

Desatoro zásad v diagnostike sepsy

Roman Záhorec

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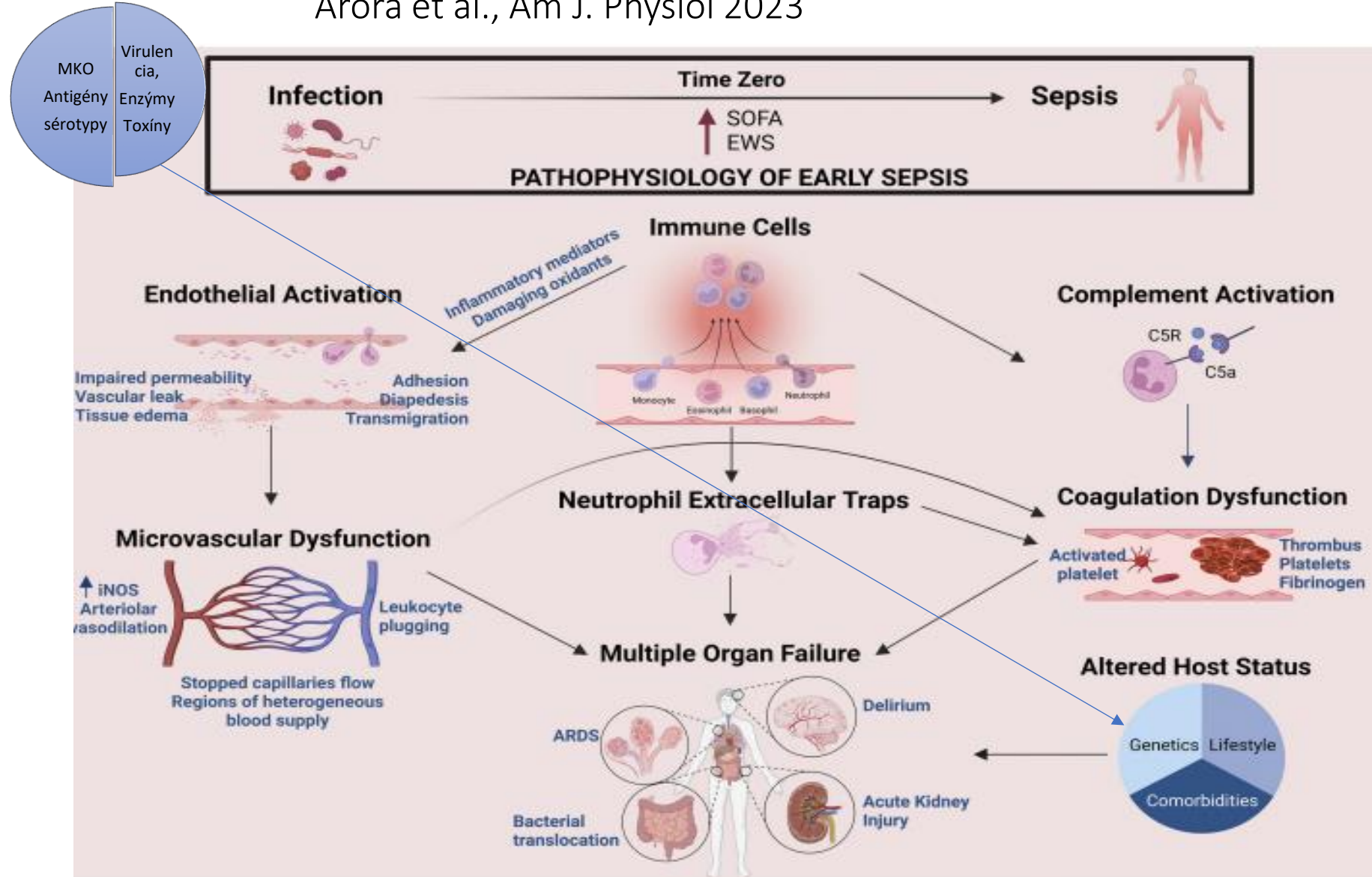


Diagnostika sepsy a septického šoku

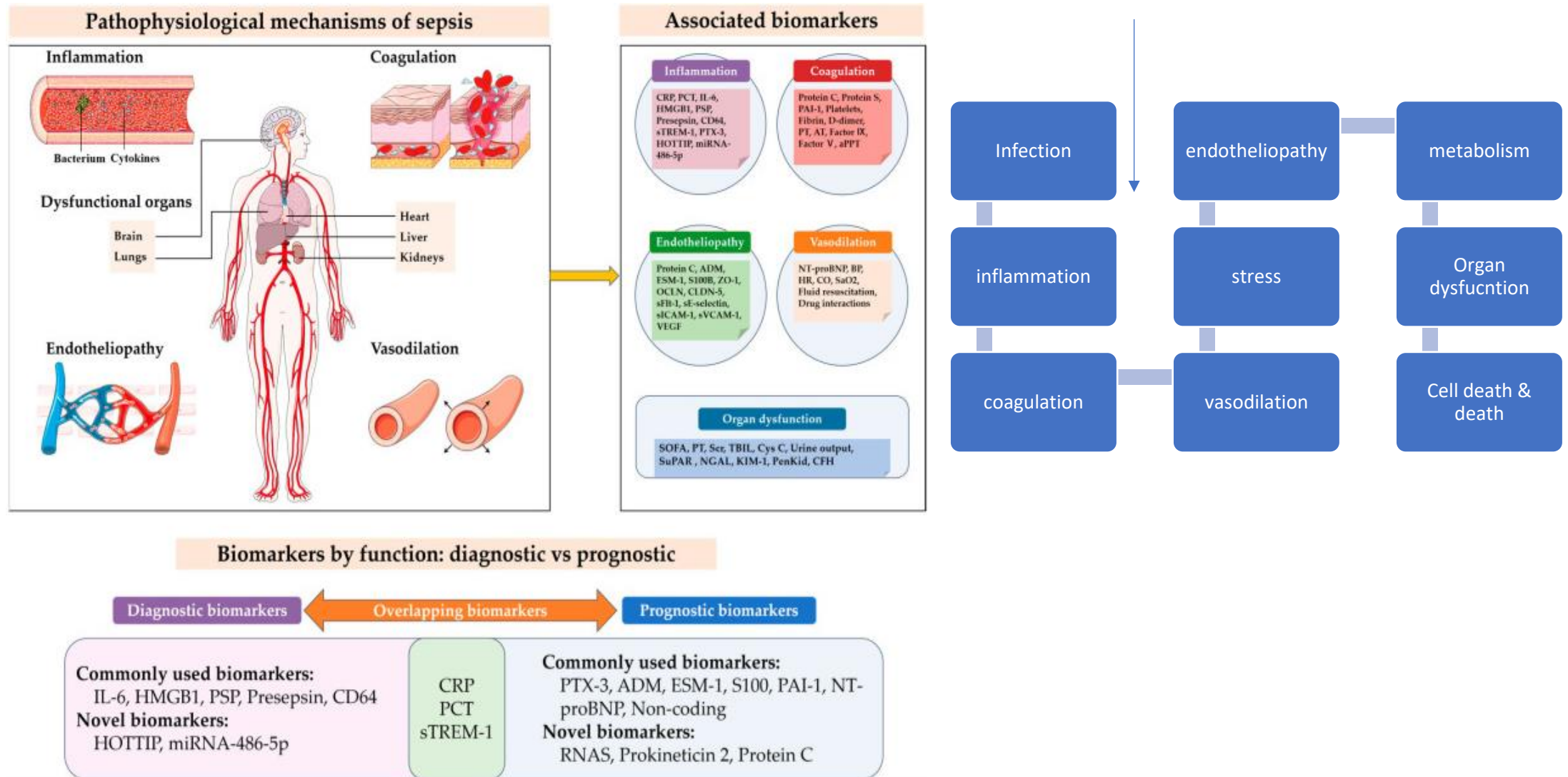
- Každý prípad sepsy /septického šoku je unikátny , jedinečný
- Príznaky sú vysoko variabilné, významné intra- a interindividuálne rozdiely ,
- až 1/3 príznakov je netypická „vážna“ neistá, *Filbit et al.2018, Seymour et al.2010*
- Trajektória pacientov s klinickým syndrómom sepsy je rôznorodá, závislá od miesta infekcie, od pôvodcu a virulencie mko, zdravotného stavu a veku pacienta.
- Diagnostika septického stavu v závislosti od miesta, časového priebehu infekcie, od možností vyšetrení: prednemocničné, odd. urgentnej medicíny, lôžkové oddelenia nemocníc, JIS, KAIM.
- Dg. musí byť komplexná , interdisciplinárna, založená na súbore anamnézy, klinických, laboratórnych, mikrobiologických vyšetrení a zobrazovacích metód

