Fulminantní myokarditida

Jan Krejčí

FAKULTNÍ NEMOCNICE U SV. ANNY V BRNĚ

I. INTERNÍ KARDIOANGIOLOGICKÁ KLINIKA FNUSA A LF MU

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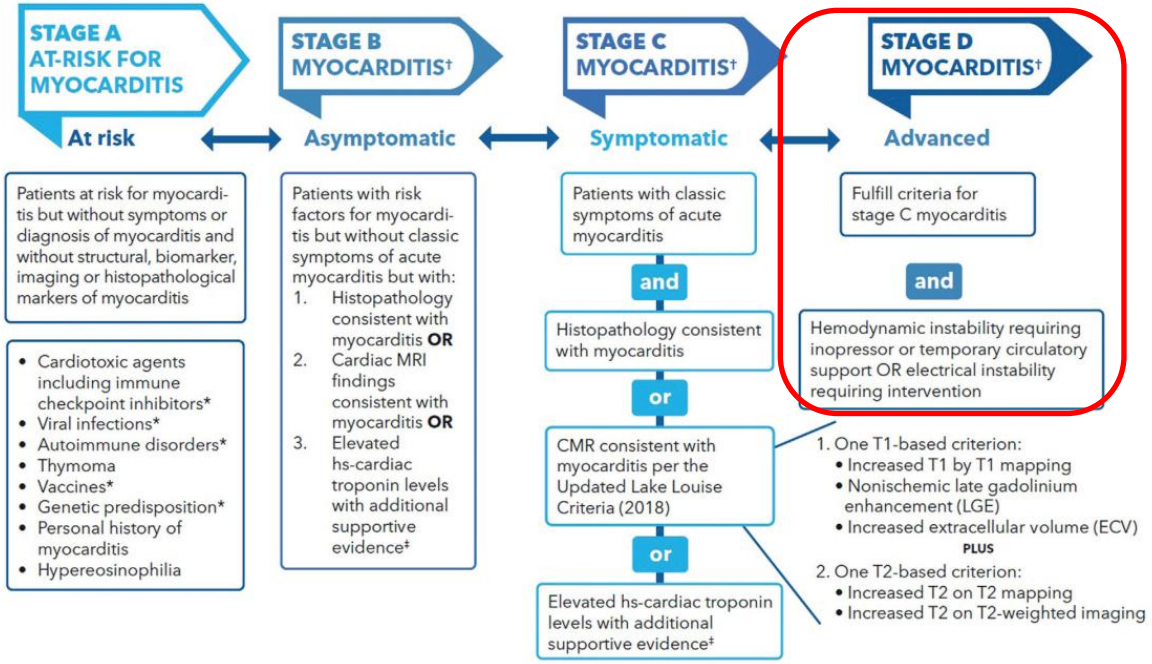
Co je nového - 2024 ACC consensus

