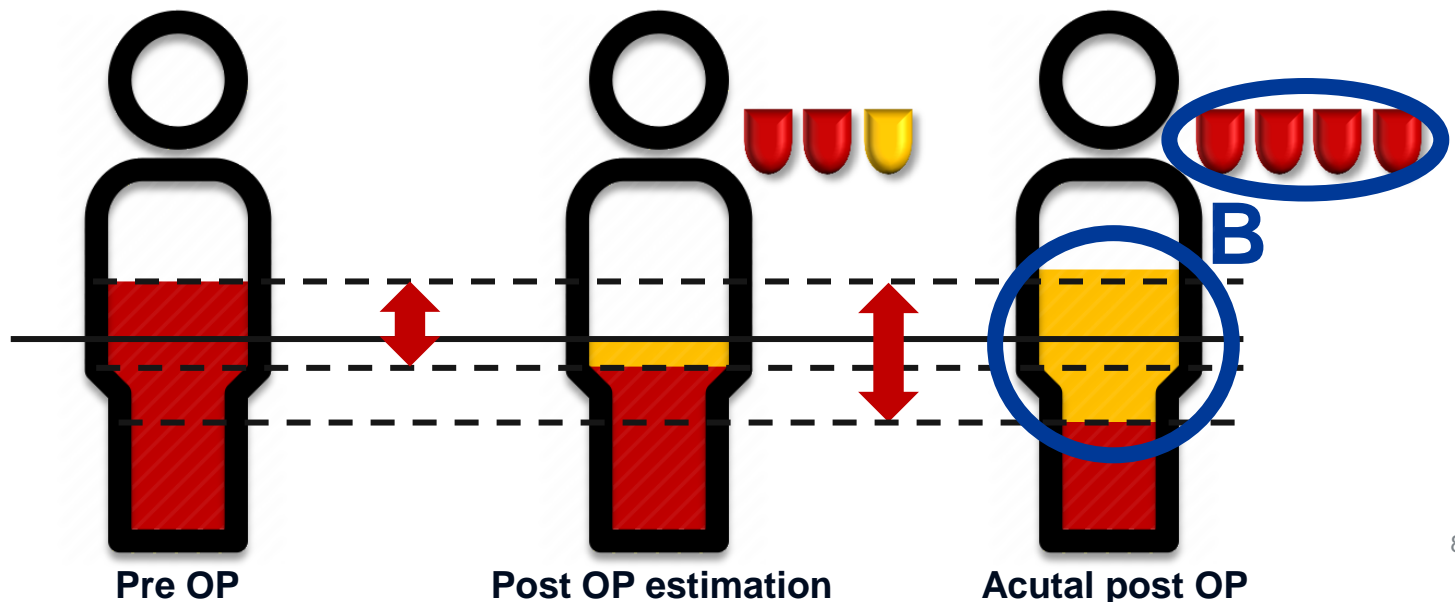
- Currently based on
 - historic data from the respective center
- Improve prediction by including
 - Demographic patient data
 - Current patient data (e.g. laboratory, body weight, etc.)



Research Question B

Individual prediction of erythrocyte volume transfused

- Based on
 - Demographic patient data
 - Historic data from the respective center
 - Current patient data (e.g. laboratory, body weight, etc.)



Methods – Dataset

- Data from two Austrian Patient Blood Management trials
 - H. Gombotz, P. H. Rehak, A. Shander, and A. Hofmann
Blood use in elective surgery: the Austrian benchmark study
Transfusion, vol. 47, pp. 1468-80, Aug 2007.
 - H. Gombotz, P. H. Rehak, A. Shander, and A. Hofmann,
The second Austrian benchmark study for blood use in elective surgery: results and practice change
Transfusion, vol. 54, pp. 2646-57, Oct 2014.
- 6,530 case records
- 16 centers (408 \pm 222 records per center, min 164, max 907)
- Elective surgeries
 - total hip replacement
 - total knee replacement
 - coronary artery bypass grafting
- 44 features from historic data, pre-op, intra-op and post op