Sepsis network pathophysiology, tool for biomarkers

Arora et al., Am J. Physiol 2023



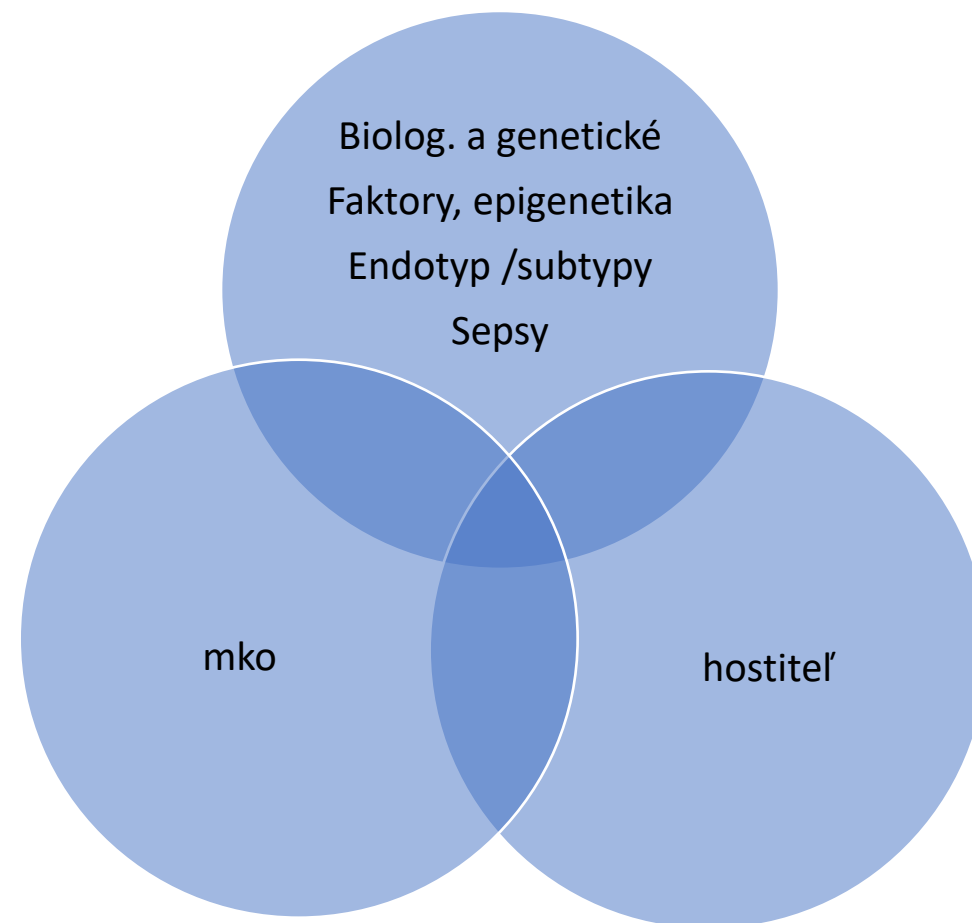
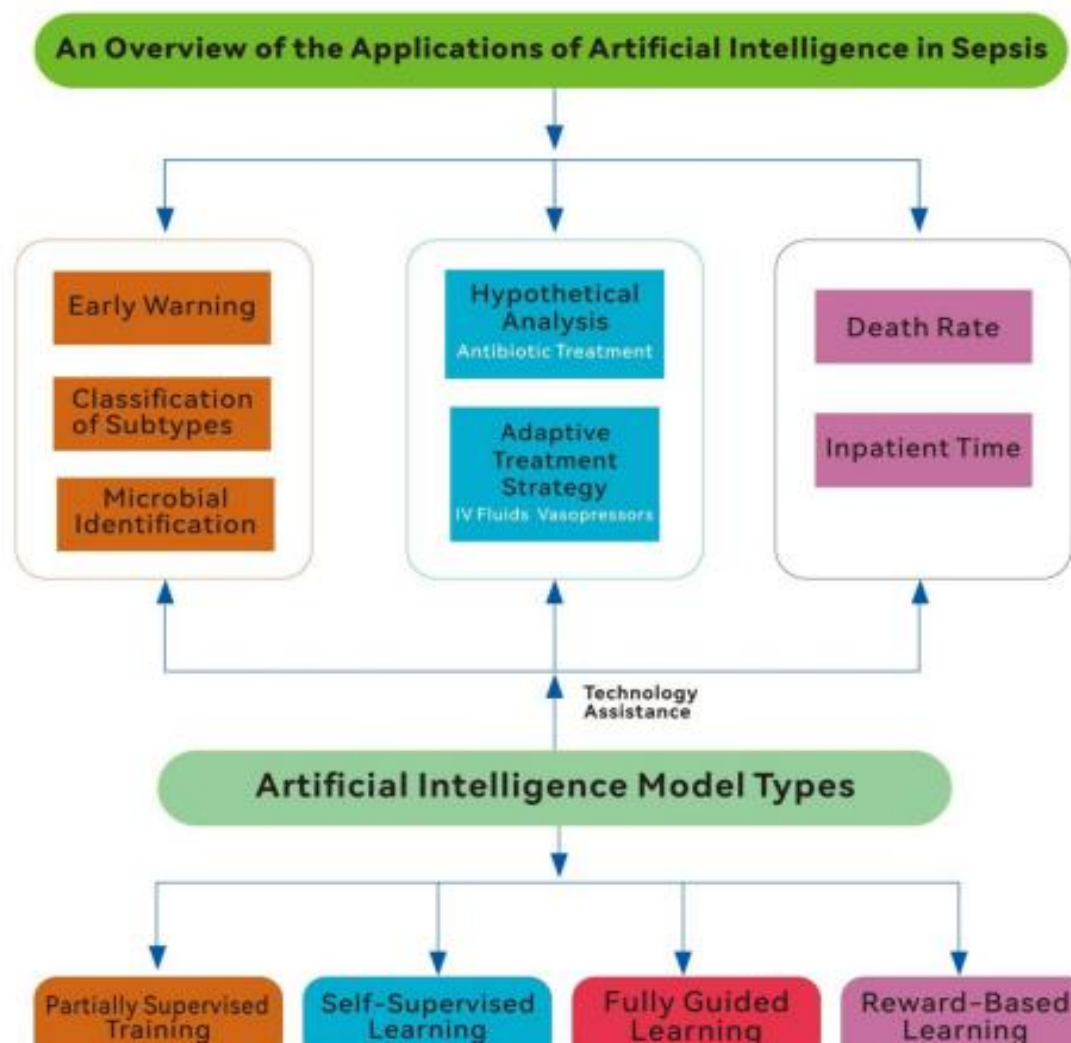
SEPSA - OTRAVA KRVI. Patofyziologické deje počas sepsy : Infekcia, systémová zápalová reakcia, Aktivácia a dysfunkcia koagulácie, Aktivácia endotelu, endotelopatia, Vasodilatácia, Endokrinný a metabolický stres, organová dysfunkcia, smrť buniek & smrť



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Praha 2025
9.oktober

Harnessing artificial intelligence in sepsis care: advances in early detection, personalized treatment, and real-time monitoring

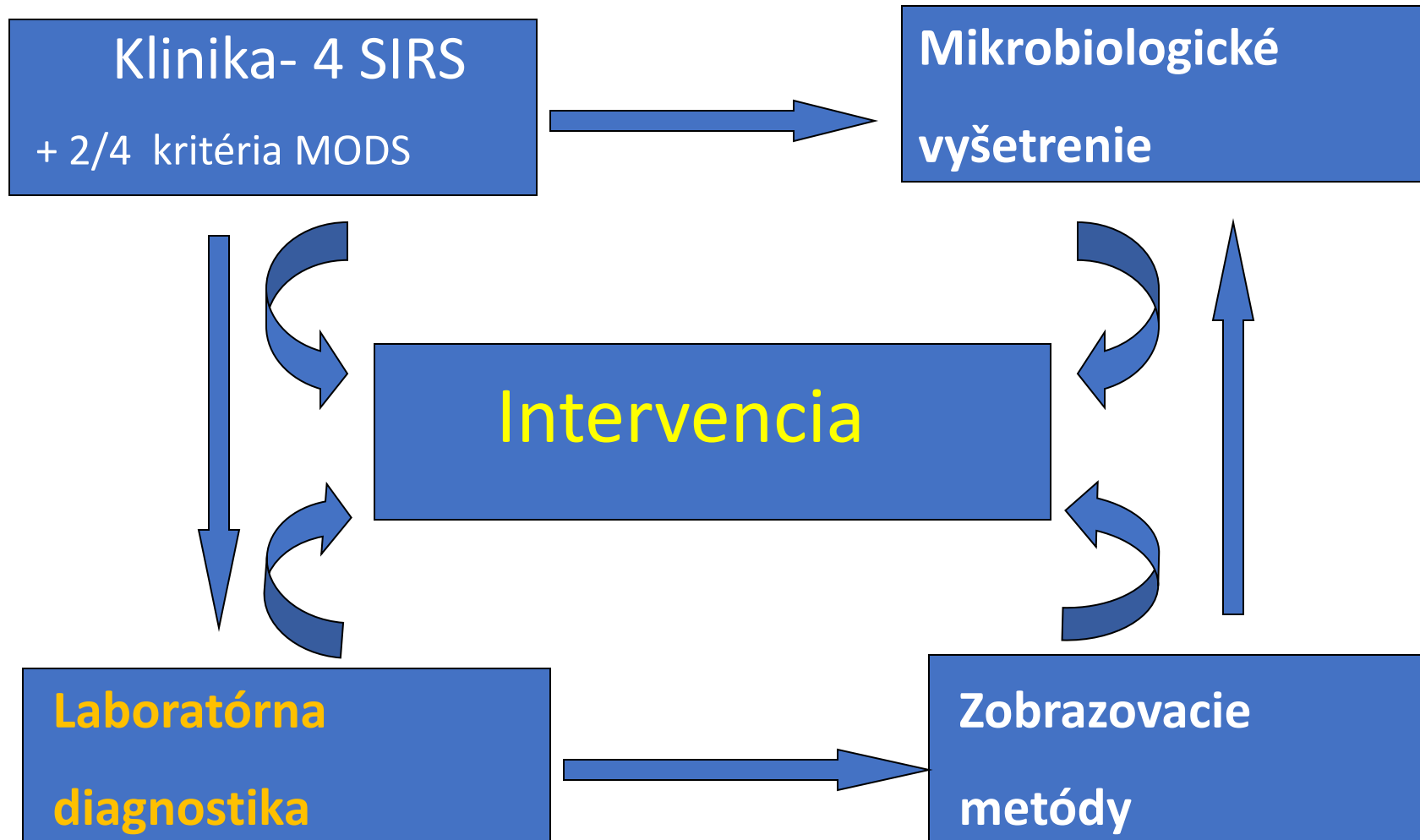
Fang Li¹, Shengguo Wang², Zhi Gao², Maofeng Qing²,
Shan Pan², Yingying Liu² and Chengchen Hu^{2*}



Rizikové faktory a rizikovní pacienti pre vznik sepsy

- Vek (≥ 50 r., ≥ 60 r., > 75 r. alebo novorodenci a deti < 3 roky)
- Chronické choroby pečene a obličiek
- Chronické hematologické ochorenia
- Rakovina
- Podvýživa alebo morbidná obezita BMI > 40
- Casus socialis, abusery (drogy)
- Nedávne užívanie ATB
- Imunosupresia po lieková (kortikoidy, CHT)
- Spôsob životného štýlu, psychosociálne faktory /osamotení „single“

Algoritmus diagnostiky sepsy a SIRS



Intenzivní a resuscitační péči nelze provádět bez znalosti základních biochemických parametru.