2024 ACC Expert Consensus Decision Pathway on Strategies and Criteria for the Diagnosis and Management of Myocarditis

…vytvoření stagingu podobného jako u srdečního selhání

FIGURE 5 Proposed Stages of Myocarditis



JACC VOL. 85, NO. 4, 2025
FEBRUARY 4, 2025:391-431

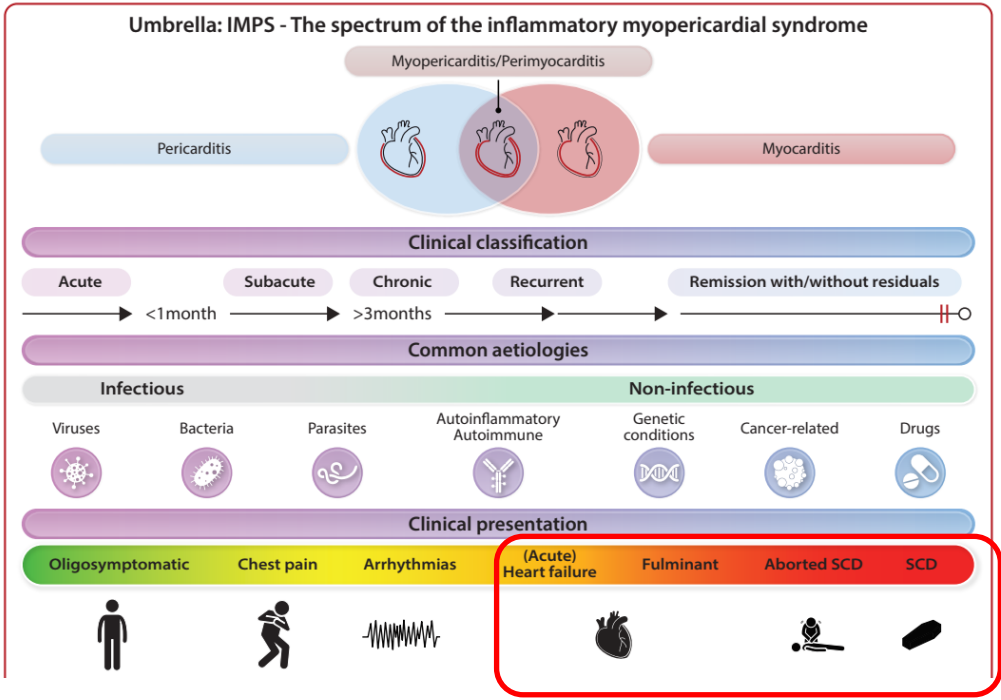
Co je nového - 2025 ESC Guidelines

2025 ESC Guidelines for the management of myocarditis and pericarditis

Developed by the task force for the management of myocarditis and pericarditis of the European Society of Cardiology (ESC)

Endorsed by the Association for European Paediatric and Congenital Cardiology (AEPC) and the European Association for Cardio-Thoracic Surgery (EACTS)

„zánětlivý myoperikardiální syndrom“



European Heart Journal (2025) **00**, 1–90
https://doi.org/10.1093/eurheartj/ehaf192

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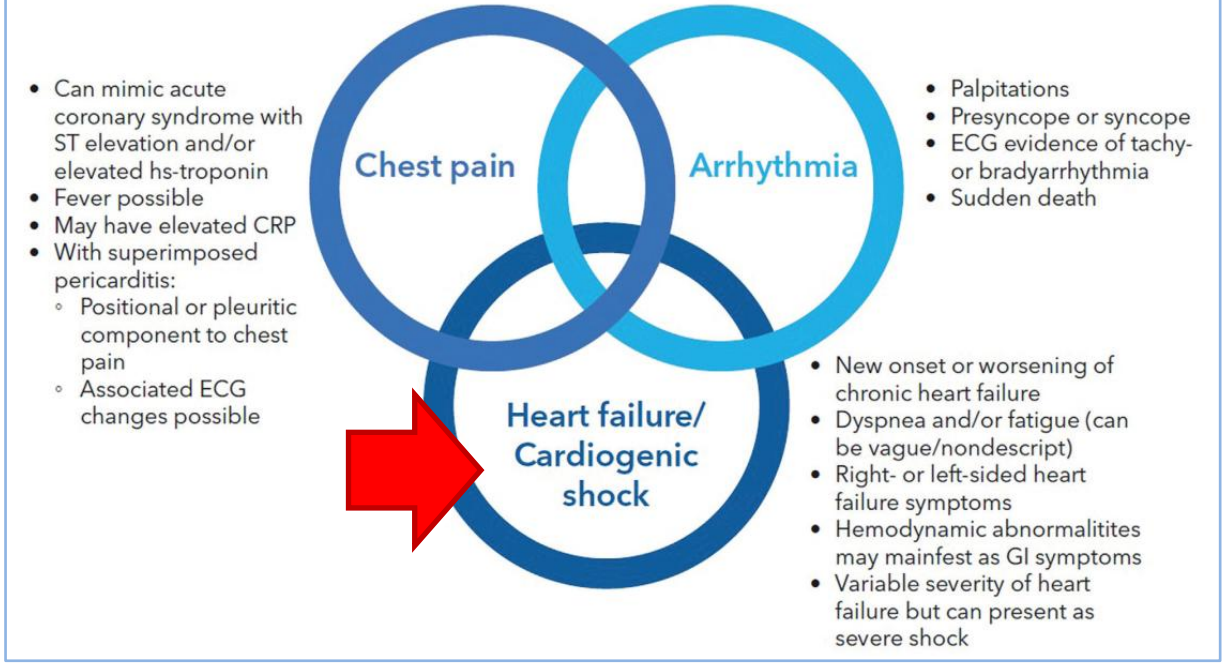
Myokarditididy – klinický obraz

2024 ACC Expert Consensus Decision Pathway on Strategies and Criteria for the Diagnosis and Management of Myocarditis

FIGURE 2 Three Classic Presentations of Myocarditis



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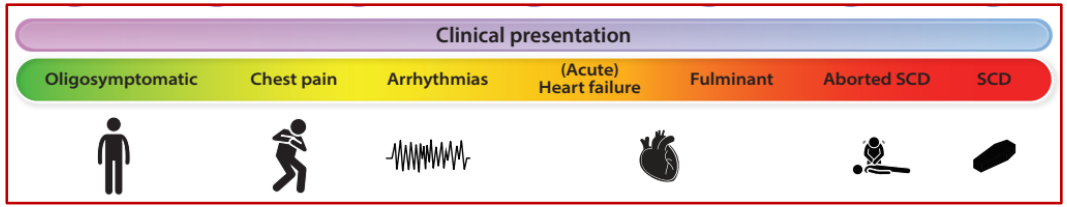
4.2.2. Fulminant myocarditis

