Risk factors Associated with Mortality in the Infective Endocarditis

Eva Strīķe MD PhD

Paula Stradina CUH, Anesthesiology and ICU

Latvian Society of Anaesthesiology and Intesive Care

RSU, Department of Anaesthesiology and Intensive Care

Disclosure

I do not have any conflicts of interest to disclose

Infective Endocarditis (IE)

- Infective endocarditis (IE) is typically **an asymptomatic diagnosis** that is made on the basis of **multiple findings** rather than a definitive result
- If the features of IE are **atypical or masked by coexisting conditions**, misdiagnosis may lead to clinical disaster

- Overdiagnosis of IE may **lead to numerous iatrogenic problems** arising from antimicrobial therapy
  - Aminoglycoside-induced ototoxicity or nephro**toxicity**
  - **Allergic or idiosyncratic reactions** to various antimicrobial agents that are generally tolerable for short courses may be associated with **significant reactions** in the setting of **long-term therapy**
  - Intravenous catheter-associated **thrombosis**

Challenges in Infective Endocarditis

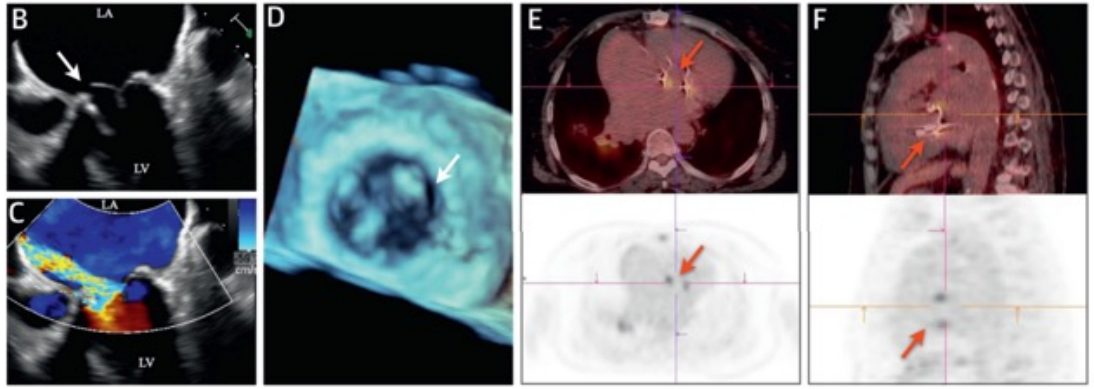
- **St. aureus** is now the most common causative pathogen
  - For approximately 30% of cases (staphylococcus and streptococcus infections 33.4% and 32.0% respectively*)
  - Aggressive disease (risk of embolism, stroke, persistent bacteremia...)
  - The most common cause of PVE, often requiring redo surgery
- Additionally, 10% to 20% of patients have **negative blood cultures** at presentation, leading to diagnostic uncertainty
- The incidence of blood culture-negative IE may **decrease using newer techniques** (mass spectrometry)
- **Healthcare associated organisms** have increasingly defined the microbiology of today's IE

Healthcare - Associated IE

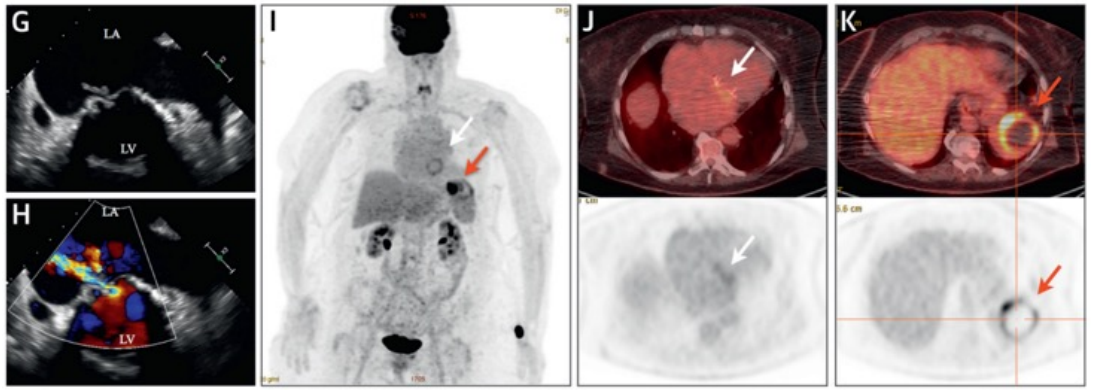
- Definitions vary, healthcare-associated IE generally includes **IE acquired 48 hours after hospital admission** or associated with a significant **invasive procedure performed 6 months before clinical diagnosis**
- Healthcare-associated IE already accounts **for half of all cases** and is expected to increase in the near future
- Predisposing factors are advanced age, cardiac implants, and comorbidity
- Significant sources of infection are **intravascular catheters or frequent vascular access**
- This entity should be recognized **at the time of admission** rather than being treated as a community-acquired IE