Description	Hist. LEV	Hist. TEV	Pre	Pre + ordered	Intra	Post
center number	1	1	1	1	1	1
type of surgery	1	1	1	1	1	1
Historic mean LEV per center and type of surgery	1		1	1	1	1
Historic mean TEV per center and type of surgery		1	1	1	1	1
gender			1	1	1	1
aggregation inhibitors			1	1	1	1
type of aggregation inhibitors			1	1	1	1
surgical technique			1	1	1	1
preoperative anemia			1	1	1	1
preoperative Hb > normal value			1	1	1	1
preoperative Hb category			1	1	1	1
preoperative Hb			1	1	1	1
Hbpre as percentage of WHO-anemia limit			1	1	1	1
preoperative Hct			1	1	1	1
preoperative circulating ery-volume			1	1	1	1
age			1	1	1	1
body mass index			1	1	1	1
body weight			1	1	1	1
body surface area			1	1	1	1
blood volume			1	1	1	1
total number of PRBC ordered				1	1	1
tranexamic acid					1	1
ASA-Score					1	1
duration of surgery					1	1
Euroscore					1	1
number of bypasses					1	1
extracorporeal circulation (ECC) used					1	1
duration of ECC					1	1
cell saver volume					1	1
cell saver ery-volume					1	1
cell saver used					1	1
unwashed shed blood					1	1
type of anaesthesia					1	1
regional anaesthesia only					1	1
Hb at the end of surgery					1	1
type&screen					1	1
Hb on postoperative day 3						1
Hb on postoperative day 5						1
min of all documented perioperative Hb-values						1
Hb3 as percentage of WHO anemia limit						1
Hb5 as percentage of WHO anemia limit						1
Hbmin as percentage of WHO anemia limit						1
Hct on postoperative day 3						1
Hct on postoperative day 5						1

Historic data
(lost and transfused)

pre OP data

General patient data
(age, weight, etc.)