A. Kazda, 1986

Diagnosis of sepsis: which clinical and laboratory biomarkers are useful?

Polish Arch Int Med 2024

Miroslav Prucha¹, Roman Zahorec^{2,3}

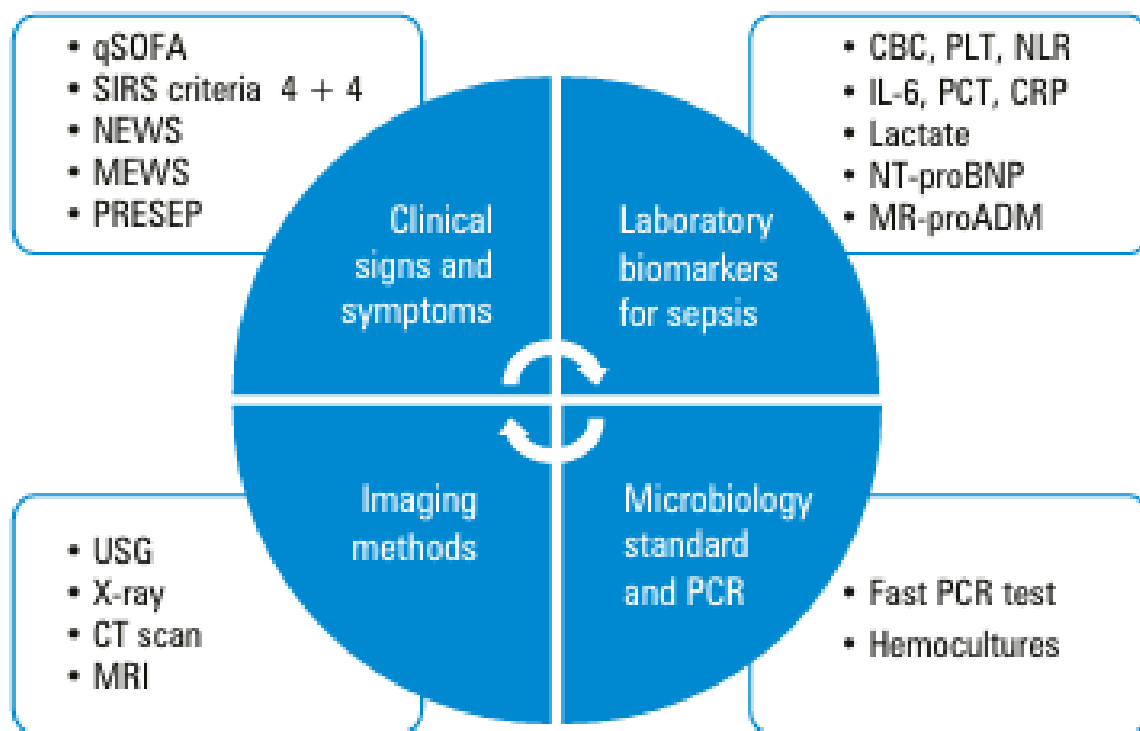


FIGURE 1 Algorithm for diagnosing sepsis

Abbreviations: CBC, complete blood count; CT, computed tomography; MEWS, modified early warning score; MRI, magnetic resonance imaging; NEWS, national early warning score; PCR, polymerase chain reaction; PRESEP, prehospital sepsis score; SIRS, criteria according to R. Bone¹²; qSOFA, quick sequential organ failure assessment score;

Aké sú symptómy sepsy ?

WHAT ARE THE SYMPTOMS?

SYMPTOMS IN CHILDREN

A child may have sepsis if he or she:

- **Is breathing very fast**
- **Has a 'fit' or convulsion**
- **Looks mottled, bluish, or pale**
- **Has a rash that does not fade when you press it**
- **Is very lethargic or difficult to wake**
- **Feels abnormally cold to touch**

SYMPTOMS IN ADULTS

An adult may have sepsis if they show any of these signs:

- S**lurred speech or confusion
- E**xtrême shivering or muscle pain
- P**assing no urine (in a day)
- S**evere breathlessness
- I**t feels like you're going to die
- S**kin mottled or discoloured

Hlavné príznaky predchádzajúce sepse alebo vedúce k sepse.

V prednemocničných podmienkach

Wallgren U.M et al. Scand J Trauma, Resuscitation, Emergency Medicine, 2017,25:23-

- Náhla horúčka, triaška alebo rigor
- Náhle dyspnoe. fd > 24/min
- Náhla akútna silná bolesť
- Náhla zmena mentálneho stavu
- Náhla svalová slabosť
- Strata svalovej sily, malátnosť
- Náhla nevoľa, alebo hnačka
- Bolesti hlavy



Figure 7. Systemic symptoms seen in patients with sepsis. These symptoms vary between

SEPSIS SCORE - to measure severity of sepsis

Elebute, Stoner, BMJ 1983.

XXVI. Kongres ČSARIM Brno 2.10.2019

Clinical severity of sepsis,

Infection origin G+ 2 points, G- 4 points,
polymicrobial sepsis 5-6 points

Temperature - **pyrexia** 1-3 points

Organ dysfunction (MODS) 1 – 3 points (tachykardia, hypotenzia, tachypnoe, hypoxémia), BAS 90-30-90 (HR>90/min sAP < 90 mmHg, RR > 30/min, SpO2 < 90%)

Laboratory parameters : **leukocytosis 1-3 points, (> 12 tis, > 20 tis, > 27 tis)**
hemoglobin (anemia) 1 – 3 points,
hypoalbuminemia 1 – 3 points (< 36 g/l, < 30 g/l, < 25 g/l) , and
trombocytopenia 1 – 3 (< 150 tis, < 100 tis/μl, < 50 tis/μl)

Sepsis score < 16 points good outcome

Sepsis score > 16 points , bad outcome

Varovné vitálne znaky na skorú identifikáciu pacientov so syndrómom sepsy na oddeleniach urgentnej medicíny.

Skóre na Skrining sepsy

Ljungstrom , Community onset sepsis in Sweden. PhD Thesis, Univ Gothenburg 2017

- **SIRS kritéria 2/4** , variabilita výskytu jednotlivých kritérii od 42-78% , zmena teploty 51-65%, najpriekaznejší znak **dyspnoe /tachypnoe > 24 d/min. až > 30 d./min**
tachykardia > 90/min. (67-78 %) a **hypotenzia sAP < 90 mmHg**
- **NEWS** (Vedomie APUV, sTK, HR, SpO2 ,) , resp. **MEWS modified emergency**
- **PRESEP skóre** , t > 38 C 4 body, srdc. Frekvencia > 90/min 2 body, hypotenzia sTK < 90 mmHg 2 body, tachypnoe > 22/min. 1 bod, hypoxémia SpO2 < 90 % 2 body.
PRESEP > 4 body bola **senzitivita 0,85 a špecificita 0,86** .
- **BAS 90-30-90** , sAP < 90 mmHg, tachypnoe > 30/min, SpO2 < 90 %. Identifikácia 62-71% septických pacientov.
- **MEDS skóre** – vek > 65 r, hypoxémia, zmena vedomia, **tachykardia, tachypnoe**
- **qSOFA** , **sAP < 100 mmHg**, alterácia vedomia , tachypnoe fd > 22 d/min. alebo SpO2 <92% - výťažnosť od 29 % po 42% (Williams , 2017), resp. 55% dg. ťažkej sepsy.
- **SPEED skóre** – Bewersdorf 2015,2017

Lars Ljungstrom , Community onset sepsis in Sweden. PhD. Univ Gothenburg 2017.

Sepsis Immuno Score

De Novo FDA Authorization (April 2024)

The Sepsis ImmunoScore™

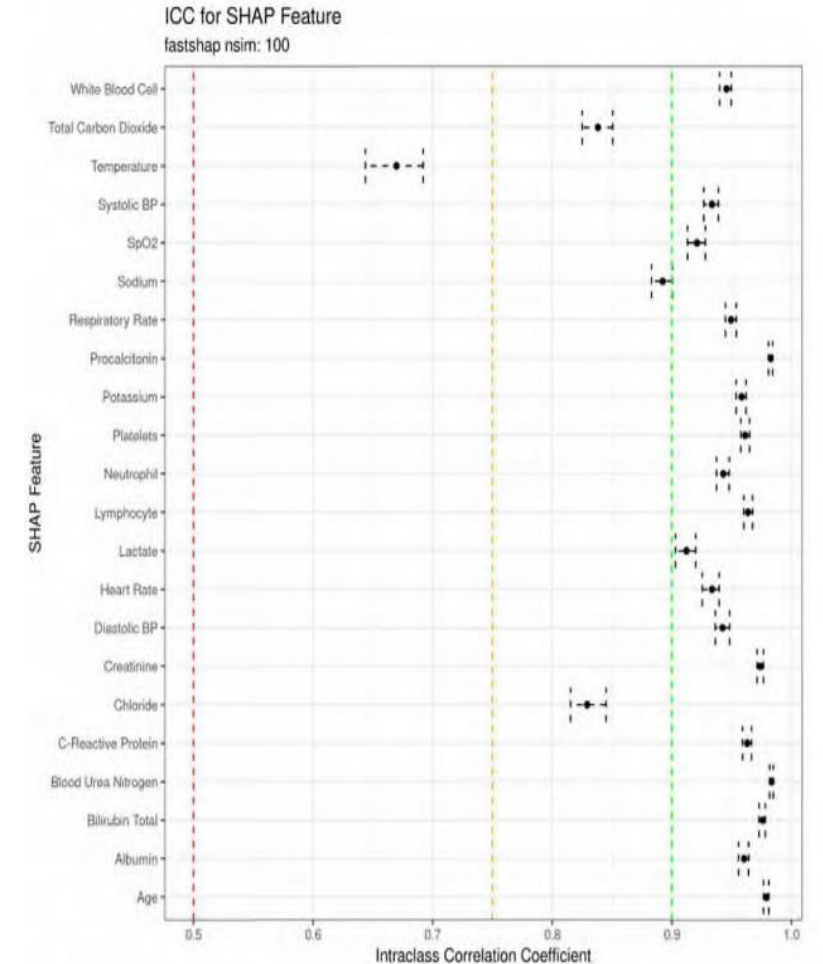
First-ever FDA authorized AI sepsis diagnostic tool with powerful diagnostic