Integrated Imaging Strategy in Patients with Suspected IE

Confirmation of diagnosis



Detection of complications

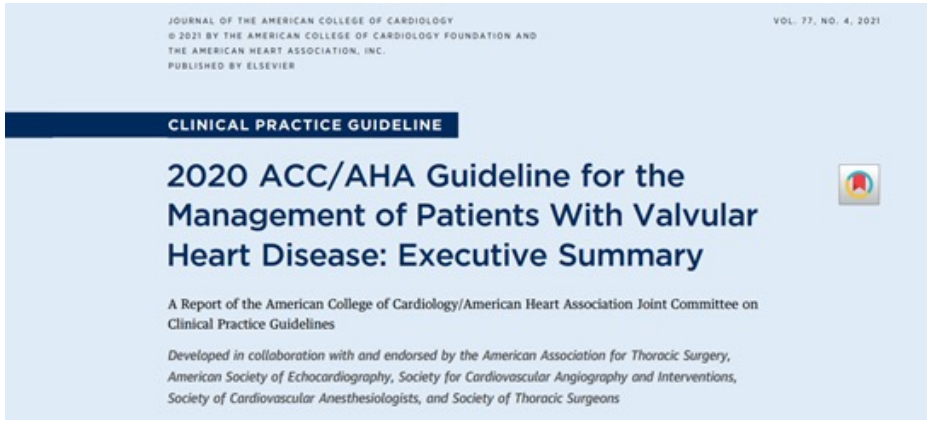


- A 54-year-old p-t with a history of MV replacement 5 years previously (admitted with LV failure)
- Admission TTE showed severe intraprosthetic regurgitation but **no evidence of vegetation**
- **Blood cultures** on admission **were negative,** inflammatory markers were raised
- 18-Fluorodeoxyglucose **positron emission tomography** (18FDG-PET/CT)

- A 65-year-old p-t with a mitral bioprosthesis was diagnosed with St. aureus IE
- TEE revealed a **mobile vegetation with leaflet prolapse and severe regurgitation**
- Cross-sectional imaging by CT or MRI scans may assist with **detection of complications** (abscess, mycotic aneurysm, infarct, or hemorrhage in patients with definite IE)

Recommendations for Intervention for IE
Referenced studies that support the recommendations are summarized in Online Data Supplement 42.

COR	LOE	RECOMMENDATIONS
1	B-NR	1. Decisions about the timing of surgical intervention for IE should be made by a Heart Valve Team (612-617).
1	B-NR	2. In patients with IE who present with valve dysfunction resulting in symptoms of HF, early surgery (during initial hospitalization and before completion of a full therapeutic course of antibiotics) is indicated (598,618-629).
1	B-NR	3. In patients with left-sided IE caused by *S. aureus*, a fungal organism, or other highly resistant organisms, early surgery (during initial hospitalization and before completion of a full therapeutic course of antibiotics) is indicated (515,598,618,625,630-644).
1	B-NR	4. In patients with IE complicated by heart block, annular or aortic abscess, or destructive penetrating lesions, early surgery (during initial hospitalization and before completion of a full therapeutic course of antibiotics) is indicated (598,618,645-653).
1	B-NR	5. In patients with IE and evidence of persistent infection as manifested by persistent bacteremia or fevers lasting >5 days after onset of appropriate antimicrobial therapy, early surgery (during initial hospitalization and before completion of a full therapeutic course of antibiotics) for IE is indicated (598,618,625,634,635,654-657).
1	B-NR	6. In all patients with definite endocarditis and an implanted cardiac electronic device, complete removal of the pacemaker or defibrillator systems, including all leads and the generator, is indicated (544,658-663).
1	C-LD	7. For patients with prosthetic valve endocarditis and relapsing infection (defined as recurrence of bacteremia after a complete course of appropriate antibiotics and subsequent negative blood culture results) without other identifiable source of infection, surgery is recommended (618).
(Continued)		
2a	B-NR	9. In patients with IE who present with recurrent emboli and persistent vegetations despite appropriate antibiotic therapy, early surgery (during initial hospitalization and before completion of a full therapeutic course of antibiotics) is reasonable (518,542,661,667-670).
2b	B-NR	10. In patients with native left-sided valve endocarditis who exhibit mobile vegetations >10 mm in length (with or without clinical evidence of embolic phenomenon), early surgery (during initial hospitalization and before completion of a full therapeutic course of antibiotics) may be considered (515,518,667,668,671).
2b	B-NR	11. In patients with IE and an indication for surgery who have suffered a stroke but have no evidence of intracranial hemorrhage or extensive neurological damage, operation without delay may be considered (672-674).
2b	B-NR	12. For patients with IE and major ischemic stroke with extensive neurological damage or intracranial hemorrhage, if the patient is hemodynamically stable, delaying valve surgery for at least 4 weeks may be considered (672,675).



