Personalised dynamic super learning: an application in predicting hemodiafiltration's convection volumes: supplemental document

Arthur Chatton, Michèle Bally, Renée Lévesque, Ivana Malenica, Robert W. Platt, and Mireille E. Schnitzer

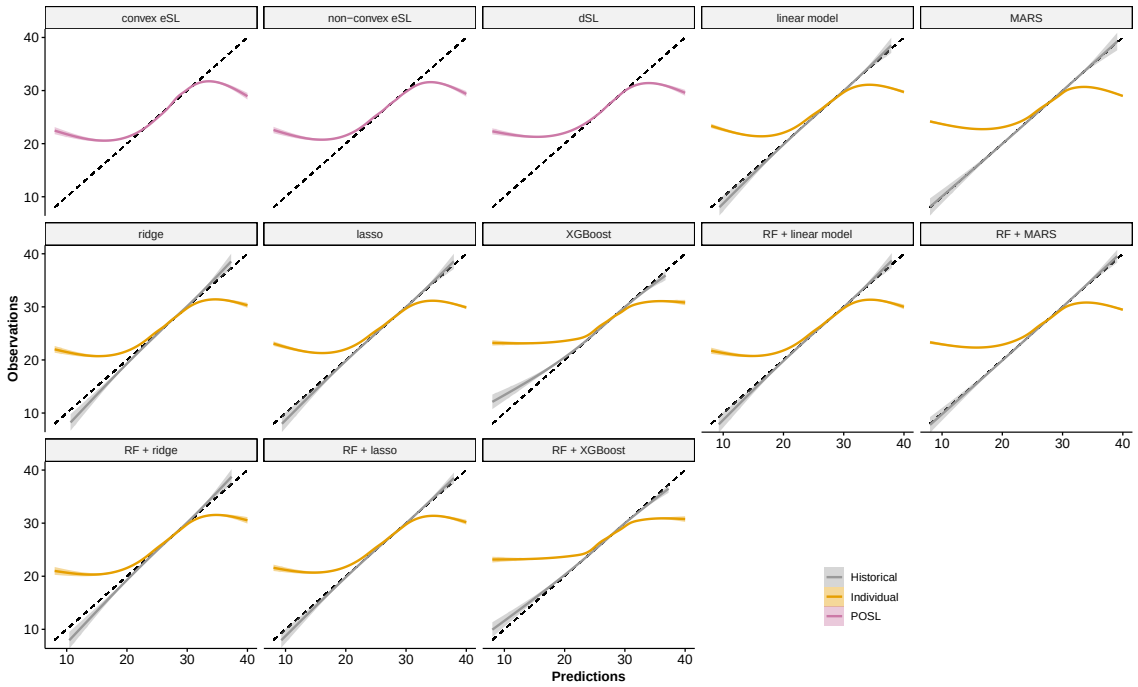

Fig. S1. Calibration-in-the-small (or moderate calibration) of the POSLs and their candidate learners. Flexible curves were obtained through generalised additive models with integrated smoothness estimation. The dashed line represents an ideal calibration. Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; MARS, multivariate adaptive regression splines; POSL, Personalised Online Super Learner; RF, random forest screening before training; and XGBoost, extreme gradient boosting tree.

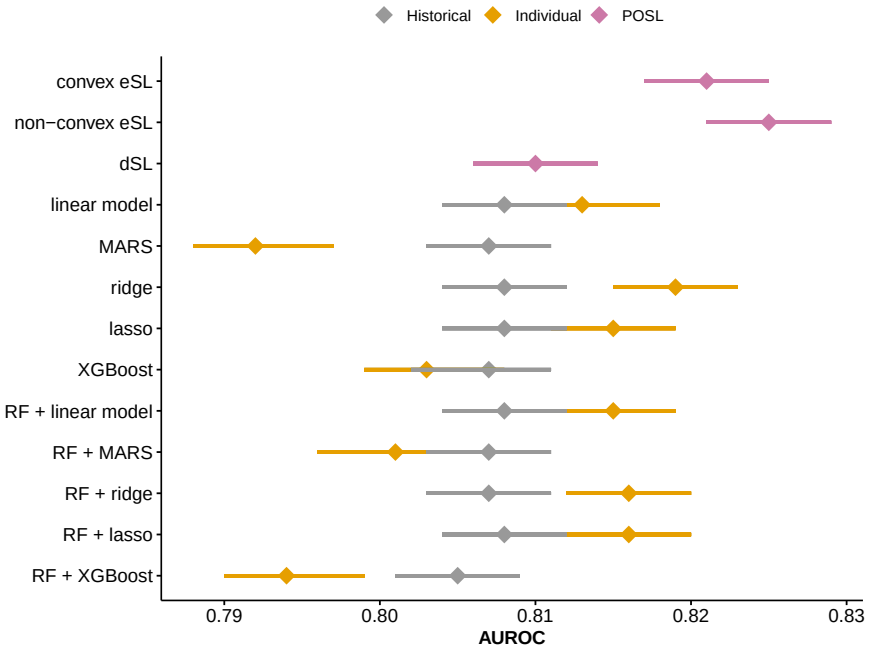

Fig. S2. Discrimination, through the area under the receiver operating curve, of the POSLs and their candidate learners.
Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; MARS, multivariate adaptive regression splines; POSL, Personalised Online Super Learner; RF, random forest screening before training; and XGBoost, extreme gradient boosting tree.