FDA-Authorized AI/ML Tool for Sepsis Prediction: Development and Validation

Authors: Akhil Bhargava, M.S. , Carlos López-Espina, M.S. , Lee Schmalz, B.S. , Shah Khan, Ph.D. L. Watson, Ph.D. , Denny Urdiales, B.S. , Lincoln Updike, B.S. , +44 , and Nathan I. Shapiro, M.D.

	Parameter	Data Source	Example Device	Imputable
1	Age	Triage	-	Yes
2	Systolic Blood Pressure	Triage Vitals	Blood Pressure Monitor	No
3	Diastolic Blood Pressure	Triage Vitals	Blood Pressure Monitor	No
4	Temperature	Triage Vitals	Oral or Rectal Thermometer	No
5	Respiratory Rate	Triage Vitals	Manual Measurement	No
6	Heart Rate	Triage Vitals	Pulse Monitor	No
7	Blood Oxygen Saturation	Triage Vitals	Pulse Oximeter	No
8	White Blood Cell Count	CBC Panel	Sysmex XN-9100	No
9	Lymphocyte Count	CBC Panel	Sysmex XN-9100	Yes
10	Neutrophil Count	CBC Panel	Sysmex XN-9100	Yes
11	Platelet Count	CBC Panel	Sysmex XN-9100	No
12	Blood Urea Nitrogen	BMP or CMP Panel	Siemens Atellica CH 930	No
13	Creatinine	BMP or CMP Panel	Siemens Atellica CH 930	No
14	Potassium	BMP or CMP Panel	Siemens Atellica CH 930	Yes
15	Chloride	BMP or CMP Panel	Siemens Atellica CH 930	Yes
16	Total Carbon Dioxide	BMP or CMP Panel	Siemens Atellica CH 930	Yes
17	Sodium	BMP or CMP Panel	Siemens Atellica CH 930	Yes
18	Albumin	CMP Panel	Siemens Atellica CH 930	Yes
19	Bilirubin	CMP Panel	Siemens Atellica CH 930	Yes
20	Procalcitonin	Stand-alone Test	Roche Cobas e411	No
21	C-Reactive Protein	Stand-alone Test	Roche Cobas e411	No
22	Lactate	Stand-alone Test	Siemens Atellica CH 930	Yes

Table 1. List of algorithm inputs



PRAHA 2025
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De Novo FDA Authorization (April 2024)

The Sepsis ImmunoScore™

First-ever FDA authorized AI sepsis diagnostic tool with powerful diagnostic

FDA-Authorized AI/ML Tool for Sepsis Prediction: Development and Validation

Authors: Akhil Bhargava, M.S. , Carlos López-Espina, M.S. , Lee Schmalz, B.S. , Shah Khan, Ph.D. , L. Watson, Ph.D. , Dennys Urdiales, B.S. , Lincoln Updike, B.S. ,  **+44**, and Nathan I. Shapiro, M.D. 

First all features were ranked by summing the absolute SHAP value across all subjects for each input parameter in the validation dataset:

- Sepsis

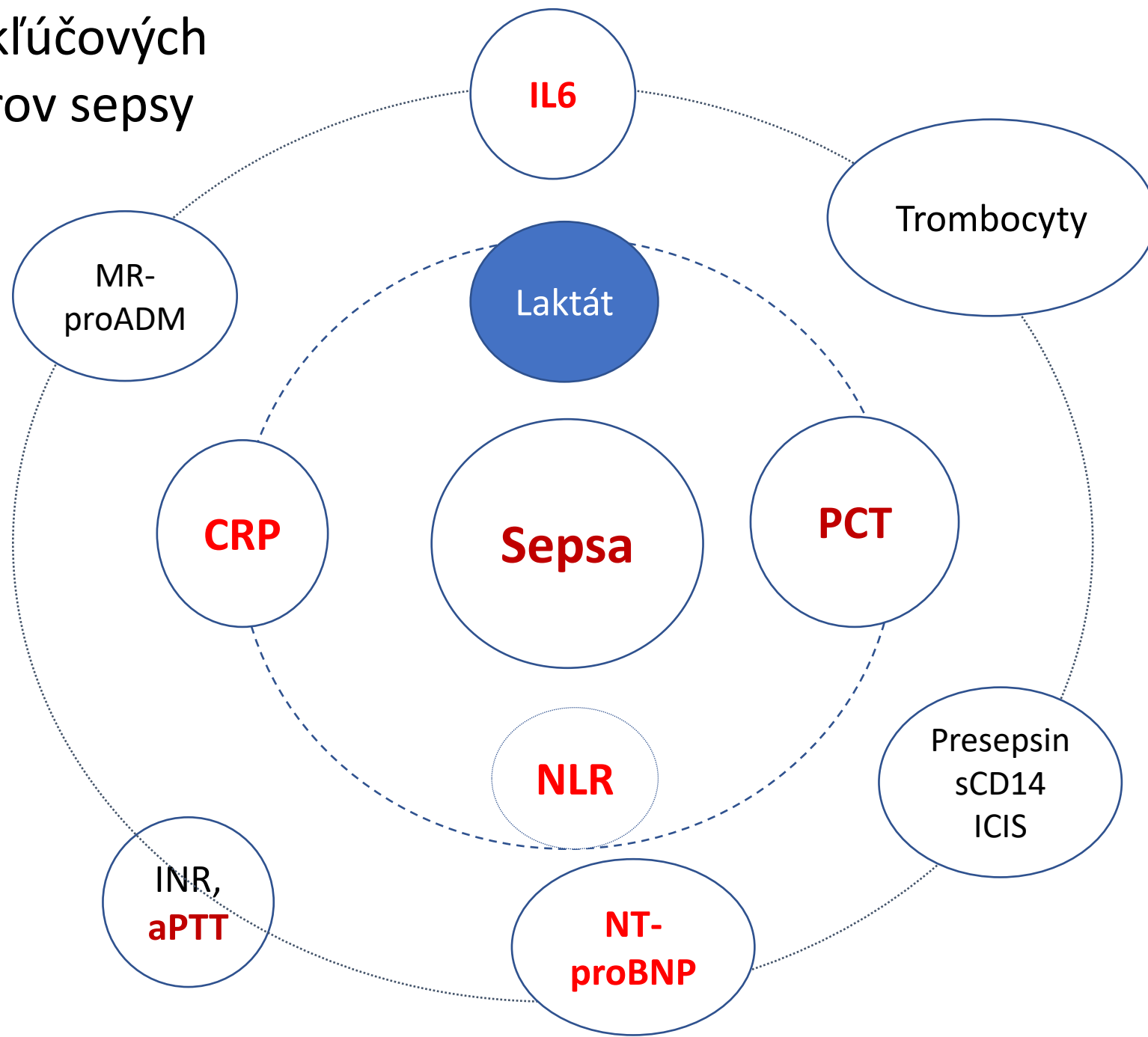
immunoscore

Feature	Sum SHAP Values	Ranking
Procalcitonin (PCT)	26.833	1
Respiratory Rate	26.129	2
Platelets	24.632	3
Systolic BP	22.147	4
Blood Urea Nitrogen	20.051	5
Bilirubin Total	17.856	6
Diastolic BP	15.85	7
Albumin	11.983	8
Age	11.564	9
Creatinine	10.683	10
SpO2	10.193	11
Potassium	7.994	12
Total Carbon Dioxide	6.651	13
C-Reactive Protein (CRP)	6.394	14
Temperature	6.342	15
Lactate	5.047	16
Sodium	4.94	17
Lymphocyte	4.836	18
Chloride	3.603	19
Heart Rate	3.364	20
Neutrophil	2.817	21
White Blood Cell	2.628	22



Table 27. Global Feature Importance Ranking

Desať klíčových markerov sepsy



Diagnosis of sepsis: which clinical and laboratory biomarkers are useful?