- **Control of infection**, involving removal of infected and necrotic tissue, surgical drainage of abscess combined with early **antimicrobial therapy**, is essential to the successful treatment of sepsis

- After surgery, in-hospital mortality is high (29–50%), but it is **higher in rejected patients** (52–83%)

AHA vs. ESC Guidelines

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THE PRESENT AND FUTURE

STATE-OF-THE-ART REVIEW

Challenges in Infective Endocarditis

Thomas J. Cahill, MBBS,[a] Larry M. Baddour, MD,[b] Gilbert Habib, MD,[c,d] Bruno Hoen, MD, PhD,[e] Erwan Salaun, MD,[d] Gosta B. Pettersson, MD, PhD,[f] Hans Joachim Schäfers, MD,[g] Bernard D. Prendergast, DM[h]

TABLE 3 Indications for Surgery in AHA and ESC Guidelines

	AHA Guidelines 2015 (89)	Class, Level of Evidence	ESC Guidelines 2015 (68)	Class, Level of Evidence	Timing†
Heart failure	Early surgery* is indicated in patients with IE who present with valve dysfunction resulting in symptoms or signs of HF	I, B	Aortic or mitral NVE, or PVE with severe acute regurgitation, obstruction, or fistula causing refractory pulmonary edema or cardiogenic shock	I, B	Emergency
	Early surgery* is indicated in patients with PVE with symptoms or signs of HF resulting from valve dehiscence, intracardiac fistula, or severe prosthetic valve dysfunction	I, B	Aortic or mitral NVE, or PVE with severe regurgitation or obstruction causing symptoms of HF, or echocardiographic signs of poor hemodynamic tolerance	I, B	Urgent
Uncontrolled infection	Early surgery* is indicated in patients when IE is complicated by heart block, annular or aortic abscess, or destructive penetrating lesions	I, B	Locally uncontrolled infection (abscess, false aneurysm, fistula, enlarging vegetation)	I, B	Urgent
	Early surgery* is reasonable for patients with relapsing PVE	IIa, C			
	Early surgery* should be considered, particularly in patients with IE caused by fungi or highly resistant organisms (e.g., VRE, multidrug-resistant gram-negative bacilli)	I, B	Infection caused by fungi or multiresistant organisms	I, C	Urgent/elective
	Early surgery* is indicated for evidence of persistent infection (manifested by persistent bacteremia or fever lasting >5-7 d, and provided that other sites of infection and fever have been excluded) after the start of appropriate antimicrobial therapy	I, B	Persisting positive blood cultures despite appropriate antibiotic therapy and adequate control of septic metastatic foci	IIa, B	Urgent
			PVE caused by staphylococci or non-HACEK gram-negative bacteria	IIa, C	Urgent/elective
Prevention of embolism	Early surgery* is reasonable in patients who present with recurrent emboli and persistent or enlarging vegetations despite appropriate antibiotic therapy	IIa, B	Aortic or mitral NVE, or PVE with persistent vegetations >10 mm after ≥1 embolic episode despite appropriate antibiotic therapy	I, B	Urgent
	Early surgery* is reasonable in patients with severe valve regurgitation and mobile vegetations >10 mm	IIa, B	Aortic or mitral NVE with vegetations >10 mm, associated with severe valve stenosis or regurgitation, and low operative risk	IIa, B	Urgent
	Early surgery* may be considered in patients with mobile vegetations >10 mm, particularly when involving the anterior leaflet of the mitral valve and associated with other relative indications for surgery	IIb, C	Aortic or mitral NVE, or PVE with isolated very large vegetations (>30 mm)	IIa, B	Urgent
			Aortic or mitral NVE, or PVE with isolated large vegetations (>15 mm) and no other indication for surgery	IIb, C	Urgent

