Supplementary

Table S1 Search strategy

DB	Ovid MEDLINE (ALL -1946 to present) Searched on July 26, 2023 No language, article type, or publication date limits	
Line No.	Search	No. of results
1	Artificial Intelligence/ or Machine Learning/ or Deep Learning/ or Supervised Machine Learning/ or Bayes Theorem/ or Decision Trees/ or Neural Networks, Computer/ or Support Vector Machine/	184,618
2	(artificial intelligence or AI or computational intelligence or machine intelligence or computer reasoning or computer vision system* or machine learn* or learning machine or transfer learning or deep learning or hierarchical learning or decision tree* or neural network* or Naive Bayes or support vector machine or perceptron or radial basis function* or Bayesian network* or Bayesian learn* or random forest* or classification tree* or elastic net* or ridge or lasso or boosting or bagging or ensemble or nearest neighbor or logi* regression or KNN or generative adversarial network* or memory network* or classification algorithm* or fuzzy system* or learning algorithm* or hidden Markov model*).tw.	754,599
3	1 or 2	828,160
4	Cardiac Pacing, Artificial/ or Pacemaker, Artificial/	45,630
5	(pacemaker* or cardiac pacing or pace-maker* or cardiac rhythm management device* or cardiac electronic device* or cardiac electrophysiology analysis system* or cardiac electrophysiology stimulation system* or heart rhythm management device*).tw.	44,375
6	4 or 5	68,540
7	Transcatheter Aortic Valve Replacement/	10,902
8	((transapical or transventricular or percutaneous or transcatheter*) adj3 (valve* or prosthe* or bioprosthe*)).tw.	19,560
9	(TAVI or PAVR or TAVR).tw.	10,977
10	or/7-9	22,149
11	3 and 6 and 10	136
DB	Ovid Embase (1974 to present) Searched on July 26, 2023 No language, article type, or publication date limits	
Line No.	Search	No. of results
1	artificial intelligence/ or machine learning/ or deep learning/ or supervised machine learning/ or Bayes theorem/ or "decision tree"/ or artificial neural network/ or support vector machine/	284,539
2	(artificial intelligence or AI or computational intelligence or machine intelligence or computer reasoning or computer vision system* or machine learn* or learning machine or transfer learning or deep learning or hierarchical learning or decision tree* or neural network* or Naive Bayes or support vector machine or perceptron or radial basis function* or Bayesian network* or Bayesian learn* or random forest* or classification tree* or elastic net* or ridge or lasso or boosting or bagging or ensemble or nearest neighbor or logi* regression or KNN or generative adversarial network* or memory network* or classification algorithm* or fuzzy system* or learning algorithm* or hidden Markov model*).tw.	995,724
3	1 or 2	1,085,510
4	cardiac rhythm management device/	5,834
5	(pacemaker* or cardiac pacing or pace-maker* or cardiac rhythm management device* or cardiac electronic device* or cardiac electrophysiology analysis system* or cardiac electrophysiology stimulation system* or heart rhythm management device*).tw.	64,722
6	4 or 5	66,381
7	transcatheter aortic valve implantation/	31,321
8	((transapical or transventricular or percutaneous or transcatheter*) adj3 (valve* or prosthe* or bioprosthe*)).tw.	33,658
9	(TAVI or PAVR or TAVR).tw.	23,218
10	or/7-9	42,461
11	3 and 6 and 10	344
DB	Cochrane Library (Wiley) Searched on July 26, 2023 No language, article type, or publication date limits	
ID	Search	Hits
#1	(artificial intelligence or AI or computational intelligence or machine intelligence or computer reasoning or computer vision system* or machine learn* or learning machine or transfer learning or deep learning or hierarchical learning or decision tree* or neural network* or Naive Bayes or support vector machine or perceptron or radial basis function* or Bayesian network* or Bayesian learn* or random forest* or classification tree* or elastic net* or ridge or lasso or boosting or bagging or ensemble or nearest neighbor or logi* regression or KNN or generative adversarial network* or memory network* or classification algorithm* or fuzzy system* or learning algorithm* or hidden Markov model*):ti,ab	44,488
#2	(pacemaker* or cardiac pacing or pace-maker* or cardiac rhythm management device* or cardiac electronic device* or cardiac electrophysiology analysis system* or cardiac electrophysiology stimulation system* or heart rhythm management device*):ti,ab	4,319
#3	((transapical or transventricular or percutaneous or transcatheter*) NEAR/3 (valve* or prosthe* or bioprosthe*)):ti,ab	1,314
#4	(TAVI or PAVR or TAVR):ti,ab	1,077
#5	#3 OR #4	1,452
#6	#1 AND #2 AND #5	10