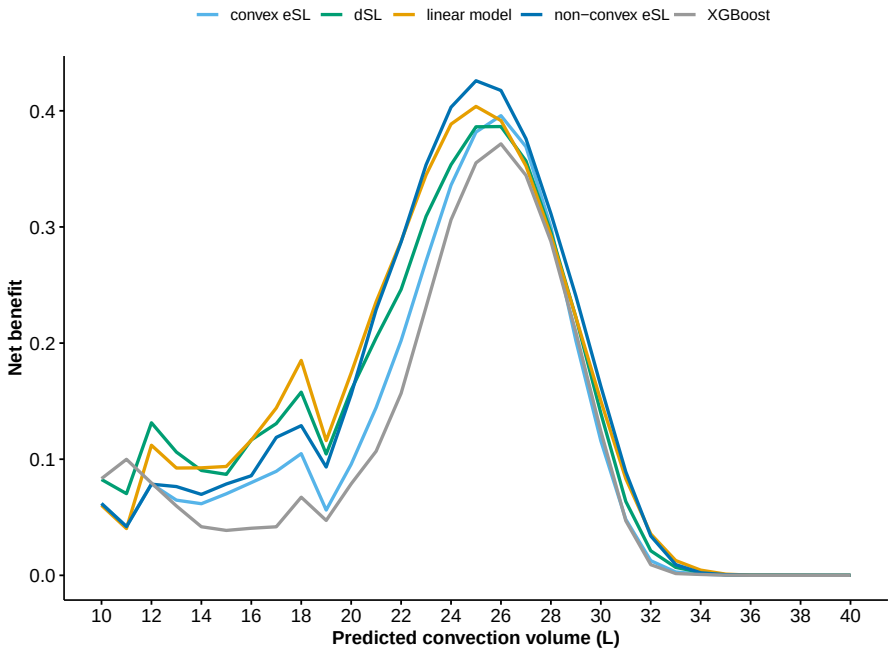

Fig. S3. Net benefit of monitoring more closely the patients according to their predicted convection volume using POSLs, an individual linear model, or a historical XGBoost.
Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; and XGBoost, extreme gradient boosting tree.

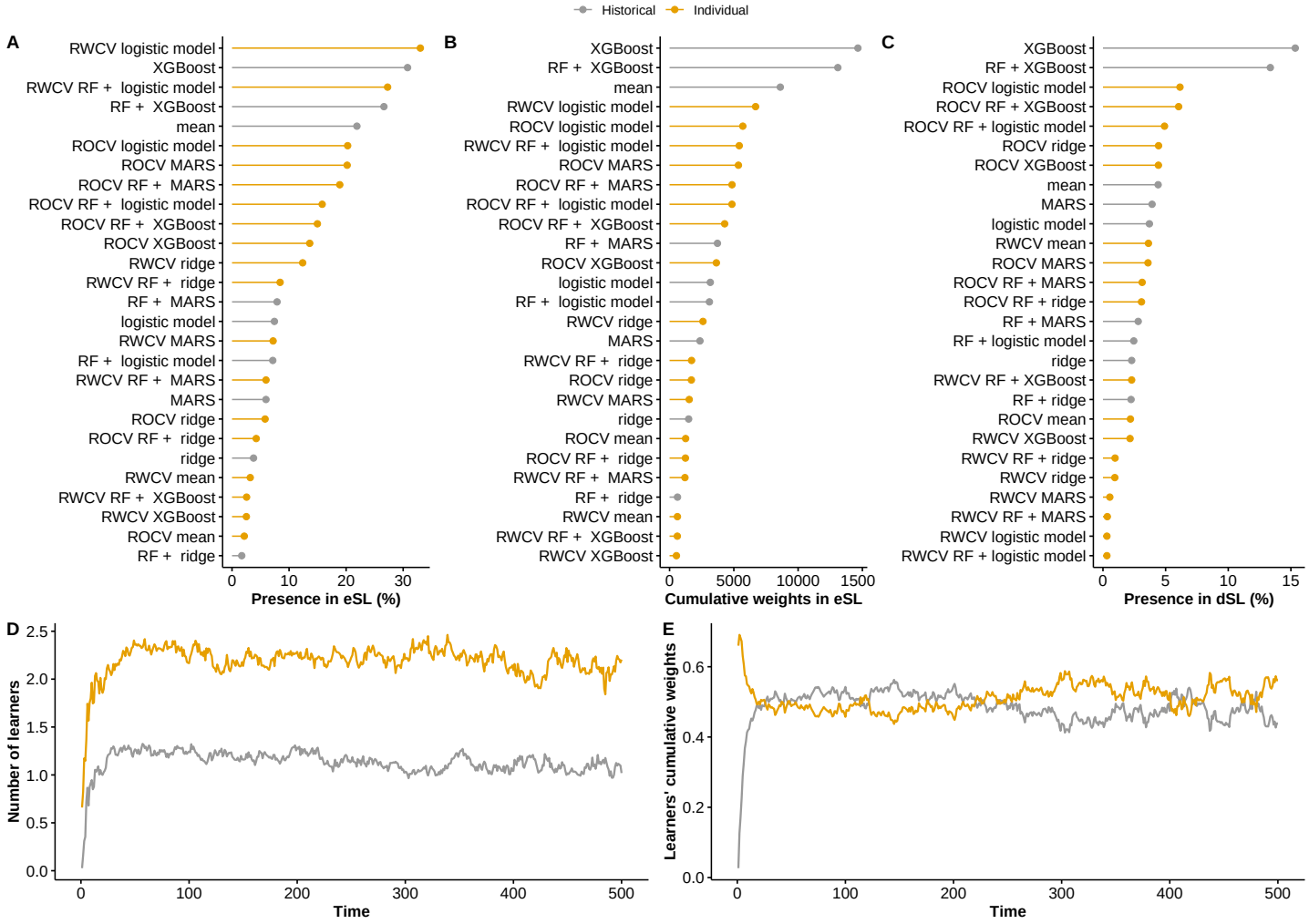

Fig. S4. Candidate learner distributions in the convex eSL and the dSL for the sensitivity analysis. (A) Percentage non-null weights in the eSL, (B) Sum of weights across time and individuals, (C) Percentage selection by dSL, (D) Number of learners composing the convex eSL over time, and (E) Sum of weights over time averaged between individuals. The X-axis of panels D and E is bound to 500 due to an insufficient number of observations after, and time 1 corresponds to the first predicted session.
Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; MARS, multivariate adaptive splines regression; RF, random forest screening before training; ROCV, rolling-origin cross-validation; RWCV, rolling-window cross-validation; and XGBoost, extreme gradient boosting tree.