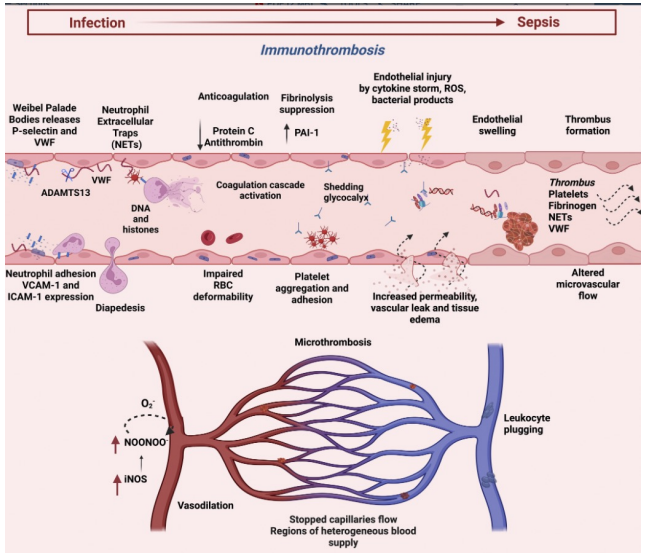
The emphasis on **"early surgery"** differs significantly between European and U.S. guidelines

1. The ESC guidelines distinguish
   - **emergency** surgery (performed within 24 h)
   - **urgent surgery** (within a few days)
   - **elective surgery** (after 1 to 2 weeks of antibiotic therapy)

2. The AHA Guidelines define **early surgery** as "performed during the initial hospitalization and before completing a full course of antibiotics"

Characteristics of Septic Patients

- The imbalance of immune and inflammatory response in the development of sepsis could cause
  - The disruption of vascular endothelial barrier
  - Tissue edema
  - Hypotension
  - Decrease of oxygen-carrying function of red blood cells
  - Thrombosis of microcirculation



- Preoperative analysis of organ function, medical history, and surgical conditions of septic patients should be focused on for accurate assessment of **anesthetic risk and effective therapy**

Impact of Open Heart Surgery on Inflammatory Response

INFLAMMATORY REACTION TO CARDIOPULMONARY BYPASS

STIMULI

Surgical trauma

Blood contact with CPB surfaces

Endotoxemia

Ischemia

ADHESION MOLECULES

Selectins: E selectin, P selectin, L selectin

Integrins: CD11/CD18 (MAC-1)

Immunoglobulin superfamily: ICAM, VCAM, PECAM

TRANSCRIPTION FACTOR

NF-kB

MEDIATORS

Complement system: C3a, C5a

Cytokines: IL-1, IL-2, IL-6, IL-8, TNF-α, IL-10

iNOS

Oxygen free radicals

EFFECTS

Leukocyte extravasation

Lipid peroxidation

Edema

Cell death

ELSEVIER

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Review

Cardiopulmonary bypass induced inflammation: pathophysiology and treatment. An update

D. Paparella[a,*], T.M. Yau[a], E. Young[b]

[a]Division of Cardiovascular Surgery, Toronto General Hospital, University of Toronto, Eaton North 13-222, 200 Elizabeth Street, Toronto, Ontario, Canada M5G 2C4

[b]Department of Pathology and Molecular Medicine, McMaster University, Hamilton Civic Hospital Research Centre, Hamilton, Ontario, Canada

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I. Tools for the diagnosis and prognosis of IE

- **SOFA Score (Sequential Organ Failure Assessment)**: While not specific to IE, the SOFA score is often **used in critical care settings** to assess the severity of multiple organ dysfunction
- **EuroSCORE (European System for Cardiac Operative Risk Evaluation)**: EuroSCORE is primarily used to assess the risk of **mortality associated with cardiac surgery**, including valve surgery for IE

II. Tools for the diagnosis and prognosis of IE

- **Modified Duke Criteria**: They help classify patients as having possible, definite, or rejected IE based on clinical, microbiological, and echocardiographic criteria. This is an adaptation of the original Duke Criteria, which **includes additional imaging criteria** for the diagnosis of IE
- **PALS (Predisposition, Age, Microbiology, Location of IE, and Staphylococcus aureus Bacteremia) Score**: The PALS score takes into account predisposing conditions, age, microbiology, the location of IE, and the presence of Staphylococcus aureus bacteremia
- **Heart Failure and Shock Criteria**: Various criteria and scoring systems, such as the Killip Classification or ACC/AHA heart failure stages, may be used to evaluate these aspects