Fulminant myocarditis (occurring in 3%–9%) is characterized by cardiogenic shock at presentation for which haemodynamic support is needed.[28] Isolated right ventricle (RV) dysfunction is uncommon; however, biventricular failure occurs frequently in FM. Sustained ventricular arrhythmias (VA) may also occur in these patients (46.9%) and some present with sudden cardiac death (SCD) (25.8%).[28,56,57]



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Diagnostický algoritmus

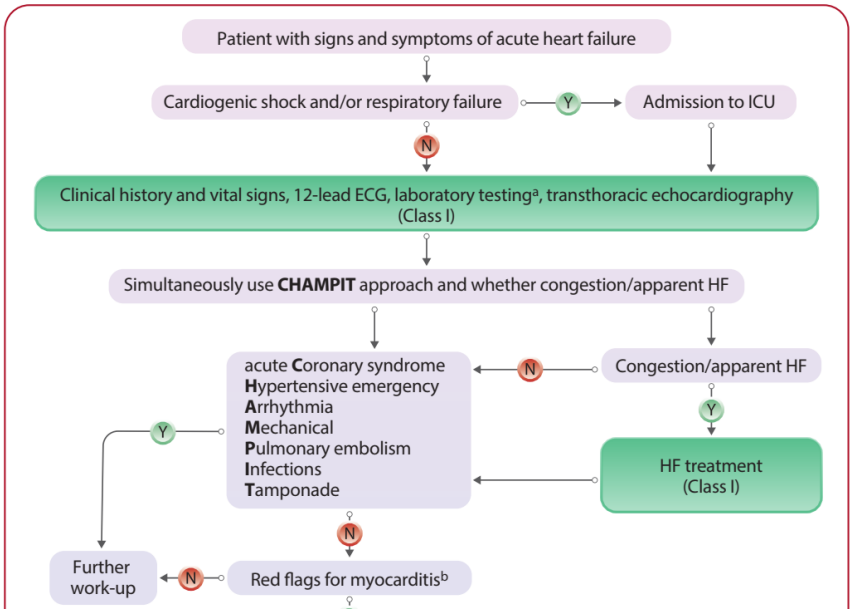

Table 6 **Red flags for the clinical diagnosis of myocarditis**

Myocarditis
Recent or concomitant flu-like syndrome or gastroenteritis
Infarct-like chest pain
Palpitations
HF symptoms
ECG changes[a]
Ventricular arrhythmias (isolated, complex)
Syncope
Haemodynamic instability
Elevated markers of myocardial lesion (hs-Tn, CK-MB elevation)
Elevated markers of HF (NT-proBNP)
Abnormal wall motion, increased wall thickness and/or impaired systolic function on imaging
CMR imaging with myocardial oedema and/or LGE

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Diagnostický algoritmus

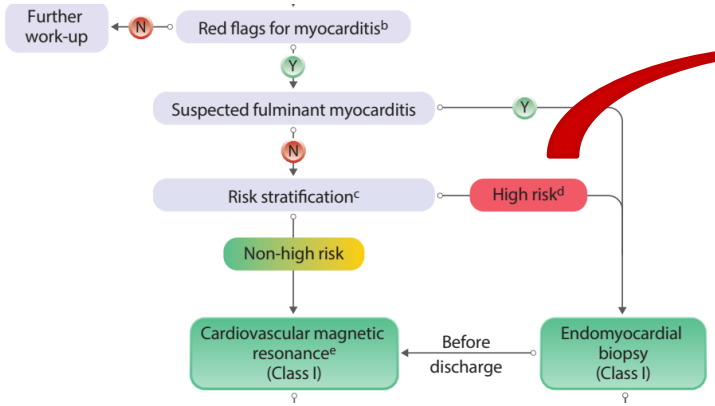

Table 7 Clinical risk stratification to guide

Risk	High risk
Myocarditis	• Acute HF/cardiogenic shock • Dyspnoea NYHA III–IV refractory to medical therapy • Cardiac arrest/syncope[a] • Ventricular fibrillation/sustained ventricular tachycardia[a] • High-level AV block[a]
	Imaging criteria:
	• Newly reduced LVEF (<40%)[a] • Extensive LGE on CMR[a]