Labor data

Blood ordered

OP data

post OP labor data

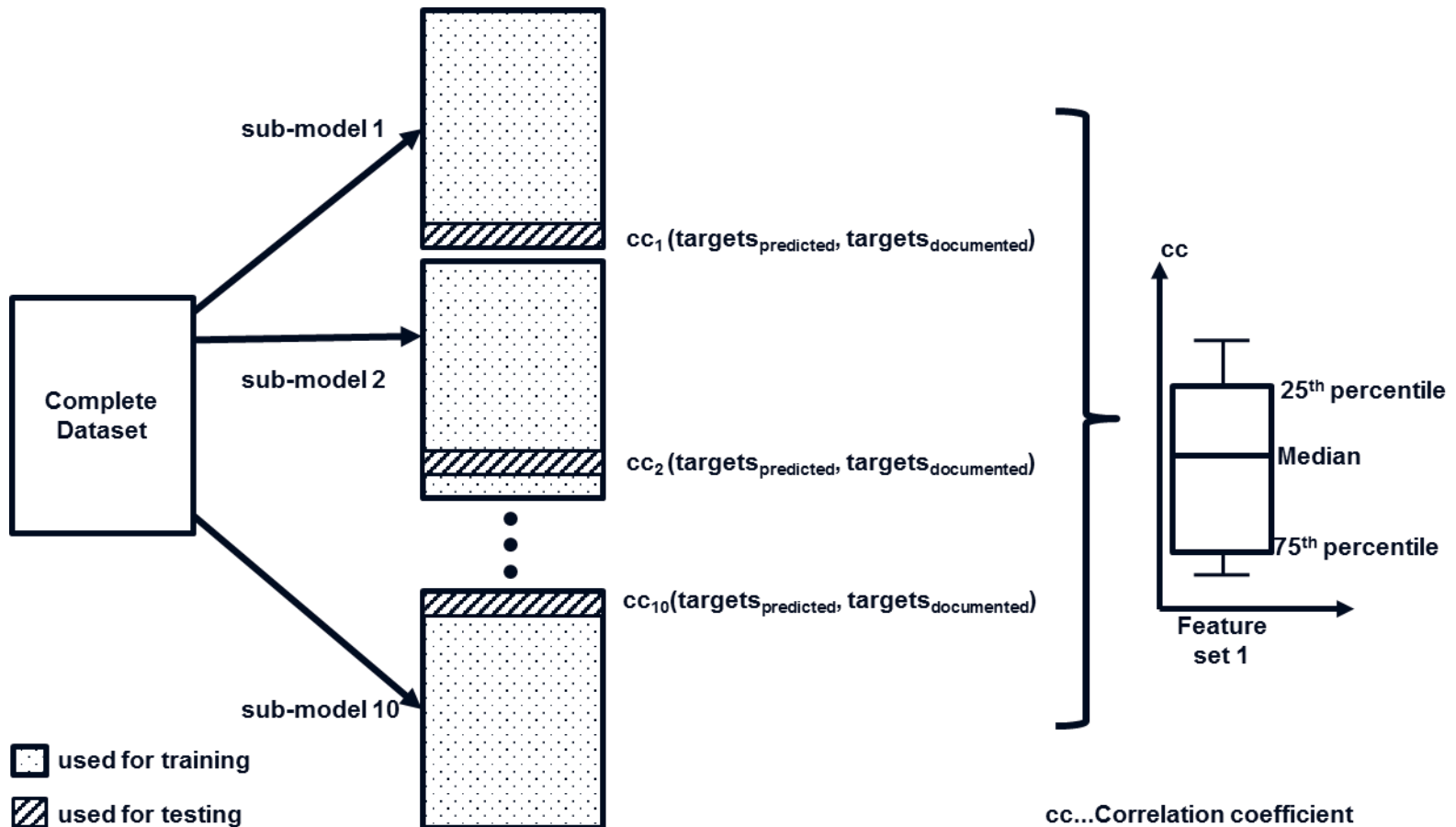
Methods – Predictive Modelling

- XLSX-Files for specification of
 - Source data
 - Features
 - Models
 - Evaluation procedure