Risk Models

- Some research studies have developed **risk prediction models specific to IE**, taking into account a combination of clinical, microbiological, and echocardiographic factors to estimate mortality risk
- These models may vary in complexity and may be tailored to local patient populations
- The selection of **the most appropriate scoring system should be made by healthcare providers** based on the patient's individual characteristics and the available clinical data

Predicting Infective Endocarditis (IE) Patients' Risk of Death Following Surgery

Table 7. Specific Predictive Scoring Systems for In-Hospital Mortality After Surgery for IE

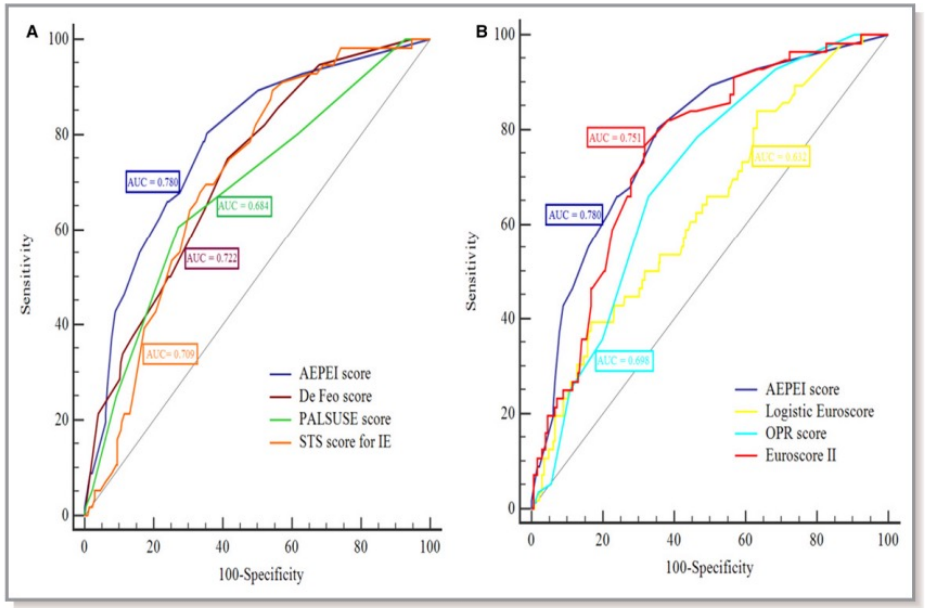
Scoring System	Study Population	Variables (Points)	Discrimination Power	Expected Hospital Mortality
AEPEI score, the original model* (2016)	361 pts. (mean age, 59.1±15.4 years); AEPEI registry (223 pts., 7 French hospitals, 2008) & Cardiovascular Department of Trieste, Italy (138 pts., 2000–2015); Hospital mortality, 15.5%; 30-Day mortality, 11.6%	5 variables: BMI >27 kg/m^2 (1) eGFR <50 mL/min (2.2) NYHA class IV (1.3) sPAP >55 mm Hg (1) Critical state (1.5)	AUC, 0.780 (95% CI, 0.734–0.822)	Score, 0 to 1 point: expected mortality, 4.5% to 7.7%; Score, 1.3 to 2 points: expected mortality, 9% to 12.9%; Score, 2.2 to 2.8 points: expected mortality, 14.1% to 18.9%; Score, 3.2 to 3.8 points: expected mortality, 22.6% to 29.4%; Score, 4.5 to 5 points: expected mortality, 38.2% to 45.1%; Score, 5.5 to 6 points: expected mortality, 52.5% to 59.4%; Score, 7 points: expected mortality, 72.4%
AEPEI score, the alternate model* (2016)	Idem	3 variables: eGFR <50 mL/min (1.8) NYHA class IV (1) Critical state (1.1)	AUC, 0.774 (95% CI, 0.727–0.816)	Score, 0 to 1 point: expected mortality, 19.6% to 34.1%; Score, 1.1 to 1.8 points: expected mortality, 36.6% to 47.7%; Score, 2.1 to 2.9 points: expected mortality, 55% to 68.3%; Score, 3.9 points: expected mortality, 82%
PALSUSE score[14] (2014)	437 pts. (mean age, 61.4±15.5 years); GAMES registry (26 Spanish hospitals, 2008–2010); Hospital mortality, 24.3%	7 variables: Prosthetic valve (2) Age ≥70 years (1) Large intracardiac destruction (2) *Staphylococcus* spp (2) Urgent surgery (2) Sex, female (2) EuroSCORE II ≥10% (1)	AUC, 0.84 (95% CI, 0.79–0.88)	Hospital mortality ranged from 0, in patients with score=0, to 45.4% in patients with score >3
De Feo score (for native valve IE)[15] (2012)	440 pts. (mean age, 49±16 years); Department of Cardiothoracic Surgery of Naples, Italy (1980–2009); Hospital mortality, 9.1%	6 variables: Age, 5 classes (5–13) Renal failure (5) NYHA class IV (9) Preop. ventilator support (11) Positivity of latest preop. blood cultures (5) Perivalvular involvement (5)	AUC, 0.88 (95% CI, 0.82–0.93)	Score, 0 to 5 points: expected mortality ≤4.55%; Score, 7 to 13 points: expected mortality, 4.55% to 9.1%; Score, 14 to 19 points: expected mortality, 9.2% to 27.3%; Score ≥20 points: expected mortality >27.3%
STS risk score for IE[16] (2011)	19 543 pts. (mean age, 55 years); STS database (2002–2008) 30-day mortality, 8.2%	12 variables: Emergency, salvage status, or cardiogenic shock (17) Preop. hemodialysis, renal failure, or creatinine level >2.0 mg/dL (12) Preop. inotropic or balloon pump support (10) Active (vs treated) endocarditis (10) Multiple valve involvement (9) Insulin-dependent diabetes mellitus (8) Arrhythmia (8) Previous cardiac surgery (7) Urgent status without cardiogenic shock (6) Non-insulin-dependent diabetes mellitus (6) Hypertension (5) Chronic lung disease (5)	AUC, 0.758	…