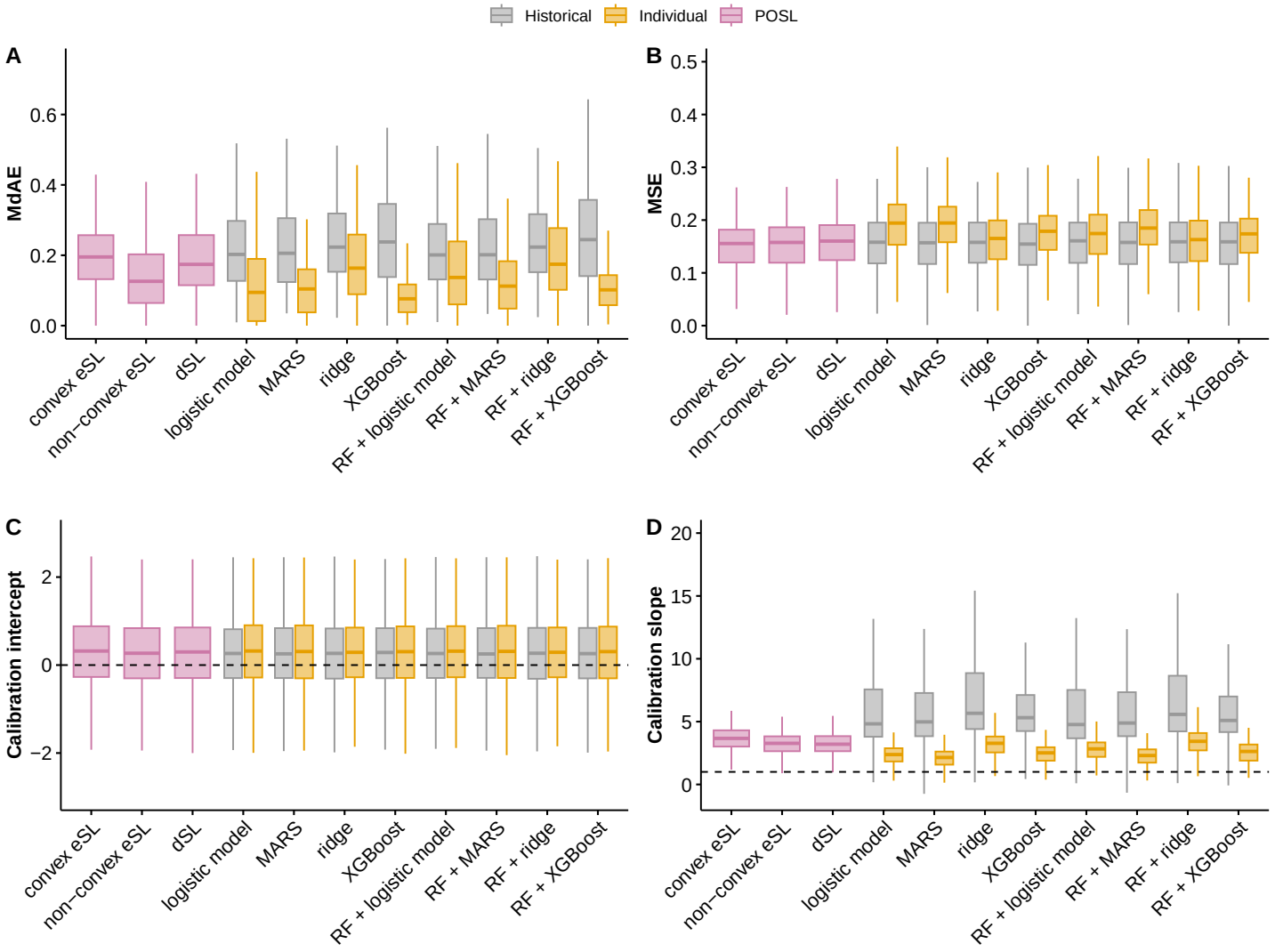

Fig. S5. Time-pooled performance measures of the different POSL implementations and their candidate learners for the sensitivity analysis. (A) Accuracy assessed by the MdAE, (B) Accuracy assessed by the MSE, (C) Calibration-in-the-large (or mean calibration) assessed by the calibration intercept, and (D) Weak calibration assessed by the calibration slope. The dashed line represents the median of the best-performing POSL for accuracy measures or the ideal value for calibration measures.
Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; MARS, multivariate adaptive regression splines; MdAE, median absolute error; MSE, mean square error; POSL, Personalised Online Super Learner; RF, random forest screening before training; and XGBoost, extreme gradient boosting tree.