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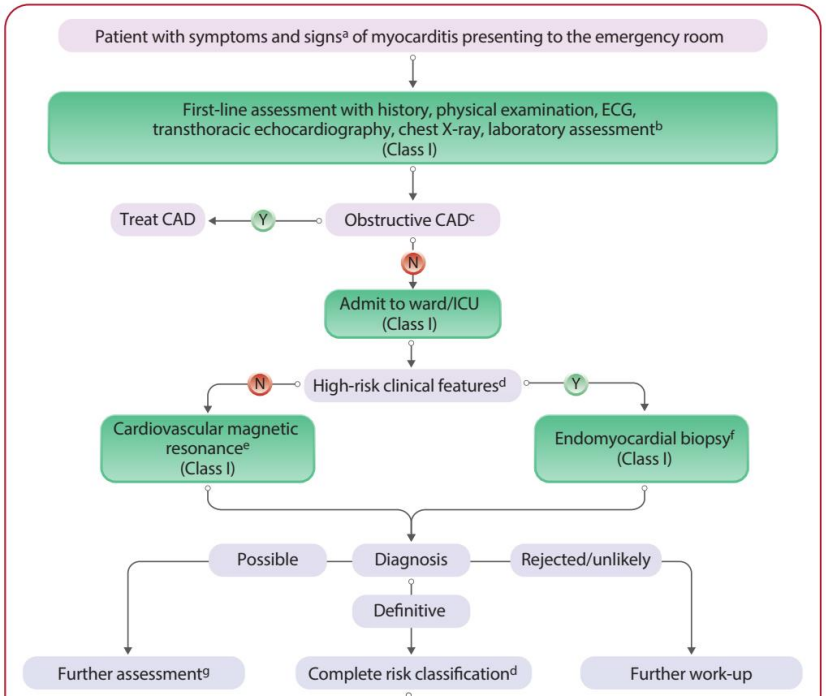
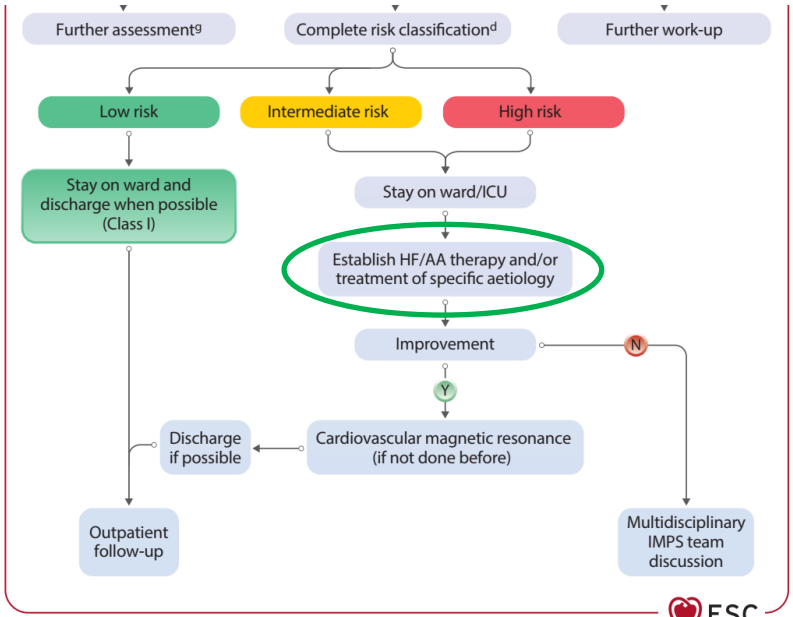
Diagnosticko-terapeutický algoritmus





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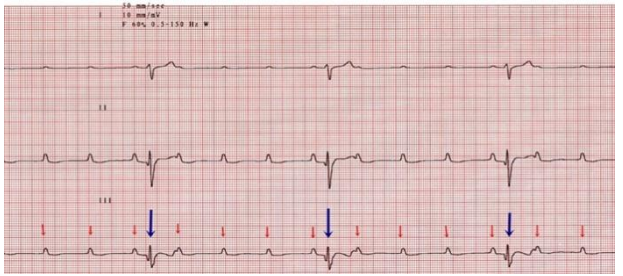
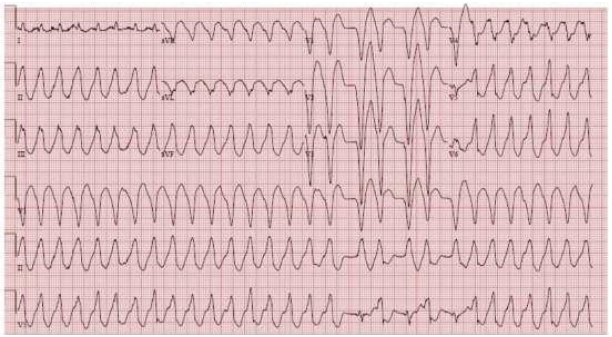
EKG v akutní fázi myokarditidy