ORIGINAL RESEARCH

American Heart Association | American Stroke Association

Simple Scoring System to Predict In-Hospital Mortality After Surgery for Infective Endocarditis

Giuseppe Gatti, MD; Andrea Perrotti, MD; Jean-François Obadia, MD, PhD; Xavier Duval, MD, PhD; Bernard Iung, MD; François Alla, MD, PhD; Catherine Chirouze, MD, PhD; Christine Selton-Suty, MD, PhD; Bruno Hoen, MD, PhD; Gianfranco Sinagra, MD, FESC; François Delahaye, MD; Pierre Tattevin, MD; Vincent Le Moing, MD; Aniello Pappalardo, MD; Sidney Chocron, MD, PhD; on behalf of The Association for the Study and Prevention of Infective Endocarditis Study Group–Association pour l'Étude et la Prévention de l'Endocadite Infectieuse (AEPEI)*



This study **did not evaluate** the contribution of potentially important factors (antibiotic treatment and preoperative patient preparation) to the risk of death

Models' Characteristics

Contents lists available at ScienceDirect
Clinical Microbiology and Infection
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Systematic review

Prognostic models for mortality after cardiac surgery in patients with infective endocarditis: a systematic review and aggregation of prediction models

Borja M. Fernandez-Felix [1,2,*], Laura Varela Barca [3], Esther Garcia-Esquinas [2,4,5], Andrea Correa-Pérez [1,6], Nuria Fernández-Hidalgo [7,8], Alfonso Muriel [1,2], Jesus Lopez-Alcalde [1,2,6,9], Noelia Álvarez-Diaz [10], Jose I. Pijoan [2,11,12], Aida Ribera [2,13], Enrique Navas Elorza [14], Patricia Muñoz [15], María del Carmen Fariñas [16], Miguel Ángel Goenaga [17], Javier Zamora [1,2,18]