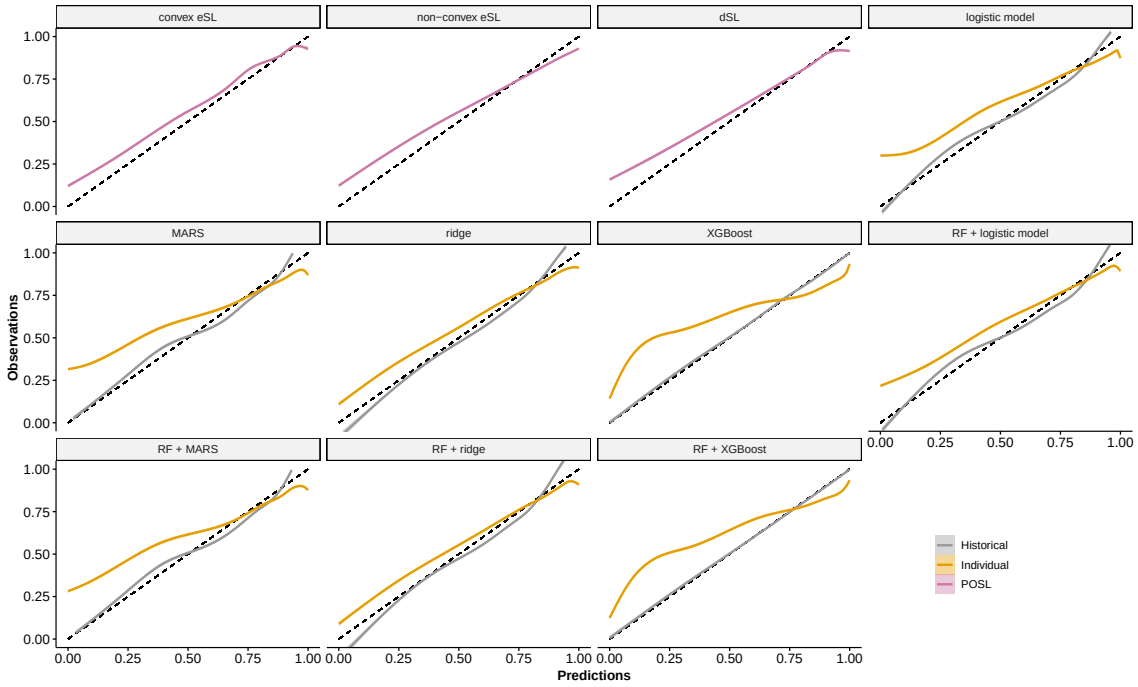

Fig. S6. Calibration-in-the-small (or moderate calibration) of the POSLs and their candidate learners for the sensitivity analysis. Flexible curves were obtained through generalised additive models with integrated smoothness estimation. The dashed line represents an ideal calibration.
Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; MARS, multivariate adaptive regression splines; POSL, Personalised Online Super Learner; RF, random forest screening before training; and XGBoost, extreme gradient boosting tree.

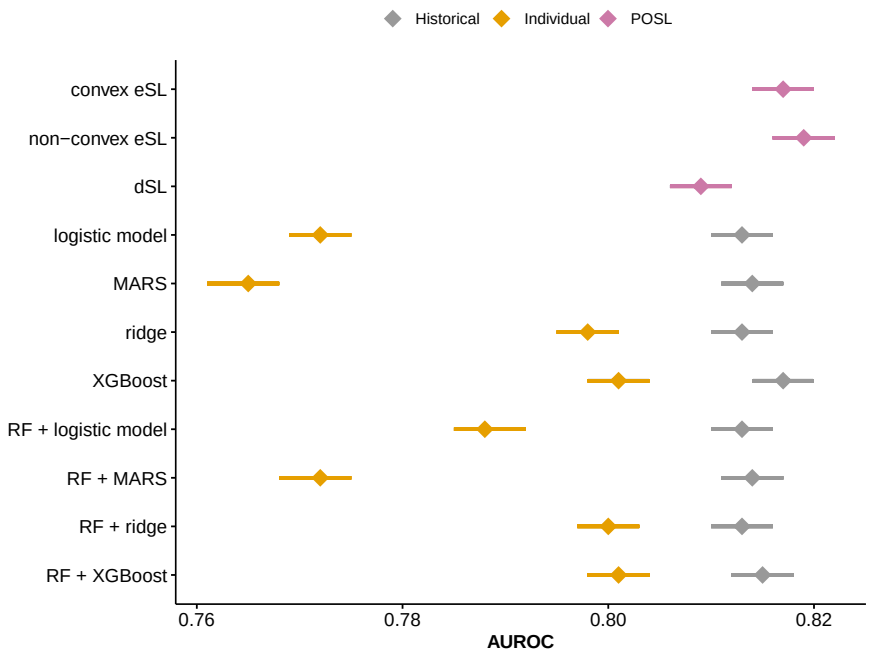

Fig. S7. Discrimination, through the area under the receiver operating curve, of the POSLs and their candidate learners for the sensitivity analysis.
Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; MARS, multivariate adaptive regression splines; POSL, Personalised Online Super Learner; RF, random forest screening before training; and XGBoost, extreme gradient boosting tree.

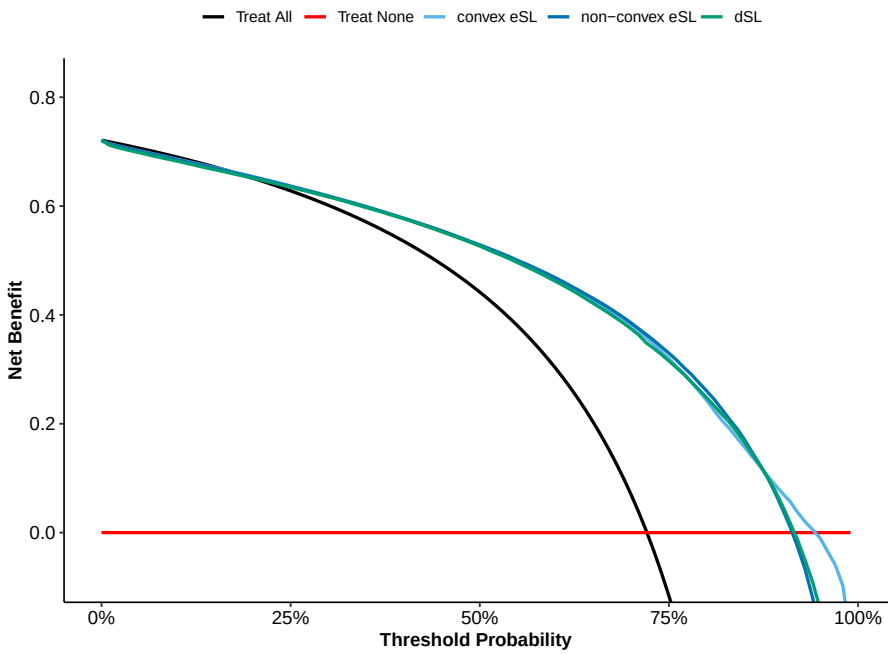

Fig. S8. Decision curve analysis for the sensitivity analysis.
Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; and XGBoost, extreme gradient boosting tree.