Polish Arch Int Med. 2024

Miroslav Prucha¹, Roman Zahorec^{2,3}

1 Department of Clinical Biochemistry, Hematology and Immunology, Na Homolce Hospital, Prague, Czech Republic

2 Department of Anesthesiology and Intensive Medicine, University Hospital Bratislava, Bratislava, Slovak Republic

TABLE 2 Cutoff values of most often used biomarkers for sepsis

Basic biomarkers	Reference range in healthy adults	Mild systemic infection, sepsis	Severe invasive infection, septic shock	References
PCT, µg/l	0.05–0.1	0.5–1	≥2–3, ≥5–10 ^a	1,13,15–17,19,23–30
CRP, mg/l	0–5	50–150	≥150–200	1,11,17,21,24–34
IL-6, ng/l	1–10	100–300	≥500, ≥1000 ^a	28–30,85,86
NLR	1.1–2.2	3.5–7	≥7, ≥11 ^a	13,15,27,36–40,43,44
Presepsin (sCD14), ng/l	100–200	≥600	≥1000	50–54
NT-proBNP, ng/l	50–290	300–1000	≥1000, ≥3000 ^a	1,92,93
Arterial lactate, mmol/l	0.6–1.5	≥2.2–2.5	≥3.5–4	13,23,28,30,87
Platelets, count × 10 ³ /l	150–300	≥300, <150	≥400, <100 ^a	28,30,37,41,43,91
MR-proADM, nmol/l	<0.7	1.2–2.3	≥2.3, ≥5 ^a	79–81
Albumin, g/l	40–48	25–34	<25	1,15,28,90,94
Cholesterol, mmol/l	3.8–5.4	2.2–3.3	<2.1	88,89
HDL-C, mmol/l	0.9–1.2	0.6–0.8	<0.6	

a Values typical of septic shock and hyperinflammatory response

TABLE 1 Classification of biomarkers for sepsis according to their physiological function

Physiology	Basic panel of biomarkers for sepsis	Extended panel of biomarkers for sepsis
Humoral immune system and complement system	IL-6	IL-1 β , IL-8, IL-17, IL-17A, C3a, C5a
Cellular immune system, WBC differential count	Neutrophil, lymphocyte, eosinophil, and basophil counts	Monocyte count, MDW%, IG%, bands plasmablasts
Complete blood count	Hemoglobin, platelet count	RDW%, normoblasts IP%, MPV, IG%,
Blood coagulation	Fibrinogen, D-dimer	aPTT, INR, ATIII, suPAR, PAI-1
Positive and negative APPs	CRP, PCT, albumin	Ferritin, heparin-binding protein, transferrin, HDL-C
Hormones	NT-proBNP	MR-proADM, bioadrenomedullin
Metabolism	Lactate	Cholesterol, HDL-C, myristic acid
Cell-surface receptors	sCD14 (presepsin), nCD64,	sTREM-1, sCD163
Transcriptomics, metabolomics	–	ncRNA, miRNA, myristic acid
Ratios and indices based on blood cells	NLR	PNI, PLR, SII, SIRI, MPV/PLT
Ratios and indices based on proteins	CAR	PCT/ALB, ICIS, AFR, CLR, CALLY, NAR, PNI
Peptides	Troponin T, I	PSP, DPP3, NGAL
Proteins	LDH	PLA2
Electrolytes	Calcium, iCa ²⁺	Serum Na, K, Mg, osmolality
Acid base balance	pH, BE	

Abbreviations: AFR, albumin-to-fibrinogen ratio; APP, acute phase protein; aPTT, activated partial throm-

Diagnosis of sepsis: which clinical and laboratory biomarkers are useful?

Miroslav Prucha¹, Roman Zahorec^{2,3}

Polish Arch Int Med. 2024

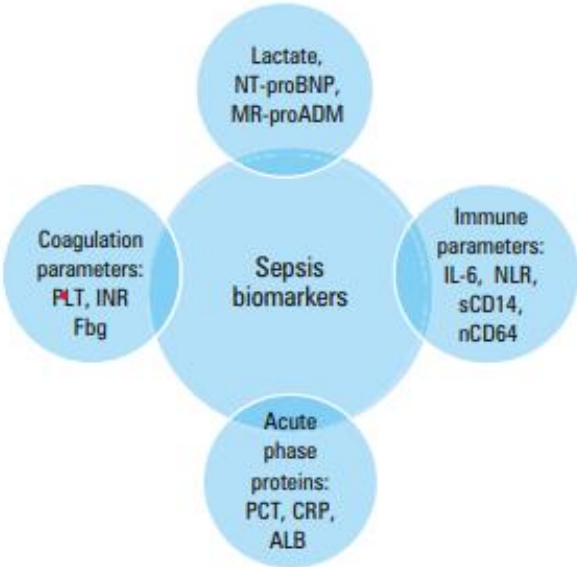


FIGURE 2 Most commonly used biomarkers for sepsis diagnosis in clinical practice
Abbreviations: ALB, albumin; sCD14, soluble sign CD14 (presepsin); nCD64, sign CD6 on neutrophils; Fbg, fibrinogen; others, see **TABLE 1**

TABLE 4 How to use biomarkers for sepsis diagnosis: tips and tricks

Understand the biology, half-life, and limitations of each biomarker.
Always evaluate sepsis biomarkers with regard to the clinical status and clinical context.
Use valid reliable laboratory parameters that are screened 24/7.
Collect serial measurements of biomarkers every day in the acute phase to monitor kinetic peak and nadir values.
Use a panel of different markers of sepsis (IL-6, NLR, PCT, CRP) and shock (lactate, NT-proBNP) to measure intensity of immune–inflammatory and stress response.
Use ratios of markers (NLR, CAR), indexes (SII, SIRI), and combined scores (ICIS, SOFA+ 0.15 × NLR).
Integrate clinical signs (SOFA, MEWS) with evaluation of biomarkers in the decision making (FIGURE 1).
Follow dynamic changes of marker levels during the course of sepsis (Δ, clearance) on days 1, 3, 5, 7, and 10 to evaluate patient outcomes and prognosis.

Effects of C-reactive protein trajectories of critically ill patients with sepsis on in-hospital mortality rate

31.kongres ČSARIM, PRAHA 2025

Xuandong Jiang¹, Chenlu Zhang², Yuting P

Sepsis, a life-threatening condition caused by an

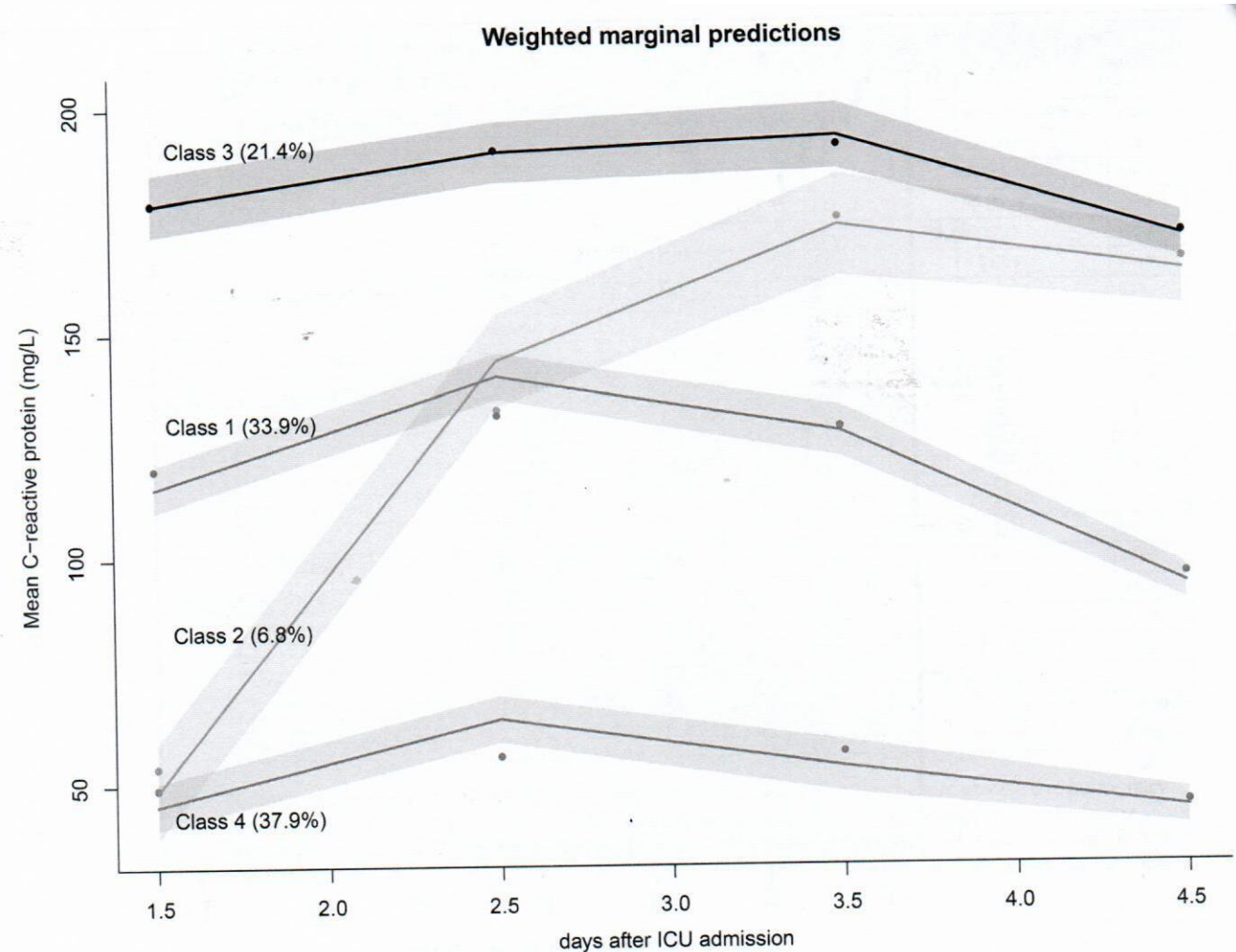


Figure 2. CRP-based trajectories of patients with sepsis. The shaded area indicates the 95% confidence interval for each mean trajectory. The percentages in the parentheses indicate the percentages of patients each class accounts for. CRP, C-reactive protein; ICU, Intensive Care Unit.