2024 ACC Expert Consensus Decision Pathway on Strategies and Criteria for the Diagnosis and Management of Myocarditis

4.2.1. Electrocardiogram

Electrocardiogram (ECG) is widely used as an initial screening tool for diagnosis of myocarditis, despite its low sensitivity of 47%.[9] ECGs of patients with myocarditis often display a myriad of nonspecific findings, including sinus tachycardia, nonspecific ST/T-wave changes, low voltage, and PR-segment depression, none of which are pathognomonic for myocarditis.[10] A normal ECG or ECG with nonspecific changes do not rule out myocarditis but presence of pathological Q waves, left bundle branch block, wide complex QRS ≥120 ms, prolonged QT interval, high-grade atrioventricular (AV) block, malignant tachy-arrhythmias, fragmented QRS, and T-wave inversion are often associated with decreased left ventricular function, presence of left ventricular scar and overall poor clinical prognosis in patients with myocarditis.[10-13] Involvement of the conduction system also raises the suspicion for sarcoidosis, GCM, or Lyme disease. Ongoing research,





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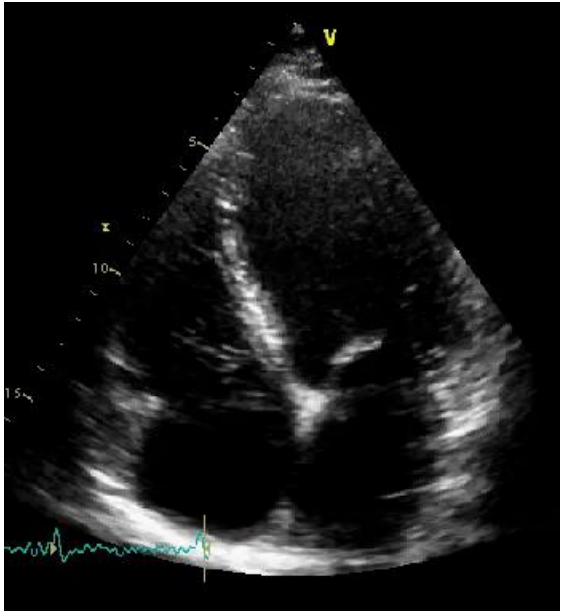
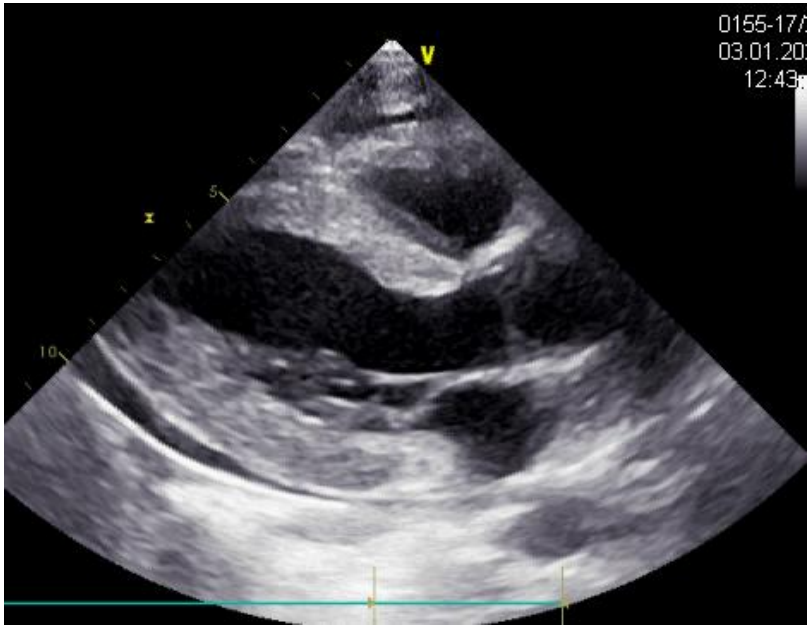
Echokardiografie v akutní fázi myokarditidy