Table S1. Raw study variables.

Variable description	Variable type	Measurement frequency	Recording	Measurement error / misclassification‡
Outcome of HDF session				
Convection volume, L†	Continuous	Each dialysis	Automatic	Dialiser's inadequate monitoring: Very low risk
Predictors – Between dialysis sessions				
Time between HDF sessions, days	Continuous	Each dialysis	Automatic	Very low risk
Hemoglobin, g/L	Continuous	Monthly or more frequent	Automatic	Interpolation of values: Low to moderate risk
Albumin, g/L†	Continuous	Monthly or more frequent	Automatic	Interpolation of values: Low to moderate risk
CVC change	Dichotomous	Each new catheter installed	Automatic	Low risk
Predictors – At start of dialysis session				
Excess weight, kg†	Continuous	Each dialysis	Manual	Human: Low risk
Dalteparin dose, IU†	Discrete	Each dialysis	Manual	Human: Low risk
Access by CVC	Dichotomous	Each dialysis	Manual	Human: Low risk
Intercurrent hospitalisation	Dichotomous	Each hospitalisation	Automatic	Very low risk
Predictors – During dialysis (for history)				
Inversion of dialysis lines	Dichotomous	Each dialysis	Manual	Human: Low risk
Alteplase doses	Discrete	Each dose given	Manual	Human: Low risk
Predictors - Demographics and comorbidities				
Age at baseline	Continuous	Cohort start	Manual	Human: Very low risk
Male sex	Dichotomous	Cohort start	Manual	Human: Very low risk
Hypertension	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Diabetes	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Peripheral vascular disease	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Congestive heart failure	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Cardiac arrhythmia	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Acute myocardial infarction	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Chronic pulmonary disease	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Liver disease	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Valvular disease	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Cancer	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Metastatic solid tumour	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Cerebrovascular disease	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Dementia	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Peptic ulcer disease	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Hemi- or paraplegia	Dichotomous	Onset carried forward	Manual	Human: Moderate risk
Rheumatic disease	Dichotomous	Onset carried forward	Manual	Human: Moderate risk

Missingness reason: (a) Convection volume: Session by hemodialysis, session incomplete or cancelled, or outlier (>80L); (b) Albumin: Not measured; (c) Excess weight: Session by hemodialysis, session incomplete or cancelled, or outlier (>6L); and (d) Dalteparin dose: Outlier set to missing.

The risk of bias was evaluated subjectively by one investigator (MB) according to domain knowledge.

Abbreviations: CVC, Central venous catheter; HDF, Hemodiafiltration, and IU, International unit.

Table S2. Replication requirements.

Purpose	R Package	Version	Authors	Learner†	Hyperparameters†	Reference
Candidate learners	glmnet	4.1-6	J. Friedman, T. Hastie, R. Tibshirani	lasso	$\lambda = 0.004$ $\alpha = 1^{\ddagger}$	(1)
				ridge	$\lambda = 0.285$ $\alpha = 0^{\ddagger}$	
	earth	5.3.2	S. Milborrow	MARS	nprune=6 degree=1	(2)
	xgboost	1.6.0.1	Chen *et al.*†	XGBoost	nrounds=150 maxdepth=3 $\eta = 0.4$ $\gamma = 0$ colsample_bytree=0.8 min_child_weigth=1 subsample=1	(3)
Screening	ranger	0.14.1	M.N. Wright	RF	mtry=30 splitrule="extratrees" min.node.size=5	(4)
Hyperparameters tuning	caret	6.0-93	M. Kuhn	-	-	-
Meta-learner	nnls	1.4	K.M. Mullen, I.H.M. van Stokkum	-	-	-
SL utilities	sl3	1.4.4	Coyle *et al.*§	-	-	-
CV	origami	1.0.7	Coyle *et al.*§	-	-	-
AUROC	pROC	1.18.0	Robin *et al.*§	-	-	(5)
Flexible curve	mgcv	1.8-41	S. Wood	-	-	(6)
Figures	ggpubr	0.6.0	A. Kassambara	-	-	-

R version: 4.2.2 (Windows 10 x64)
Only for candidates learners
User-fixed hyperparameter
T. Chen, T. He, M. Benesty, V. Khotilovich, Y. Tang, H. Cho, K. Chen, R. Mitchell, I. Cano, T. Zhou, M. Li, J. Xie, M. Lin, Y. Geng, Y. Li, and J. Yuan; J. Coyle, N. Hejazi, I. Malenica, R. Phillips, and O. Sofrygin; J. Coyle, N. Hejazi, I. Malenica, and R. Phillips; X. Robin, N. Turck, A. Hainard, N. Tiberti, F. Lisacek, J.-C. Sanchez, and M. Müller.

Friedman J, Hastie T, Tibshirani R (2010). Regularization paths for generalized linear models via coordinate descent. J. Stat. Softw., 33(1), 1.

Friedman J (1991). Multivariate Adaptive Regression Splines (with discussion) Annals of Statistics 19(1), 1–141

Chen T, Guestrin C (2016). XGBoost: A scalable tree boosting system. In: Proceedings of the 22nd ACM SIGKDD international conference on knowledge discovery and data mining, 785–794.