Immune Subtypes in Sepsis: A Retrospective Cohort Study Utilizing Clustering Methodology

J. Inflamm Research 2024 Dec

Jian Zhao^{1,*}, Rushun Dai^{2,3,*}, Yi Zhao^{1,*}, Jiaping Tan^{4,*}, Di Hao¹, Jie Ren¹, Xianwen Wang¹, Yanqing Chen¹, Hu Peng¹, Yugang Zhuang^{1,5}, Shuqin Zhou¹, Yuanzhuo Chen¹



Figure 1 Clustering Analysis of Sepsis Immunotypes.

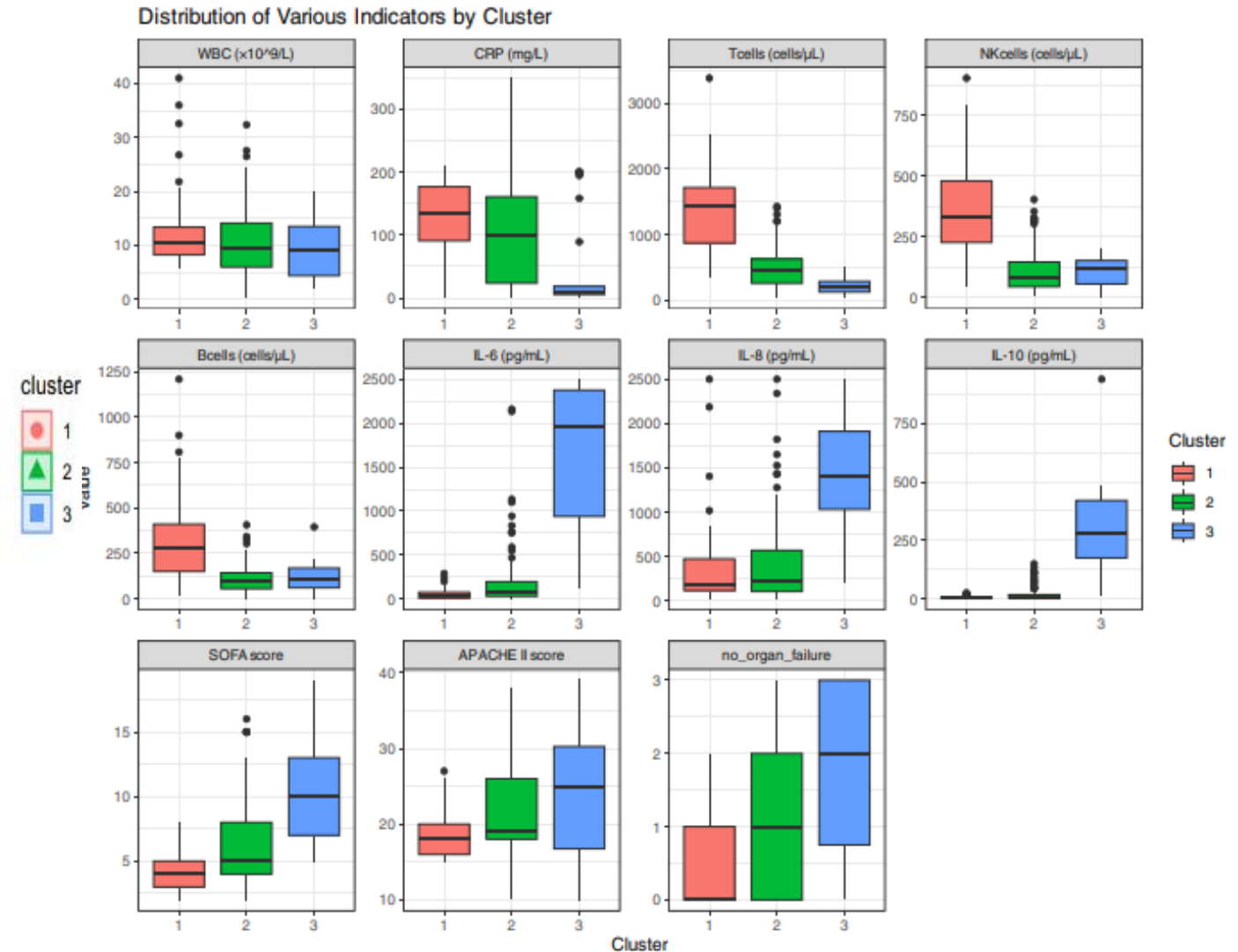
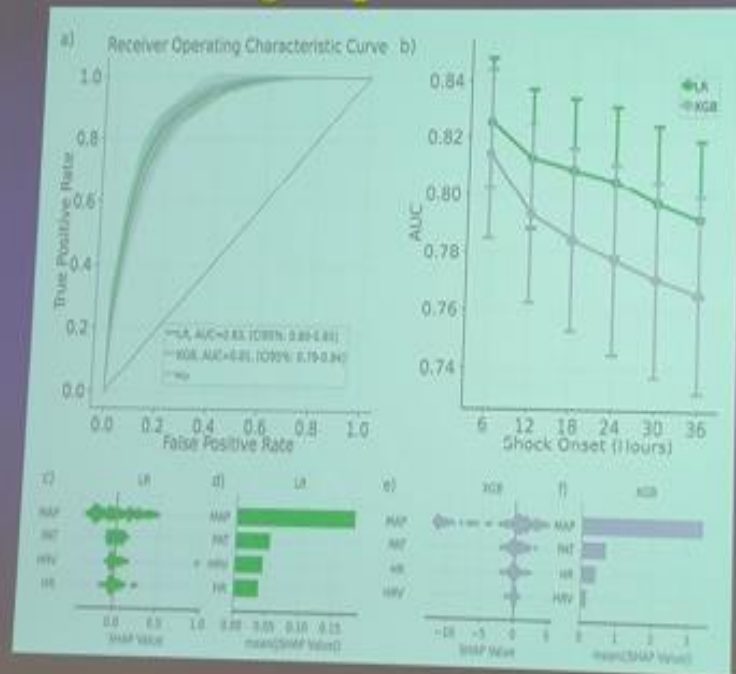


Figure 2 Distribution of Various Clinical Indicators by Cluster in Sepsis Patients.

Predicting sepsis from 5 minutes Time series. Data : MAP, Pulse Arriv Time, HRV, HR