Author, Year Model name	Modelling method	Sample size	Events n (%)	Predictors		EPCP/ EPFP	Selection of candidate predictors	Selection of final predictors	Type of validation	Performance measures	Critical appraisal				
				Cand.	Final							P	Pr	O	A
In-hospital or 30 days mortality															
De Feo, 2012 [24] De Feo score	Logistic regression	440	40 (9.1)	19	6	2.1/ 6.7	Univariable (p-value < 0.05)	n.a.	Int: Apparent Ext: n.a.	Disc: C = 0.88 (0.82;0.93) Cal: HL Test	RoB.	–	?	+	–
											App.	–	+	+	
Gaca, 2011 [30] STS Score	Logistic GEE regression	13,617	1,117 (8.2)	38	13	29.4/ 85.9	Univariable and previous STS model variables	n.a.	Int: Random Split (D:70%/V:30%) Ext: n.a.	Disc: C = 0.76 Cal: Calibration plot	RoB.	–	+	+	–
											App.	+	+	+	
Madeira 2016 [26] -	Logistic regression	128	21 (16.4)	15	2	1.4/ 10.5	Univariable	n.a.	Int: Apparent Ext: n.a.	Disc: C = 0.87 (0.79;0.94) Cal: Slope; CITL	RoB.	?	+	+	–
											App.	?	+	+	
In-hospital mortality															
Gatti 2017a [32] AEPEI score	Logistic regression	361	56 (15.5)	57	5	1.0/ 11.2	Univariable (p-value < 0.1)	Backward	Int: 0.632 Bootstrap Ext: (n=161; e=21)	Disc: C = 0.72 (0.64;0.78) Cal: HL Test	RoB.	+	+	+	–
											App.	+	?	+	
Gatti 2017a [32] Alternate AEPEI score	Logistic regression	361	56 (15.5)	57	3	1.0/ 11.2	Univariable (p-value < 0.1)	Backward	Int: 0.632 Bootstrap Ext: (n=161; e=21)	Disc: C = 0.69 (0.61;0.76) Cal: HL Test	RoB.	+	+	+	–
											App.	+	+	+	
Gatti 2017b [25] ANCLA score	Logistic regression	138	28 (20.3)	56	5	0.5/ 5.6	Univariable (p-value < 0.1)	Backward	Int: 0.632 Bootstrap Ext: n.a.	Disc: C = 0.83 (0.75;0.89) Cal: HL Test	RoB.	+	+	+	–
											App.	+	+	+	
Martínez-Sellés 2014 [31] PALSUSE	Logistic regression	437	106 (24.3)	n.a.	7	n.a./ 15.1	Univariable (p-value < 0.1)	Stepwise	Int: Apparent Ext: n.a.	Disc: C = 0.84 (0.79;0.88) Cal: HL Test	RoB.	+	+	+	–
											App.	+	+	+	
Olmos 2017 [29] RISK-E	Logistic regression	424	124 (29.2)	37	8	3.4/ 15.5	Univariable (p-value < 0.1) and clinically relevant	Stepwise	Int: Random Split (D:66%/V:33%) Ext: (n=204; e=18)	Disc: C = 0.76 (0.64;0.88) Cal: HL Test; Calibration plot	RoB.	+	+	+	–
											App.	+	+	+	
30 days mortality															
Di Mauro 2017 [27] EndoSCORE	Logistic mixed effect regression	2,715	298 (11.0)	32	15	9.3/ 19.9	Univariable (p-value < 0.2)	n.a.	Internal: Bootstrap External: n.a.	Disc: C = 0.85 (0.84;0.86) Cal: CITL and slope vs. the ideal values	RoB.	?	+	+	?
											App.	?	+	+	
Fernández-Hidalgo 2018 [28] Specific ES-I	Logistic regression	779	208 (26.7)	26	10	8.0/ 20.8	Variables in ES-I and specific IE risk factor	Bootstrap	Int: Bootstrap Ext: n.a.	Disc: C = 0.77 (0.74;0.81) Cal: Slope = 0.93 CITL = -0.06	RoB.	+	+	+	+
											App.	+	?	+	
Fernández-Hidalgo 2018 [28] Specific ES-II	Logistic regression	779	208 (26.7)	27	9	7.7/ 23.1	Variables in ES-II and specific IE risk factor	Bootstrap	Int: Bootstrap Ext: n.a.	Disc: C = 0.77 (0.73;0.81) Cal: Slope = 0.93 CITL = -0.05	RoB.	+	+	+	+
											App.	+	+	+	

P - participants; Pr – predictors O - outcome A - analysis

In predicting individual mortality risk in patients with IE, the **meta-models outperformed existing prediction models**

Models' Characteristics

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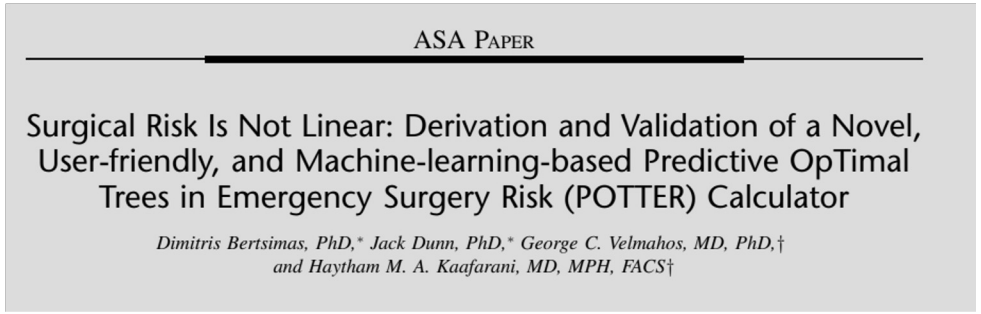
Coefficients and odds ratios of the meta-model and the prediction models used for aggregation