DB, database.

https://dx.doi.org/10.21037/jmai-23-162

Table S2 Demographics of included patients from the selected studies

Study	Age (years) (mean ± SD)		Female (%)		BMI (kg/m^2) (mean ± SD)		DM (%)		HTN (%)		PVD (%)		CAD (%)		Prior MI (%)	
	No PPI	PPI	No PPI	PPI	No PPI	PPI	No PPI	PPI	No PPI	PPI	No PPI	PPI	No PPI	PPI	No PPI	PPI
Agasthi 30 days	80.8±8.9	81.2±8.1	326 (42)	80 (42)	29.38±6.23	30.3±7.4	277 (36)	78 (41)	657 (85)	166 (88)	387 (50)	102 (54)	379 (49)	109 (58)	176 (23)	10 (11)
Agasthi 1 year	80.57±8.56	81.19±7.3	209 (44)	71 (40)	29.33±6.64	30.42±7.61	178 (37)	75 (43)	404 (84)	154 (88)	235 (49)	93 (53)	231 (48)	100 (57)	115 (24)	39 (22)
Tsushima Derivation	81.14±8.85	81.73±8.36	360 (51)	77 (42)	29.14±13.18	29.54±8.06	270 (38)	77 (42)	635 (90)	178 (97)	130 (19)	45 (25)	362 (51)	115 (63)	126 (18)	30 (16)
Tsushima Validation	80.08±7.95	79.92±7.12	118 (50)	11 (29)	29.84±8.95	29.81±6.88	80 (34)	16 (42)	199 (85)	35 (92)	50 (21)	8 (21)	124 (53)	25 (66)	19 (8)	6 (16)
Truong	80±9	81±8	230 (50)	38 (40)	28.6±6.2	29.2±6.2	168 (36)	34 (36)	400 (87)	90 (95)	95 (21)	25 (26)	269 (58)	52 (55)	NR	NR

BMI, body mass index; CAD, coronary artery disease; DM, diabetes; HTN, hypertension; MI, myocardial infarction; NR, not reported; SD, standard deviation; PVD, peripheral vascular disease.

https://dx.doi.org/10.21037/jmai-23-162

Table S3 Newcastle-Ottawa Scale

Study, year	Selection	Comparability	Outcome
Agasthi, 2023	****	*	***
Truong, 2020	****	*	**
Tsushima, 2021	****	*	**

Table S4 Risk of bias assessment

Author, year	Item 1	Item 2	Item 3	Item 4	Item 5	Risk of bias
Agasthi, 2023	Unclear	No	No	No	No	High
Truong, 2020	No	No	No	No	No	Low
Tsushima, 2021	No	Unclear	No	No	No	High

Christodoulou et al. risk of bias assessment. Item 1: unclear or biased validation of model performance; Item 2: difference in data-driven variable selection before applying machine learning versus logistic regression; Item 3: difference in handling of continuous variables before applying machine learning versus logistic regression; Item 4: different predictors considered for logistic regression and machine learning algorithms; and Item 5: corrections for imbalanced outcomes where used only for logistic regression or only for machine learning algorithms. Low risk of bias: if the answer was "no" for all 5 signaling items. If the answer was "unclear" or "yes" for at least 1 item, it was assumed high risk of bias.