Wright MN, Ziegler A (2017). ranger: A fast implementation of random forests for high dimensional data in C++ and R. J. Stat. Softw. 77:1-17.

Robin X, Turck N, Hainard A, *et al.* (2011) pROC: an open-source package for R and S+ to analyze and compare ROC curves. BMC Bioinformatics 7, 77

Wood SN (2004). Stable and efficient multiple smoothing parameter estimation for generalized additive models. J. Amer. Statist. Ass. 99:673-686.

Abbreviations: AUROC, area under the receiver operating curve; CV, cross-validation; MARS, multivariate adaptive regression splines; RF, random forest; SL, super learning; XGBoost, extreme gradient boosting trees.

Table S3. Description of the included and excluded sessions.

	Overall n=170,761	Included n=149,160	Excluded n=21,601	SMD
Time between HDR sessions, days (mean (SD))	2.56 (6.96)	2.45 (5.39)	3.26 (13.49)	0.079
Time in the graft-waiting list, days (mean (SD))	591.02 (402.30)	583.07 (399.26)	645.87 (418.61)	0.154
Hemoglobin, g/L (mean (SD))	107.95 (13.49)	108.21 (13.35)	106.20 (14.25)	0.145
Albumin, g/L (mean (SD))	37.10 (3.90)	37.20 (3.86)	36.44 (4.10)	0.191
Dalteparin dose, IU (mean (SD))	4993.40 (2569.33)	5067.45 (2484.22)	4482.04 (3045.05)	0.211
Age at baseline, years (mean (SD))	67.23 (14.01)	67.17 (13.92)	67.62 (14.58)	0.031
Excess weight, kg (mean (SD))	1.74 (1.30)	1.74 (1.29)	1.71 (1.34)	0.023
Convection volume history†, L (mean (SD))	27.30 (2.95)	27.36 (2.91)	26.88 (3.14)	0.159
Inversion of HDF lines history†(mean (SD))	0.02 (0.09)	0.02 (0.09)	0.03 (0.11)	0.063
Alteplase doses history†(mean (SD))	0.05 (0.26)	0.05 (0.26)	0.06 (0.28)	0.036
Year (N, (%))				0.258
2017	28350 (16.6)	25827 (17.3)	2523 (11.7)	
2018	44981 (26.3)	39870 (26.7)	5111 (23.7)	
2019	47182 (27.6)	41597 (27.9)	5585 (25.9)	
2020	43745 (25.6)	36196 (24.3)	7549 (34.9)	
2021	6503 (3.8)	5670 (3.8)	833 (3.9)	
CVC change since last session (N, (%))	532 (0.3)	388 (0.3)	144 (0.7)	0.060
Hospitalisation (N, (%))	10311 (6.0)	8013 (5.4)	2298 (10.6)	0.195
Access by CVC (N, (%))	82349 (48.2)	70851 (47.5)	11498 (53.2)	0.115
Male (N, (%))	107646 (63.0)	94723 (63.5)	12923 (59.8)	0.076
Hypertension (N, (%))	105715 (61.9)	90435 (60.6)	15280 (70.7)	0.214
Diabetes (N, (%))	70156 (41.1)	59296 (39.8)	10860 (50.3)	0.213
Peripheral vascular disease (N, (%))	39222 (23.0)	32449 (21.8)	6773 (31.4)	0.219
Congestive heart failure (N, (%))	33758 (19.8)	28583 (19.2)	5175 (24.0)	0.117
Cardiac arrhythmia (N, (%))	34760 (20.4)	28962 (19.4)	5798 (26.8)	0.177
Acute myocardial infarction (N, (%))	26273 (15.4)	22214 (14.9)	4059 (18.8)	0.104
Chronic pulmonary disease (N, (%))	25028 (14.7)	20563 (13.8)	4465 (20.7)	0.183
Liver disease (N, (%))	20527 (12.0)	17501 (11.7)	3026 (14.0)	0.068
Valvular disease (N, (%))	17777 (10.4)	15130 (10.1)	2647 (12.3)	0.067
Cancer (N, (%))	14873 (8.7)	12369 (8.3)	2504 (11.6)	0.110
Metastatic solid tumour (N, (%))	2243 (1.3)	1943 (1.3)	300 (1.4)	0.007
Cerebrovascular disease (N, (%))	15257 (8.9)	11904 (8.0)	3353 (15.5)	0.236
Dementia (N, (%))	6579 (3.9)	4931 (3.3)	1648 (7.6)	0.191
Peptic ulcer disease (N, (%))	5373 (3.1)	4383 (2.9)	990 (4.6)	0.087
Hemi- or paraplegia (N, (%))	5723 (3.4)	4470 (3.0)	1253 (5.8)	0.137
Rheumatic disease (N, (%))	3563 (2.1)	3268 (2.2)	295 (1.4)	0.062
Week-end HDF session (N, (%))	28384 (16.6)	24959 (16.7)	3425 (15.9)	0.024
Season (N, (%))				0.151
fall	42766 (25.0)	37047 (24.8)	5719 (26.5)	
spring	42598 (24.9)	38388 (25.7)	4210 (19.5)	
summer	42446 (24.9)	36513 (24.5)	5933 (27.5)	
winter	42951 (25.2)	37212 (24.9)	5739 (26.6)	

Averaged over three months (convection volume) or one week (inversion lines or alteplase)
Abbreviations: CVC, Central venous catheter; HDF, Hemodiafiltration; IU, International unit; SMD, Standardised mean difference.

Table S4. Summary of the main performance measures for each candidate learner ordered according to the MdAE.