Predictors	Original models			Aggregated model	
	EndoSCORE Di Mauro 2017	Sp. ES-I Fernández-Hidalgo 2018	Sp. ES-II Fernández-Hidalgo 2018	Meta-model[a]	
				Coefficient (95% CI)	OR (95% CI)
Intercept	−2.60	−3.13	−4.21	−5.00 (−5.97 to −4.00)	—
Gender (female)	0.51			0.22 (0.14–0.31)	1.25 (1.15–1.36)
Age[b] (years)	—	—	—	0.045 (0.03–0.06)	1.05 (1.03–1.06)
Renal failure	0.50	0.46		0.28 (0.17–0.41)	1.32 (1.19–1.51)
Prior cardiac surgery		1.10	0.96	0.51 (0.36–0.69)	1.67 (1.43–1.99)
Chronic pulmonary disease	0.68			0.29 (0.19–0.41)	1.34 (1.21–1.51)
Pulmonary hypertension		1.27		0.17 (−0.11 to 0.48)	1.19 (0.90–1.62)
LVEF (%)	−0.03			−0.013 (−0.02 to −0.01)	0.99 (0.98–0.99)
Critical preoperative state	1.46	1.12	1.02	1.17 (0.97–1.40)	3.22 (2.64–4.06)
NYHA class. (>I)		0.70	0.62	0.33 (0.23–0.44)	1.39 (1.26–1.55)
Abscess	1.09			0.47 (0.30–0.65)	1.60 (1.35–1.92)
Fistulae		1.22	1.14	0.59 (0.42–0.79)	1.80 (1.52–2.20)
Priority of procedure					
Urgent status			1.16	0.44 (0.16–0.68)	1.55 (1.17–1.97)
Emergency status		0.81	1.95	0.85 (0.53–1.17)	2.34 (1.70–3.22)
Number of valves treated					
Two valves treated	0.50			0.22 (0.14–0.30)	1.25 (1.15–1.35)
Three valves treated	1.50			0.65 (0.41–0.90)	1.92 (1.51–2.46)
Valve location (Mitral)		0.37	0.38	0.19 (0.14–0.25)	1.21 (1.15–1.28)
Aetiology[c]	—	—	—		
Staphylococcus spp.				0.64 (0.35–0.94)	1.90 (1.42–2.56)
Fungi				0.61 (−0.46 to 1.40)	1.84 (0.63–4.06)

POTTER score?

- Based on 382 960 ES patients, comprehensive decision-making algorithms were derived
- POTTER was created where the provider's answer to a question **interactively dictates the subsequent question**
- For any specific patient, the **number of questions needed** to predict mortality ranged from **4 to 11**
- The mortality c-statistic was 0.9162, higher than ASA



ASA PAPER

Surgical Risk Is Not Linear: Derivation and Validation of a Novel, User-friendly, and Machine-learning-based Predictive OpTimal Trees in Emergency Surgery Risk (POTTER) Calculator

Dimitris Bertsimas, PhD, Jack Dunn, PhD,* George C. Velmahos, MD, PhD,† and Haytham M. A. Kaafarani, MD, MPH, FACS†*

- POTTER, a highly accurate ES risk **calculator that outperforms, in accuracy** and user-friendliness, all the current existing risk prediction tools
- POTTER might prove useful as an evidence-based, adaptive, and interactive tool for bedside preoperative counseling

Take Home Messages

- IE remains associated with high morbidity and mortality, despite significant advances in diagnosis and treatment
- After surgery, in-hospital mortality is high (29–50%), but it **is higher in rejected patients** (52–83%)
- **It's important to note that the choice of scoring system or criteria may depend on the clinical context and the specific goals of assessment (e.g., diagnosis, risk stratification, surgical planning)**

- Although several predictive scoring models exist to predict the mortality and morbidity of patients undergoing cardiac surgery for IE, **a universal model that includes patient factors and is specific to IE is still lacking**