Predicting Sepsis from Time Series Data

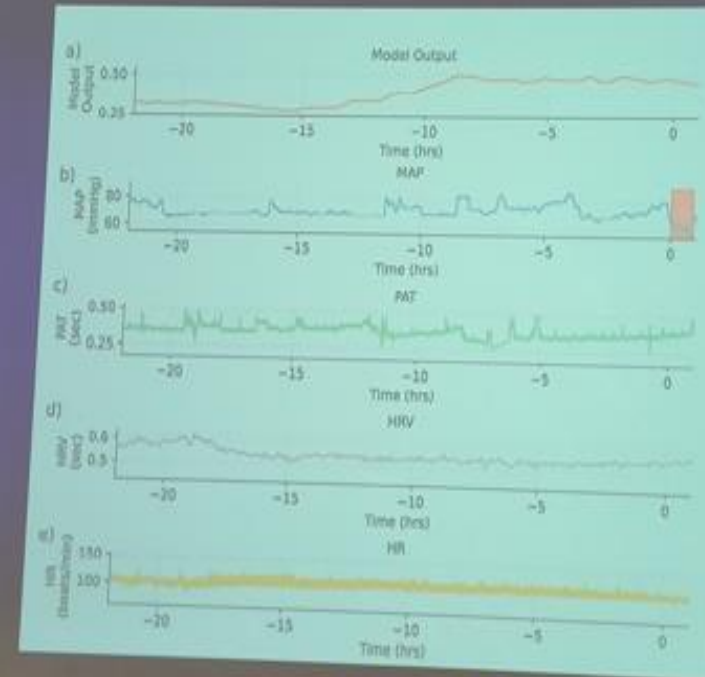


Soliman et al. Biomed Sign Proc Contr 92:105974, 2024

MAP
Pulse arrival time
Heart rate variability
Heart rate

10-12hodin
pred klinick. Začatím
rozvinutím
Sept. šoku

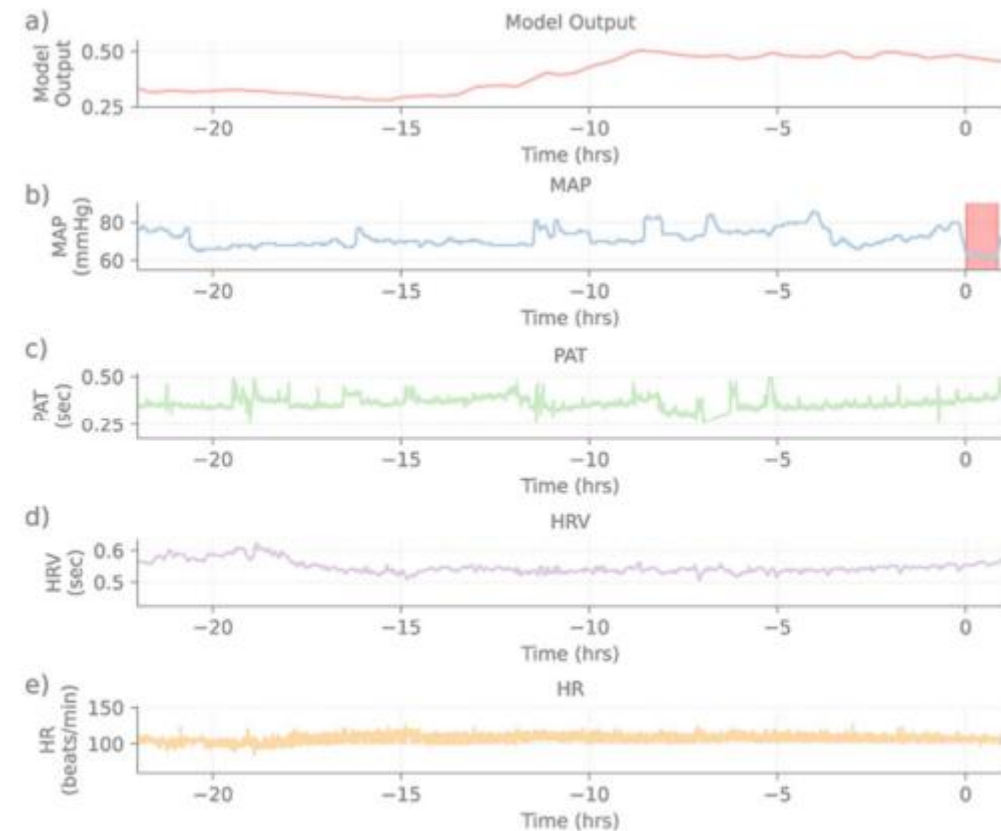
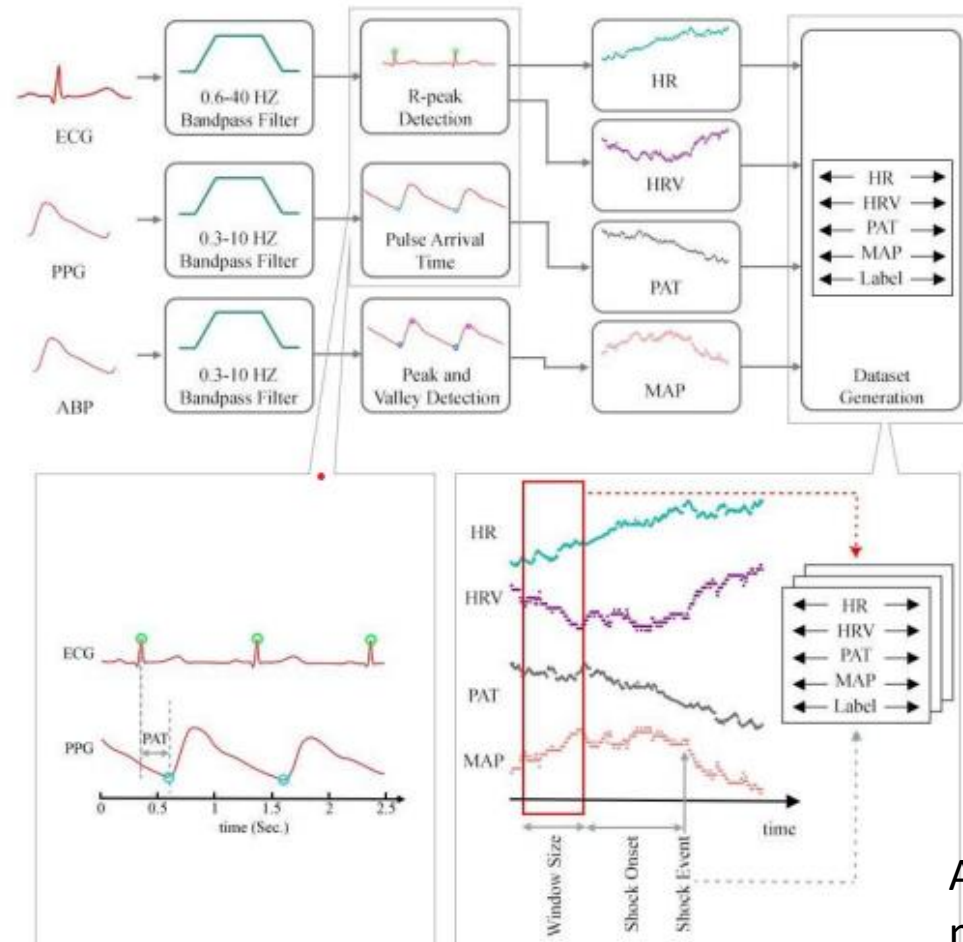
Predicting Sepsis from Time Series Data



Soliman et al. Biomed Sign Proc Contr 92:105974, 2024

Parsimonious Waveform-derived Features : MAP, Pulse Arrival Time and Heart Rate Variability Predicts the Onset of Septic Shock

Moamen M. Solimana, Curtis Marshall, Ph.D.b, Jacob P. Kimball, Ph.D.c , Tilendra Choudhary, Ph.D.b, Gilles, M. R. Pinsky, 2024



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Figure 4: A real example of logistic regression model output during testing a). The patient features are b) MAP, c) PAT, d) HRV, and e) HR features (HR, HRV, PAT, MAP) into data points as shown in Fig 1.

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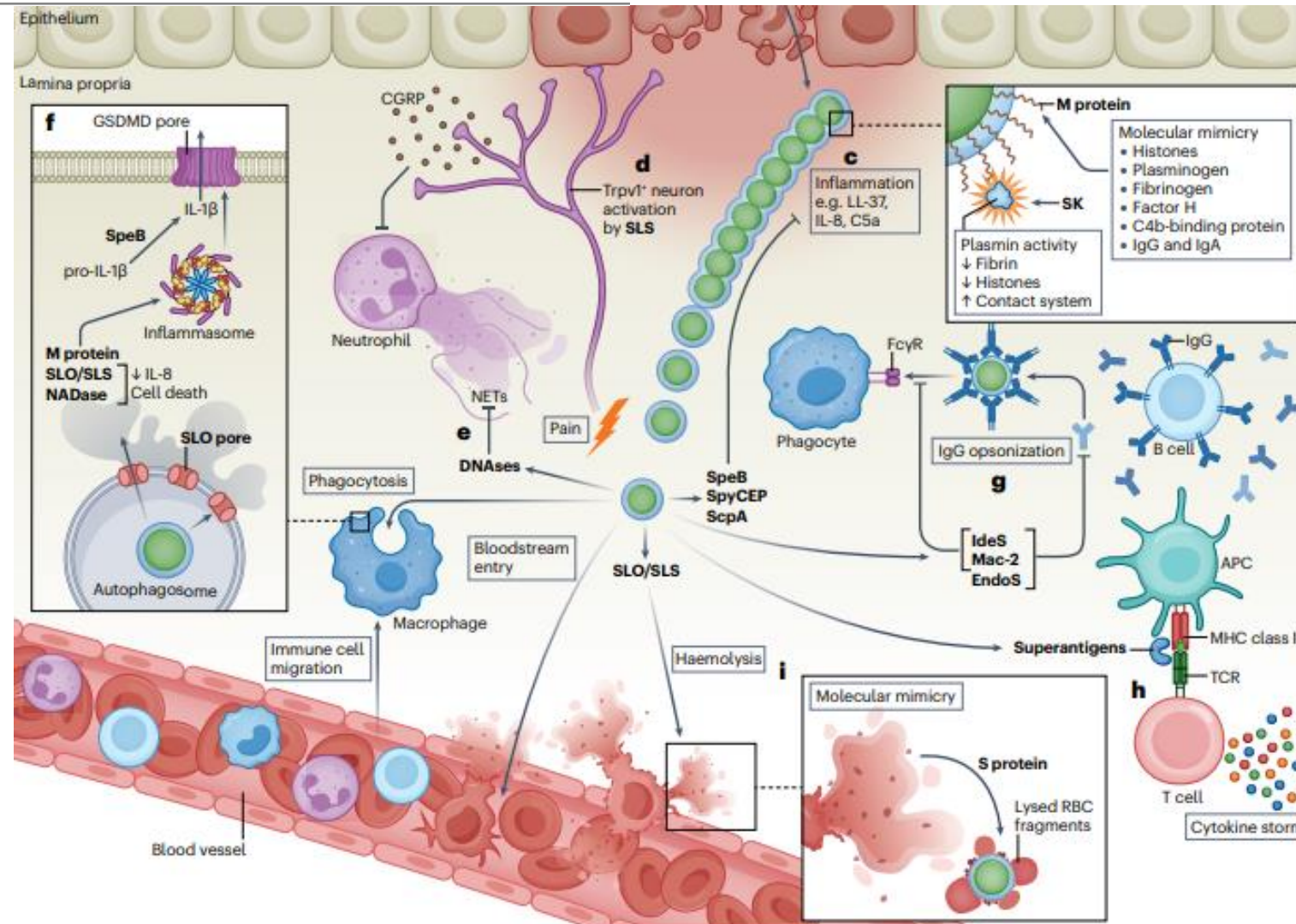
Mikrobiologická diagnostika sepsy , identifikácia etiologického agens,
identifikácia infekcie miesta a zdroja (zobrazovacie metódy) a pôvodcu
(mikrobiologická diagnostika PCR, kultivačne, Vitek, MALDI-TOF)

- Správny odber biologického materiálu a hemokultúr
- **Satelitné hemokultivačné** prístroje v nemocniciach, **transport**
- **Aktívna komunikácia a interdisciplinárna spolupráca v režime 24/7**
- Rýchla molekulová diagnostika na báze PCR metód : ePLEX Cobas Roche, Sepsfast (100 mikroorganizmov) ,
- **Presná mkb diagnostika** kmeňa, sérotyp, citlivosť na ATB, rezistencia
- Dôkladné poznanie biologických vlastností mko (sérotypy, antigénne, toxíny, enzýmy.. Mechanizmy invázie)

Pathogenesis, epidemiology and control of Group A *Streptococcus* infection

Nature Review Microbiology, 2023 July

Stephan Brouwer^{1,2,3}, Tania Rivera-Hernandez⁴, Bodie F. Curren^{1,2}, Nichaela Harbison-Price^{1,2,3}
David M. P. De Oliveira^{1,2,3}, Magnus G. Jespersen⁵, Mark R. Davies⁵ & Mark J. Walker^{1,2,3} ✉



Závery „ Desatoro zásad v diagnostike sepsy „

- Pochopenie patofyziologických mechanizmov sepsy u hostiteľa
- Dôkladné poznanie **biologických vlastností mko** (antigén, toxíny, enzýmy..)
- Nástroje na rýchle rozpoznanie sepsy **klinické, vitálne funkcie, laboratórna diagnostika (PCT,CRP, NLR, laktát), skrínigové skóre** : MEWS, NEWS, SIRS 4+4 , BAS, PRESEP
- Analýza **príčin heterogenity** klinického syndrómu sepsy : PIRO, SPEED, endotypy sepsy (SENECA , MARS, imunofenotypy)
- **Rýchla mikrobiologická diagnostika** , molekulová PCR dg. Panely vyš.
- Teamová interdisciplinárna spolupráca a komunikácia
- Stúpajúci **význam AI v diagnostike** s využitím monitorovania VF, v **klasifikácii sepsy na endotypy** podľa imunitnej odpovede hostiteľa.