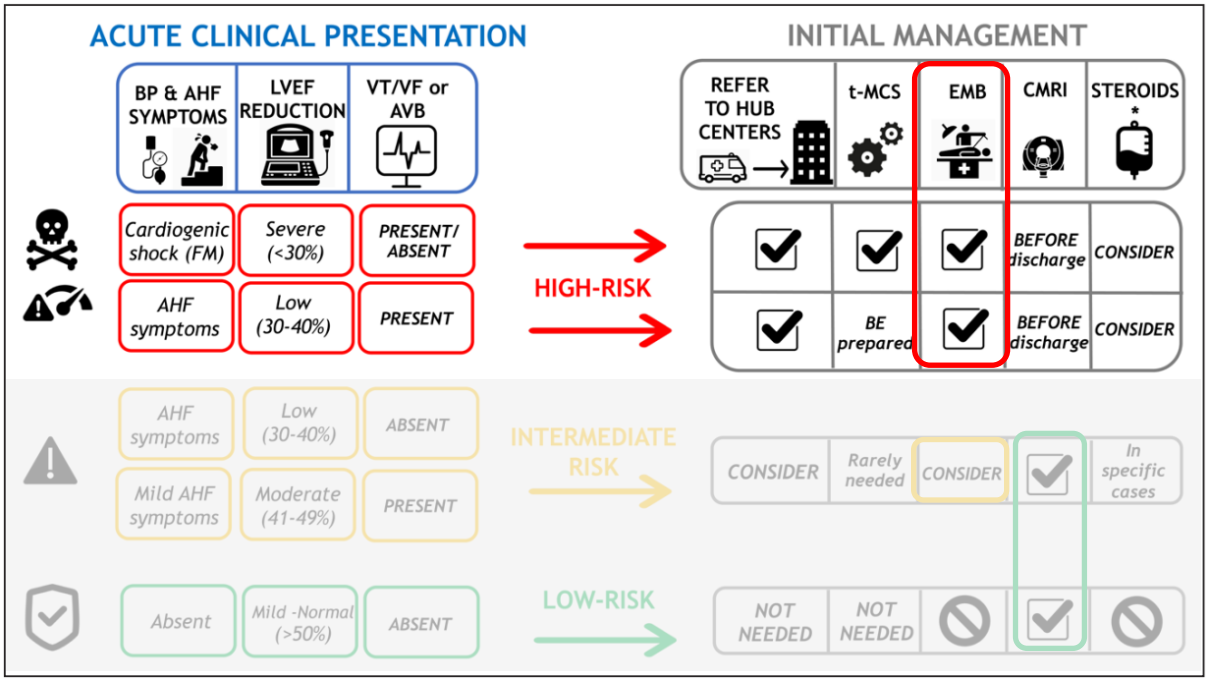




Kdy indikovat EMB u nemocných s podezřením na myokarditidu?

Management of Acute Myocarditis and Chronic Inflammatory Cardiomyopathy

An Expert Consensus Document



Circ Heart Fail. 2020 Nov;13(11):e007405.

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Kdy indikovat EMB u nemocných s podezřením na myokarditidu?

Recommendation Table 6 — Recommendations for endomyocardial biopsy (see Evidence Table 6)

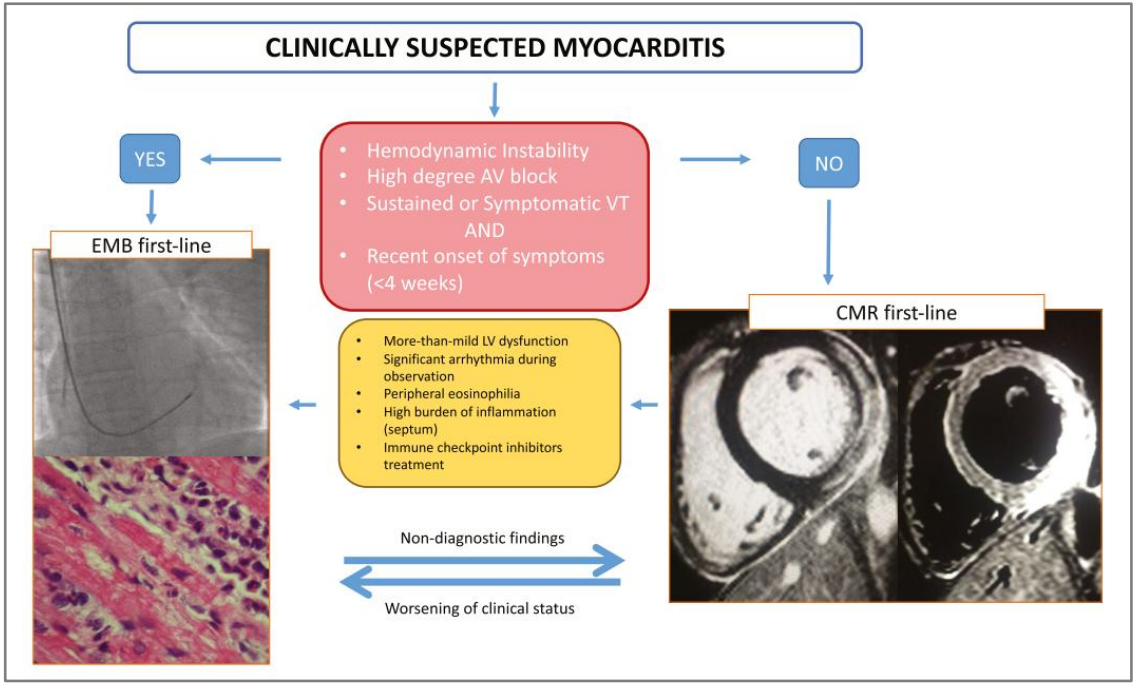
Recommendations	Class[a]	Level[b]
EMB[c] is recommended in patients with high-risk myocarditis[d], and/or haemodynamic instability, and/or in patients with intermediate-risk myocarditis not responding to conventional therapy in order to detect a specific histologic subtype and to assess the presence of viral genome for treatment.[34,63,73,131]	I	C