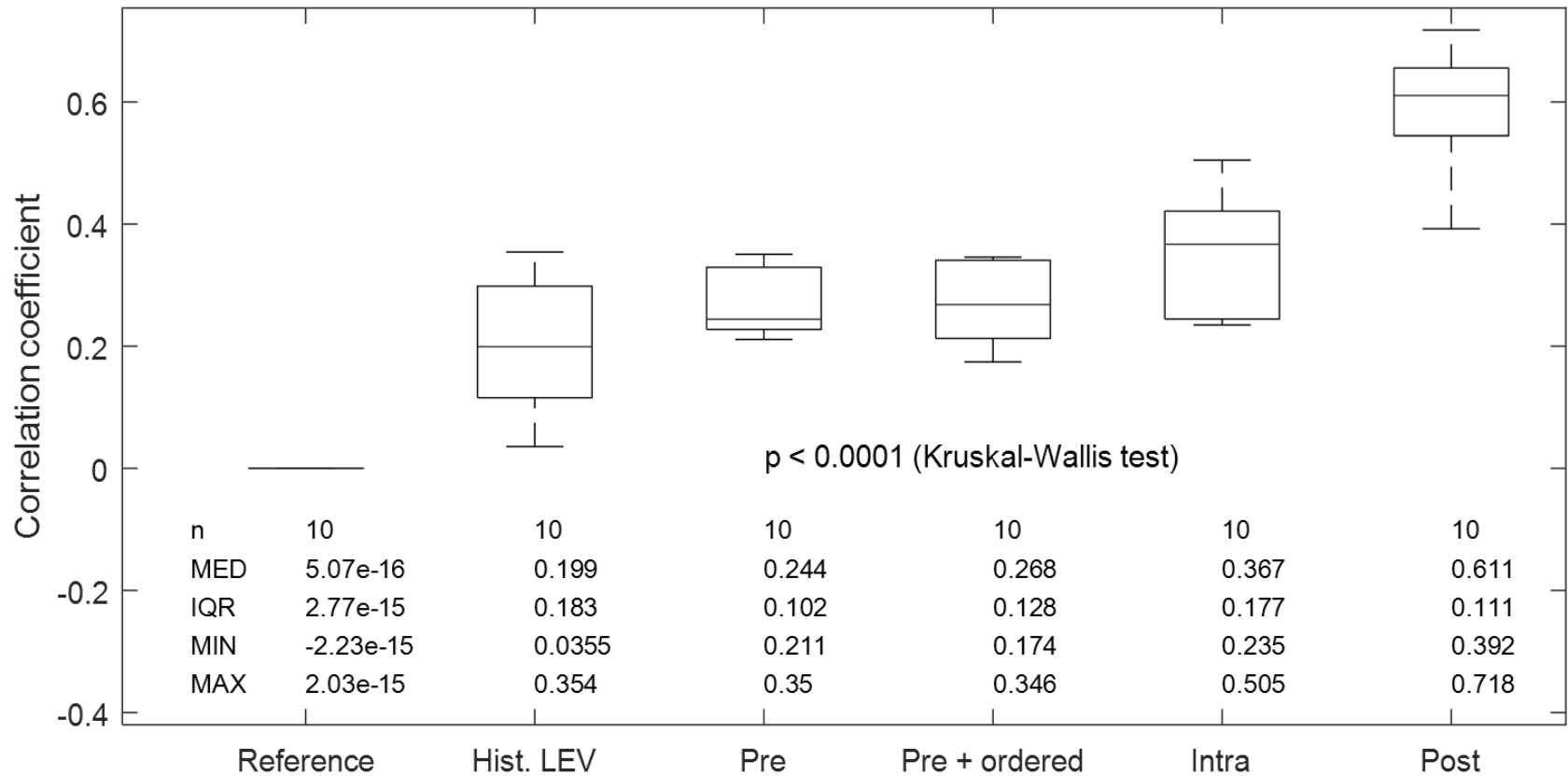
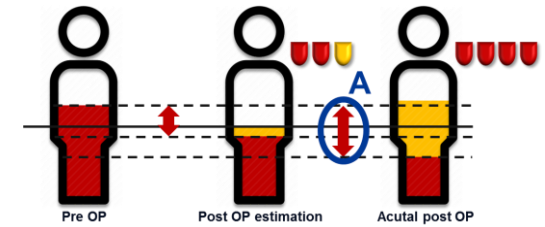
- MATLAB for training, testing and evaluation of models