Candidate learner	MdAE					MSE				
	Med	Mean	Var	Min	Max	Med	Mean	Var	Min	Max
non-convex eSL	1.50	1.74	0.66	0.63	5.36	9.79	14.97	245.68	1.32	137.19
convex eSL	1.59	1.91	0.89	0.65	6.40	9.87	14.58	226.25	1.32	139.28
dSL	1.60	1.88	0.91	0.59	6.58	10.02	14.49	167.65	1.60	108.76
Individual ridge	1.63	1.97	1.15	0.65	8.00	9.70	16.46	331.36	1.39	150.61
Historical ridge	1.67	2.01	1.11	0.72	6.71	8.84	12.60	109.32	1.52	70.14
Historical XGBoost	1.67	2.02	1.18	0.68	6.79	8.97	12.87	117.96	1.56	76.21
Individual RF + ridge	1.67	1.95	0.95	0.66	6.30	9.49	15.28	257.75	1.50	139.53
Historical lasso	1.69	1.97	1.06	0.53	6.53	8.77	12.56	109.39	1.52	70.00
Individual XGBoost	1.69	1.85	0.52	0.73	5.10	12.05	17.64	232.81	1.67	87.96
Historical RF + lasso	1.69	1.98	1.06	0.70	6.51	8.86	12.59	109.05	1.54	70.28
Individual RF + lasso	1.69	2.01	1.05	0.68	8.00	10.11	16.69	305.01	1.61	141.63
Historical linear model	1.70	1.97	1.06	0.53	6.54	8.76	12.56	109.51	1.53	70.03
Historical MARS	1.70	1.98	1.06	0.47	6.53	8.83	12.62	109.85	1.47	71.70
Historical RF + linear model	1.70	1.98	1.06	0.70	6.50	8.84	12.59	109.04	1.54	70.16
Individual RF + linear model	1.70	2.02	1.05	0.69	8.00	10.44	16.95	311.28	1.63	141.86
Historical RF + ridge	1.70	2.01	1.10	0.70	6.65	8.91	12.63	109.13	1.53	70.95
Historical RF + XGBoost	1.71	2.01	1.09	0.63	6.65	9.06	12.76	109.71	1.53	70.79
Historical RF + MARS	1.72	1.99	1.05	0.62	6.58	8.93	12.61	109.25	1.50	72.17
Individual lasso	1.75	2.14	1.54	0.68	8.67	11.95	22.14	799.49	1.53	202.59
Individual RF + MARS	1.76	2.01	0.82	0.76	6.66	14.82	20.13	236.10	2.20	109.70
Individual linear model	1.77	2.19	1.67	0.69	8.63	12.53	24.38	1122.40	1.56	235.55
Individual RF + XGBoost	1.78	1.86	0.54	0.82	5.72	12.10	18.10	236.95	1.71	85.18
Individual MARS	1.82	2.06	0.83	0.52	6.37	19.09	23.82	299.99	2.25	131.65
Candidate learner	Mean calibration					Weak calibration				
	Med	Mean	Var	Min	Max	Med	Mean	Var	Min	Max
non-convex eSL	0.00	-0.00	0.23	-4.80	3.88	0.58	0.54	0.05	-0.31	0.93
convex eSL	0.04	0.03	0.49	-5.08	3.97	0.64	0.61	0.07	-1.15	1.05
dSL	0.05	0.07	0.15	-1.78	2.45	0.55	0.51	0.05	-0.62	1.04
Individual ridge	0.01	0.00	0.27	-5.21	2.51	0.54	0.52	0.05	-0.28	0.93
Historical ridge	-0.04	-0.07	0.40	-4.33	2.18	0.97	1.08	0.72	-0.51	10.86
Historical XGBoost	-0.02	-0.04	0.58	-5.07	3.45	0.87	0.88	0.23	-0.46	6.59
Individual RF + ridge	0.01	0.01	0.30	-5.29	4.45	0.58	0.55	0.06	-0.51	1.04
Historical lasso	-0.02	-0.06	0.33	-4.35	2.20	0.91	1.02	0.69	-0.47	10.46
Individual XGBoost	0.24	0.29	0.07	-0.89	1.55	0.40	0.40	0.03	-0.15	0.85
Historical RF + lasso	-0.02	-0.06	0.34	-4.58	2.14	0.91	1.03	0.71	-0.48	10.40
Individual RF + lasso	0.03	0.03	0.46	-5.47	5.55	0.52	0.49	0.05	-0.88	0.94
Historical linear model	-0.02	-0.06	0.33	-4.33	2.25	0.90	1.02	0.66	-0.48	10.31
Historical MARS	-0.03	-0.08	0.35	-4.62	2.19	0.90	1.00	0.69	-0.61	12.65
Historical RF + linear model	-0.02	-0.06	0.34	-4.56	2.14	0.91	1.03	0.69	-0.48	10.24
Individual RF + linear model	0.04	0.03	0.47	-5.49	5.56	0.52	0.48	0.05	-0.87	0.94
Historical RF + ridge	-0.03	-0.07	0.40	-4.65	2.12	0.97	1.10	0.77	-0.53	10.83
Historical RF + XGBoost	-0.03	-0.05	0.44	-4.47	2.76	0.87	0.89	0.20	-0.42	4.40
Historical RF + MARS	-0.02	-0.06	0.35	-4.72	2.02	0.91	1.03	0.90	-0.60	12.96
Individual lasso	0.03	-0.00	0.74	-6.97	4.04	0.43	0.42	0.04	-0.18	0.90
Individual RF + MARS	0.06	0.07	0.17	-1.61	2.29	0.32	0.31	0.05	-2.39	0.81
Individual linear model	0.03	0.01	0.90	-7.60	4.08	0.41	0.40	0.04	-0.18	0.90
Individual RF + XGBoost	0.13	0.15	0.10	-1.81	2.21	0.38	0.38	0.03	-0.22	0.81
Individual MARS	0.07	0.08	0.16	-2.41	2.93	0.26	0.26	0.04	-1.60	0.98

Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; RF, random forest screening; MARS, multivariate adaptive regression splines; Max, maximum; MdAE, median absolute error; Med, median; Min, minimum; MSE, mean square error; Var, Variance; and XGBoost, extreme gradient boosting tree.