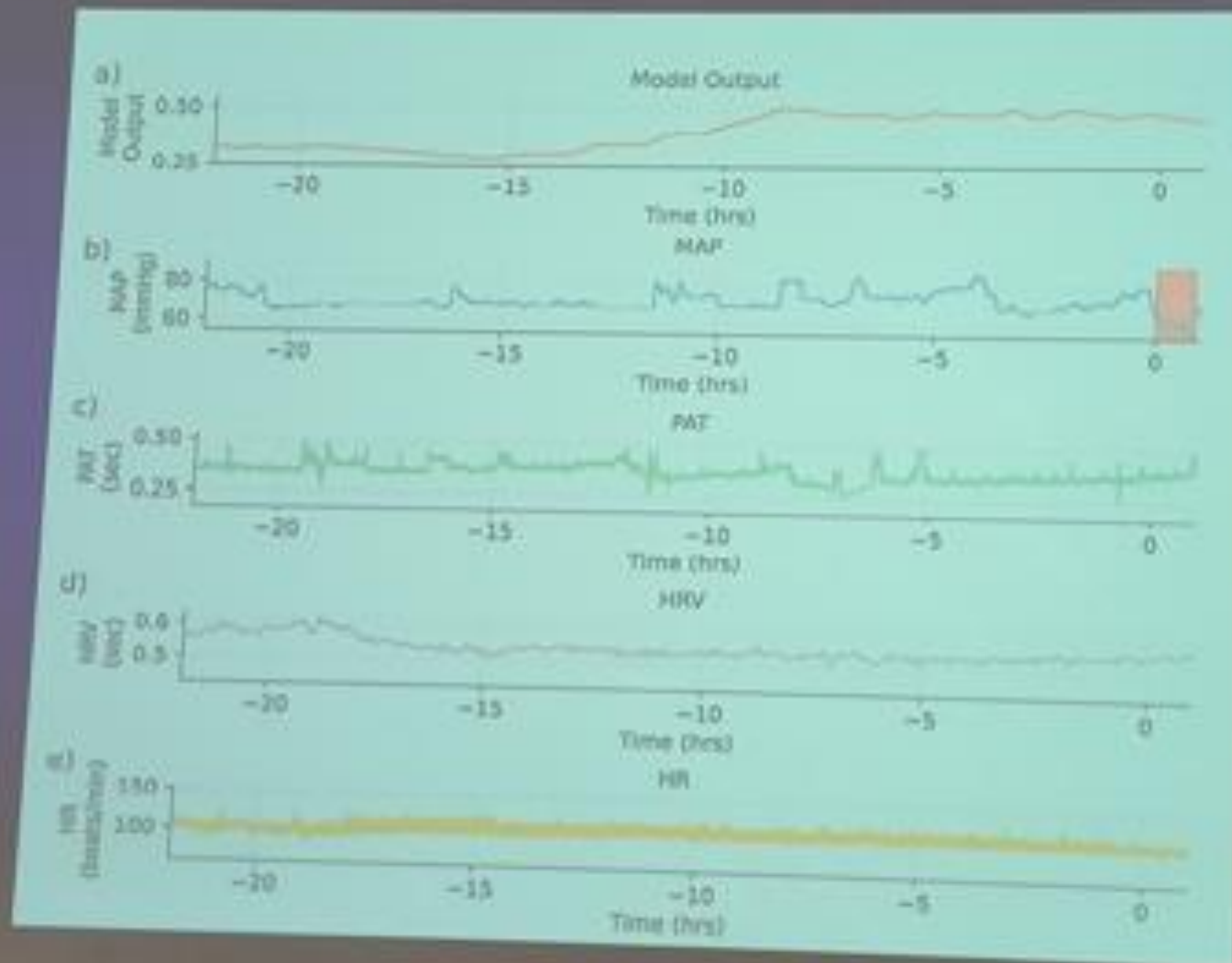
Ďakujem za pozornosť



M.M. Soliman
Biomed Sign Proc
2024, 92:

**10-12hodin
pred klinick
rozvinutím
Sept. šoku**

Predicting Sepsis from Time Series Data



Soliman et al. Biomed Sign Proc Contr 92:105974, 2024

Sepsis endotypes identified by host gene expression across global cohorts

2022

 Check for updates

Josh G. Chenoweth¹✉, Joost Brandsma¹, Deborah A. Striegel¹, Pavol Genzor¹, Elizabeth Chiyka¹, Paul W. Blair¹, Subramaniam Krishnan¹, Elliot Dogbe², Isaac Boakye³, Gary B. Fogel⁴, Ephraim L. Tsalik^{5,12}, Christopher W. Woods⁵, Alex Owusu-Ofori^{2,6}, Chris Oppong⁷, George Oduro⁷,

- Imuno supresívny t1
- Imuno-metabolický t2
- Inflamačný akútny t3
- Imuno-kompetentný t4
- Adaptívny t5

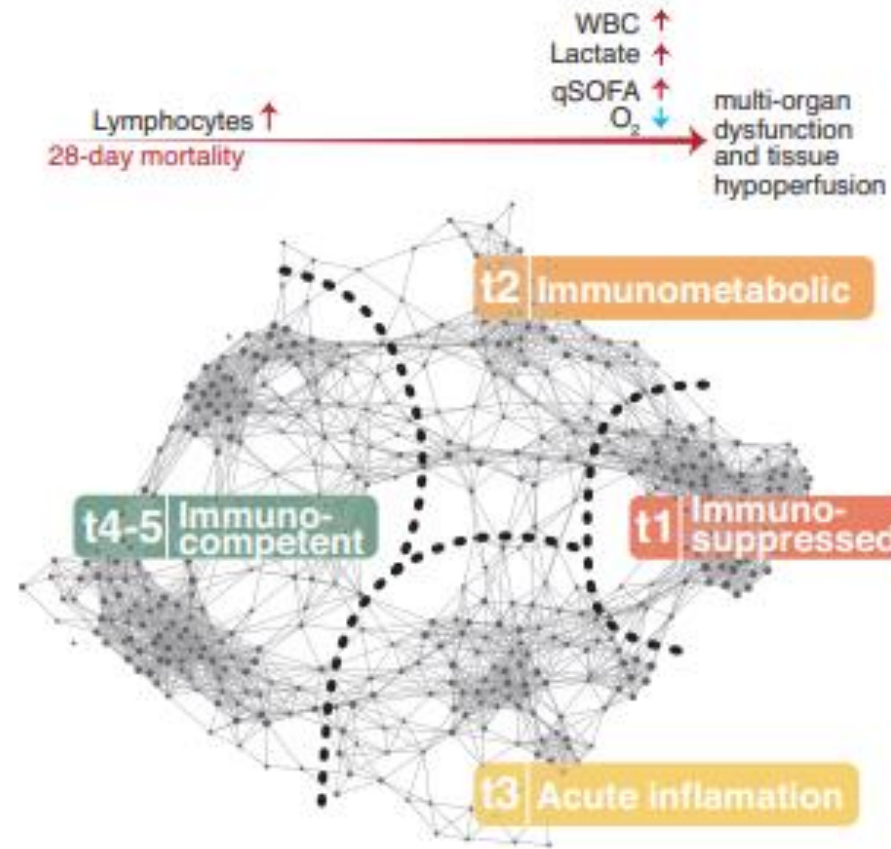


Fig. 6 | Sepsis endotype model. TDA network related to outcomes including 28-day mortality and clinical and molecular features observed in different stratified patient groups. Red horizontal arrow indicates 28-day mortality across the TDA network. Small vertical arrows indicate direction of change of specific analyte. Red color

Proof of principle: the predisposition, infection, response, organ failure sepsis staging system PIRO.

[Michael D Howell](#)¹, [Daniel Talmor](#), [Philipp Schuetz](#), [Sabina Hunziker](#), [Alan E Jones](#), [Nathan I Shapiro](#)
Crit Care Med. 2011

• PIRO koncept skríníngu sepsy na odd. urgentnej medicíny

Table 1 Scores attributed to the selected variables included in each of the four components of PIRO [6]

P score	Points	I score	Points	R score	Points	O score	Points
<i>Age, years</i>		<i>Type of infection</i>		<i>Altered temperature</i>		Hypotension	3
≤ 60	0	CAI	0	No	0	SOFA > 0	1
61–80	1	HCAI	1	Fever	– 1		
> 80	3	HAI	2	Hypothermia	1		
Male	1			Hyperglycemia	1		
Previous ATB	1			Tachypnea	1		
Chronic hepatic disease	4			<i>Severity of infection</i>			
Chronic hematologic disease	3			Infection or sepsis	0		
Cancer	3			Severe sepsis	1		
Atherosclerosis	1			Septic shock	4		
Karnovsky index < 70	2						
Total possible points	18		2		7		4
P1 (0–2 point)		I1 (0–1 point)		R1 (-1–3 points)		O1 (0 points)	
P2 (3–4 points)		I2 (2 points)		R2 (≥ 4 points)		O2 (≥ 1 points)	
P3 (≥ 5 points)							



Desatoro zásad v diagnostike sepsy

Roman Záhorec

1.KAIM LFUK a UNB nemocnica Ružinov

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UNIVERZITA KOMENSKÉHO V BRATISLAVE