Table S5 Outcomes of included studies

Study label	Model	Total cases	AUC	TP	TN	FP	FN
Truong 2020	ML	557	0.81	NA	NA	NA	NA
Truong 2020	LR	557	0.693	NA	NA	NA	NA
Tsushima 2021 (validation)	ML	272	0.696	0.397	NA	0.089	NA
Tsushima 2021 (validation)	LR	272	0.705	0.576	NA	0.274	NA
Tsushima 2021 (derivation)	ML	888	0.703	0.368	NA	0.111	NA
Tsushima 2021 (derivation)	LR	888	0.726	0.605	NA	0.372	NA
Agasthi 2023 (30 days)	ML	964	0.66	NA	NA	NA	NA
Agasthi 2023 (30 days)	LR	964	0.55	NA	NA	NA	NA
Agasthi 2023 (1 year)	ML	657	0.72	NA	NA	NA	NA
Agasthi 2023 (1 year)	LR	657	0.54	NA	NA	NA	NA

AUC, area under ROC curve; FN, false negative; FP, false positive; LR, logistic regression; ML, machine learning; TN, true negative; TP, true positive.

https://dx.doi.org/10.21037/jmai-23-162

Table S6 Significant models' variables

Author	Significant baseline, procedural and post-procedural variables
Tsushima (validation)	Female, RBBB, AVB, PR interval, QRS interval, BAV after valve deployment
Tsushima (derivation)	Female, Hypertension, prior cardiac surgery, prior CABG, LBBB, RBBB, AVB, PR interval, QRS interval, Self-expanding valve
Truong	Hypertension, RBBB, PR interval, first degree AV block, QRS interval, baseline QRS interval ≥120 ms, peak AV gradient, mean AV gradient, prosthetic valve size, valve type, delta PR interval, delta QRS interval, new-onset LBBB, peak AV gradient, mean AV gradient, prosthetic valve size, valve type, delta PR interval, delta QRS interval, new-onset LBBB
Agasthi 30 days	Prior percutaneous coronary intervention, albumin, any prior aortic valve intervention, prior aortic valve surgical replacement n, aspirin use n, coronary artery disease presentation n, myocardial infarction n, atrial fibrillation class n, heart failure 2 weeks prior to the procedure n, New York Heart Association class within 2 weeks n, conduction defect n, aortic valve annular calcification n, Society of Thoracic Surgery Risk Score, aortic annulus diameter horizontal (mm), left common femoral artery minimum diameter (mm) (mean ± SD), iliac artery atherosclerosis degree n, TVT access site n, TVT access method n, valve type, balloon expandable valve n, self-expanding valve n, Left Atrium Maximum Volume Index by 2-D Method of Discs Biplane, aortic valve regurgitation n, pulmonary valve regurgitation n, valve calcium Score, operator reason n, TVT-procedure indication, valve-in-valve transcatheter aortic valve replacement n, valve-in-valve transcatheter aortic valve replacement status n, PR, QRS, QT, corrected QT interval, right bundle branch block, 1st degree atrioventricular block, left anterior fascicular block, valve size, Charlson Comorbidity Index
Agasthi 1 year	Albumin (mean ± SD), prior other cardiac surgery n (%), number of previous cardiac surgeries (mean ± SD), any prior Aortic valve intervention n (%), prior aortic valve surgical replacement n (%), Aspirin use n (%), atrial fibrillation class n (%), Heart failure 2 weeks prior to the procedure n (%), conduction defect n (%), aortic valve annular calcification n (%), TVT access site n (%), TVT access method n (%), valve type, balloon expandable valve n (%), self-expanding valve n (%), aortic valve systolic area index by tissue velocity imaging (mean ± SD), aortic valve regurgitation n (%), elevated filling pressure n (%), mitral valve diastolic mean gradient by continuous wave doppler (mean ± SD), Valve Calcium Score, aortic annulus diameter horizontal (mm), aortic annulus diameter vertical (mm), aortic annulus area (cm^2), aortic annulus perimeter (cm), distance of Left main coronary to basal ring (mm), distance of right coronary artery to basal ring (mm), distance of right brachiocephalic artery to annulus (mm), Brachiocephalic artery to annulus distance to height ratio, LVOT (horizontal, vertical, mean diameter and area), iliac artery atherosclerosis degree n, Abdominal aorta atherosclerosis degree n, TVT-location n, TVT-procedure Indication, valve-in-valve transcatheter aortic valve replacement n, valve-in-valve transcatheter aortic valve replacement status n, operator reason n, PR, QRS, QT, corrected QT interval, right bundle branch block, 1st degree atrioventricular block, left anterior fascicular block, valve size, Charlson Comorbidity Index, fall within 6 months n, anesthesia type n