- Decision trees with Breiman's random forest algorithm

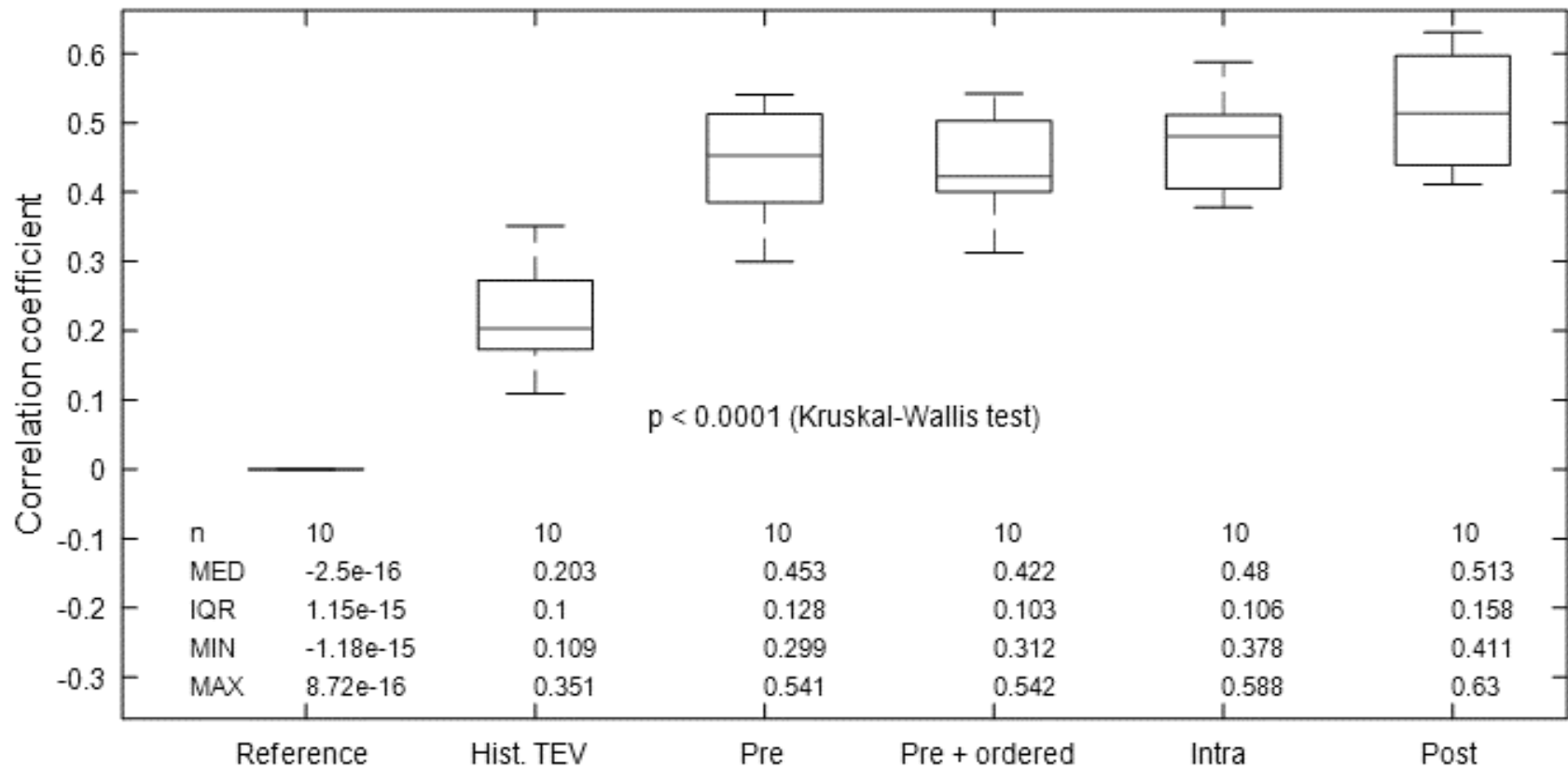
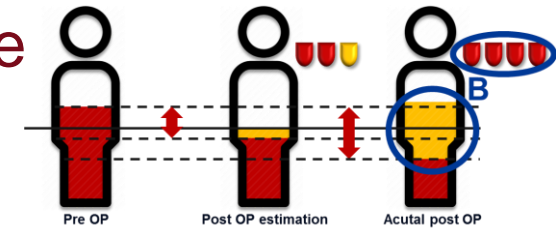
Methods – Evaluation with Leave 10 % Out Approach



Results – A Lost Erythrocyte Volume



Results – B Transfused Erythrocyte Volume



Discussion & Conclusion

- Lost erythrocyte volume is currently predicted without considering individual data
- Individual data could improve prediction

- Data from 2 benchmarking studies
 - ➔ Settings may have changed from study 1 to study 2
 - ➔ This effect has not yet been considered

- Next steps
 - *EU-PBM Patient Blood Management* project will end in 2016
 - ➔ new datasets will be available
 - Integrate PBM tools and prediction models into existing processes in hospital
 - Retrospective ➔ Prospective

- Final aim
 - Reduce unnecessary blood transfusion
 - Reduce costs
 - Improve outcomes



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Thank you for your attention

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