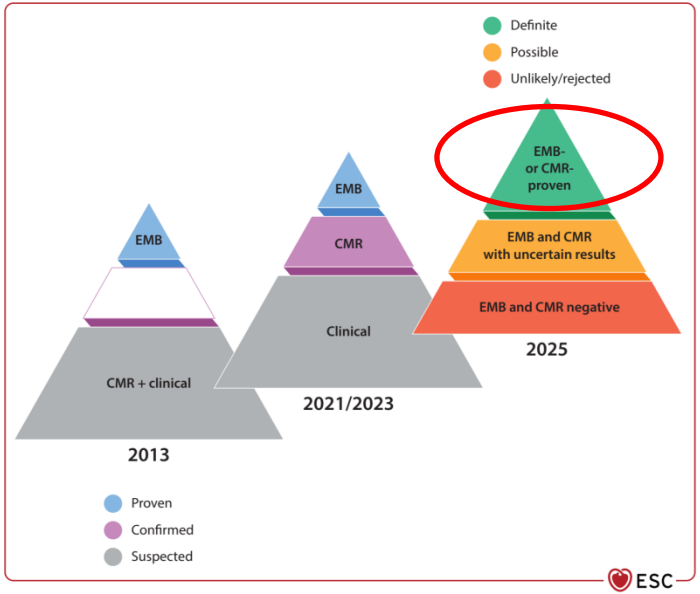
Table 7 Clinical risk stratification to guide work-up in inflammatory myopericardial syndrome

Risk	High risk	Intermediate risk	Low risk
Myocarditis	• Acute HF/cardiogenic shock • Dyspnoea NYHA III–IV refractory to medical therapy • Cardiac arrest/syncope[a] • Ventricular fibrillation/sustained ventricular tachycardia[a] • High-level AV block[a]	• New/progressive dyspnoea • Non-sustained ventricular arrhythmias • Persistent release or relapsing troponin	Stable symptoms or oligosymptomatic
	Imaging criteria:	**Imaging criteria:**	**Imaging criteria:**
	• Newly reduced LVEF (<40%)[a] • Extensive LGE on CMR[a]	• Newly mildly reduced LVEF (41%–49%) and/or WMA • Preserved LVEF (≥50%) and LGE ≥2 segments on CMR	• Preserved LVEF (≥50%) without LGE or limited LGE (<2 segments) on CMR

Invazivní a neinvazivní dg nestojí proti sobě, ale doplňují se!

State-of-the-Art of Endomyocardial Biopsy on Acute Myocarditis and Chronic Inflammatory Cardiomyopathy





Current Cardiology Reports
https://doi.org/10.1007/s11886-022-01680-x

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Potřebujeme před nasazením imunosuprese vždy EMB ?

FIGURE 10 Key Points Regarding the Use of Immunosuppressive Therapies in Myocarditis

Not all patients with myocarditis require immunosuppressive therapy

General consensus is to administer immunosuppressive therapy for the following conditions:

- Eosinophilic myocarditis
- Giant cell myocarditis
- Granulomatous myocarditis (sarcoid)
- Associated with immune checkpoint inhibitor therapy
- In setting of other autoimmune conditions

There remains lack of broad consensus but myocarditis experts from certain centers advise:

- Perform viral PCR on endomyocardial biopsy tissue to exclude active infection prior to initation of immunosuppressive therapy
- Treat chronic lymphocyctic myocarditis (with negative viral PCR) with immunosuppressive therapy

Implementation of immunosuppressive therapy

- Typically start with methylprednisolone boluses (7-14 mg/kg per day for 3 days) followed by oral prednisone taper (start at 1 mg/kg)
- Giant cell myocarditis requires higher level of immunosuppression than IV steroids, typically including a calcineurin inhibitor (cyclosporine or tacrolimus)
- Involve other specialty experts in setting of autoimmune conditions (eg, systemic lupus, vasculitis) as immunosuppressive strategy may be altered based on other organ involvement.