Table S7 Models' methodology description

Model	Description
Random forest	Classification algorithm that utilizes an ensemble of decision trees and employs bootstrapping to sample training data, subsequently splitting branches within each tree
Random forest—gradient boosting	Boosting algorithm that combines multiple weak learners into robust ones, wherein each subsequent model is trained to minimize the loss function, combination of two ensemble learning techniques
Logistic regression	Algorithm to predict a binary outcome for an event based on dataset's observations
Simple logistic regression	Algorithm to define a linear relationship between independent and dependent variables

https://dx.doi.org/10.21037/jmai-23-162

Table S8 Comprehensive models details

Author	Model	Measurement of variable importance	Accuracy	Precision	F1 score	Brier score	Validation
Truong	RF	Feature importance plot	0.76	NA	0.49	0.18	Training set (75%) and test set (25%)
Agasthi (30 days)	RF-GBM	Model hyperparameters	NA	NA	NA	NA	5-fold cross validation repeated 10 times, no external validation
Agasthi (1 year)	RF-GBM	Model hyperparameters	NA	NA	NA	NA	5-fold cross-validation repeated 10 times, no external validation
Tsushima (Validation)	RF	NA	0.63	0.77	0.50	0.30 (MCC)	10-fold cross validation, group B validation cohort
Tsushima (Derivation)	RF	NA	0.65	0.82	0.53	0.36 (MCC)	10-fold cross validation, group B validation cohort
Truong	LR	NA	0.68	NA	0.41	0.23	Training set (75%) and Test set (25%)
Agasthi (1 year)	LR	Calculating the relative influence of each variable included in the model	NA	NA	NA	NA	5-fold cross validation repeated 10 times, no external validation
Agasthi (30 days)	LR	Calculating the relative influence of each variable included in the model	NA	NA	NA	NA	5-fold cross validation repeated 10 times, no external validation
Tsushima (validation)	LR	NA	0.62	0.62	0.61	0.23 (MCC)	10-fold cross validation, group B validation cohort
Tsushima (derivation)	LR	NA	0.65	0.68	0.62	0.31 (MCC)	10-fold cross validation, group B validation cohort

MCC, Matthews correlation coefficient.

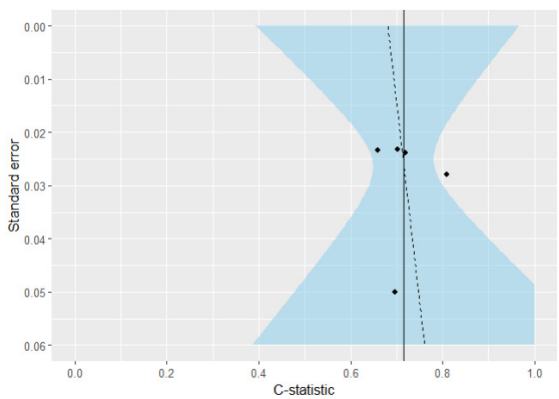

Figure S1 Funnel plot for assessment of small-study effect. Funnel plot for assessment of small-study effect, obtained by plotting the C-statistics and the standard error for each study included [Funnel plot and regression test showed no evidence of small study effect (P=0.79)]. Number of dots (studies) are 5 as we included derivation model in Tsushima 2021 and Agasthi 2023 (1 year model) as separate studies.

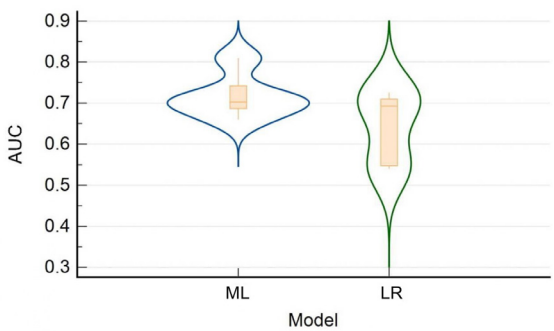

Figure S2 Boxplots showing studies' AUC in ML and corresponding LR. AUC, area under the ROC curve; LR, logistic regression; ML, machine learning.

https://dx.doi.org/10.21037/jmai-23-162