Table S5. Sensitivity analysis' summary of the main performance measures for each candidate learner ordered according to the MdAE.

Candidate learner	MdAE					MSE				
	Med	Mean	Var	Min	Max	Med	Mean	Var	Min	Max
Individual XGBoost	0.08	0.09	0.01	0.00	0.95	0.18	0.18	0.00	0.03	0.90
Individual logistic model	0.09	0.12	0.01	0.00	1.00	0.19	0.20	0.01	0.04	1.00
Individual MARS	0.10	0.12	0.01	0.00	1.00	0.19	0.20	0.01	0.04	1.00
Individual RF + XGBoost	0.10	0.11	0.01	0.00	0.95	0.17	0.17	0.00	0.03	0.90
Individual RF + MARS	0.11	0.13	0.01	0.00	1.00	0.18	0.19	0.01	0.04	1.00
non-convex eSL	0.13	0.14	0.01	0.00	0.46	0.16	0.15	0.00	0.00	0.30
Individual RF + logistic model	0.14	0.16	0.02	0.00	1.00	0.17	0.18	0.01	0.04	1.00
Individual ridge	0.16	0.18	0.01	0.00	1.00	0.17	0.16	0.01	0.03	1.00
dSL	0.17	0.19	0.01	0.00	0.54	0.16	0.16	0.00	0.00	0.35
Individual RF + ridge	0.17	0.19	0.01	0.00	1.00	0.16	0.16	0.01	0.03	1.00
convex eSL	0.20	0.20	0.01	0.00	0.47	0.16	0.15	0.00	0.00	0.30
Historical logistic model	0.20	0.22	0.01	0.01	0.69	0.16	0.15	0.00	0.00	0.36
Historical RF + logistic model	0.20	0.22	0.01	0.01	0.66	0.16	0.15	0.00	0.00	0.35
Historical RF + MARS	0.20	0.23	0.01	0.03	0.66	0.16	0.15	0.00	0.00	0.35
Historical MARS	0.21	0.23	0.01	0.03	0.67	0.16	0.15	0.00	0.00	0.36
Historical ridge	0.22	0.24	0.01	0.02	0.70	0.16	0.15	0.00	0.00	0.36
Historical RF + ridge	0.22	0.24	0.01	0.02	0.67	0.16	0.15	0.00	0.00	0.34
Historical XGBoost	0.24	0.24	0.02	0.00	0.67	0.15	0.15	0.00	0.00	0.34
Historical RF + XGBoost	0.24	0.25	0.02	0.00	0.64	0.16	0.15	0.00	0.00	0.34
Candidate learner	Mean calibration					Weak calibration				
	Med	Mean	Var	Min	Max	Med	Mean	Var	Min	Max
Individual XGBoost	0.30	0.26	0.90	-4.30	2.74	2.51	2.35	2.11	-13.44	7.35
Individual logistic model	0.32	0.27	0.94	-4.35	2.80	2.38	-10074.71	30616891130.52	-3025561.87	12543.66
Individual MARS	0.31	0.27	0.94	-4.32	2.71	2.15	-34976.05	215116138454.45	-7447005.24	18.96
Individual RF + XGBoost	0.31	0.26	0.90	-4.30	2.74	2.63	2.49	1.77	-9.10	6.43
Individual RF + MARS	0.31	0.27	0.94	-4.33	2.72	2.30	-18849.08	106256654902.78	-5636551.63	22.04
non-convex eSL	0.27	0.24	0.88	-4.10	2.72	3.27	-1.07	5412.12	-1268.77	5.90
Individual RF + logistic model	0.32	0.27	0.92	-4.34	2.77	2.83	2.86	2.80	-0.43	20.87
Individual ridge	0.29	0.25	0.89	-4.31	2.78	3.28	8.48	8522.58	-6.67	1599.23
dSL	0.30	0.26	0.87	-4.09	2.71	3.20	3.16	3.80	-16.65	13.57
Individual RF + ridge	0.29	0.25	0.89	-4.31	2.78	3.43	9.27	10362.75	-4.58	1763.43
convex eSL	0.32	0.28	0.89	-4.09	2.72	3.67	-4.01	17301.98	-2270.77	11.22
Historical logistic model	0.26	0.24	0.88	-4.17	2.79	4.82	9.26	1073.34	-55.75	544.17
Historical RF + logistic model	0.26	0.24	0.89	-4.17	2.78	4.77	9.67	792.31	-30.50	439.70
Historical RF + MARS	0.25	0.24	0.89	-4.12	2.78	4.89	8.71	891.16	-4.48	507.56
Historical MARS	0.26	0.24	0.89	-4.12	2.79	4.98	8.47	842.23	-3.21	494.53
Historical ridge	0.27	0.24	0.92	-4.23	2.81	5.66	10.73	1619.07	-36.86	679.12
Historical RF + ridge	0.27	0.23	0.92	-4.22	2.80	5.58	10.77	923.11	-24.52	472.46
Historical XGBoost	0.29	0.24	0.90	-4.09	2.71	5.31	6.48	20.14	-0.39	38.64
Historical RF + XGBoost	0.26	0.24	0.89	-4.10	2.71	5.09	10.88	6228.83	-2.39	1369.13

Abbreviations: dSL, discrete super learner; eSL, ensemble super learner; RF, random forest screening; MARS, multivariate adaptive regression splines; Max, maximum; MdAE, median absolute error; Med, median; Min, minimum; MSE, mean square error; Var, Variance; and XGBoost, extreme gradient boosting tree.