IVIG can be considered in the setting of inflammatory, antibody-mediated, or autoimmune disorders

Historické okénko

Immunosuppressive Therapy for Active Lymphocytic Myocarditis

Virological and Immunologic Profile of Responders Versus Nonresponders

Andrea Frustaci, MD; Cristina Chimenti, MD, PhD; Fiorella Calabrese, MD; Maurizio Pieroni, MD; Gaetano Thiene, MD; Attilio Maseri, MD

Methods and Results—Out of 652 biopsied patients, 112 had a histological diagnosis of active lymphocytic myocarditis; 41 of these 112 patients were characterized by progressive heart failure despite conventional therapy and were treated with prednisone and azathioprine for 6 months. All were resubmitted to cardiac catheterization, angiography, and endomyocardial biopsy at 1 and 6 months and followed-up for 1 year. A total of 21 patients responded with prompt improvement in left ventricular ejection fraction from 25.7±4.1% to 47.1±4.4% and showed evidence of healed myocarditis at control biopsy. Conversely, 20 patients failed to respond and showed a histological evolution toward dilated cardiomyopathy: 12 remained stationary, 3 underwent cardiac transplantation, and 5 died. We retrospectively performed a polymerase chain reaction on frozen endomyocardial tissue for the most common cardiotropic viruses and assessed circulating serum cardiac autoantibodies. Viral genomes were present in biopsy specimens of 17 nonresponders (85%), including enterovirus (n=5), Epstein-Barr virus (n=5) adenovirus (n=4), both adenovirus and enterovirus (n=1), influenza A virus (n=1), parvovirus-B19 (n=1), and in 3 responders, who were all positive for hepatitis C virus. Cardiac autoantibodies were present in 19 responders (90%) and in none of the nonresponders.

Conclusions—In patients with active lymphocytic myocarditis, those with circulating cardiac autoantibodies and no viral genome in the myocardium are the most likely to benefit from immunosuppression. The beneficial effect of

Circulation. 2003;107:857-863

Co je tzv. „viral shift“ u myokarditid podle ChatGPT?

Stručné shrnutí (hlavní body)

1. Historicky (20. stol., zejména 1970.–1990.) byly nejčastěji spojované s virovou myokarditidou **enteroviry** (zejména Coxsackievirus B). Nature

2. Po zavedení molekulárních metod (PCR) v 90.–00. letech začaly studie častěji detekovat **Parvovirus B19 (B19V)** a **human herpesvirus 6 (HHV6)** v endomyokardiálních biopsiích; v mnoha evropských sériích se B19V stal nejčastěji nalezeným virusem. PubMed+1

3. Kritická diskuse: u **B19V** (a částečně i HHV6) probíhá debata, zda přítomnost virového genomu v srdci vždy znamená, že virus aktivně způsobuje onemocnění, nebo je někdy „bystander“ (perzistence DNA v tkáni bez patogenetické role). Wiley Online Library+1

Potřebujeme před nasazením imunosuprese vždy EMB ?

Viral genome changes and the impact of viral genome persistence in myocardium of patients with inflammatory cardiomyopathy

Dalibor Mlejnek[1], Jan Krejci[1], Petr Hude[1], [illegible]
Iva Svobodová[1], Tomas Freiberger[3], Eva N[illegible]

to myocardial inflammation. We evaluated the change in viral presence after administration of immunosuppression therapy and compared it with the results of the group without immunosuppression. The only virus detected in the myocardium in this group was PVB19. To our best knowledge, such a study has never been published before. However, our pilot results from a small group of patients suggest that the administration of immunosuppression does not lead to a change in the viral presence or an increase in the viral load in follow-up biopsy samples.

Material and methods: We investigated the changes in viral presence and the impact of viral genome persistence in the myocardium on echocardiographic parameters, functional status and some laboratory parameters in a 6-month follow-up. Fifty-four patients with recent onset DCM, left ventricular ejection fraction < 40% and biopsy-proven myocarditis (> 14 mono-[illegible]ytes/mm² and/or > 7 T-lymphocytes/mm²) were enrolled. [illegible]in reaction (PCR) was performed to detect pathogens in the [illegible]tients were divided according to the administered therapy: [illegible] failure medication (46 patients) and immunosuppressive [illegible]nts).

[illegible]standard heart failure medication group viral clearance was [illegible]patients and viral persistence in 24 patients in the follow-up [illegible]ng both groups, there was no statistically significant differ-[illegible]rovement of 12.0 ±11.4% vs. 18.3 ±12.6%, decrease in NYHA [illegible]7 vs. 1.0 ±0.7, decline in NT-proBNP of 1335 ±1933 ng/l vs. [illegible]l and decrease in infiltrating leukocytes of 11.1 ±15.8 vs. 6.7 [illegible]² and T-lymphocytes of 5.8 ±15.1 vs. 1.8 ±10.9 cells/mm² (all [illegible]ase in PCR positive patients from 37 to 29 was observed. The [illegible]19 positive PCR findings decreased from 5 to 4 in patients [illegible]ppressive therapy.

[illegible] decrease in the number of positive PCR findings in control endomyocardial biopsy was observed. Viral genome persistence was not associated with worse outcome in short-term follow-up.

Arch Med Sci 2018; 14, 6: 1245–1253

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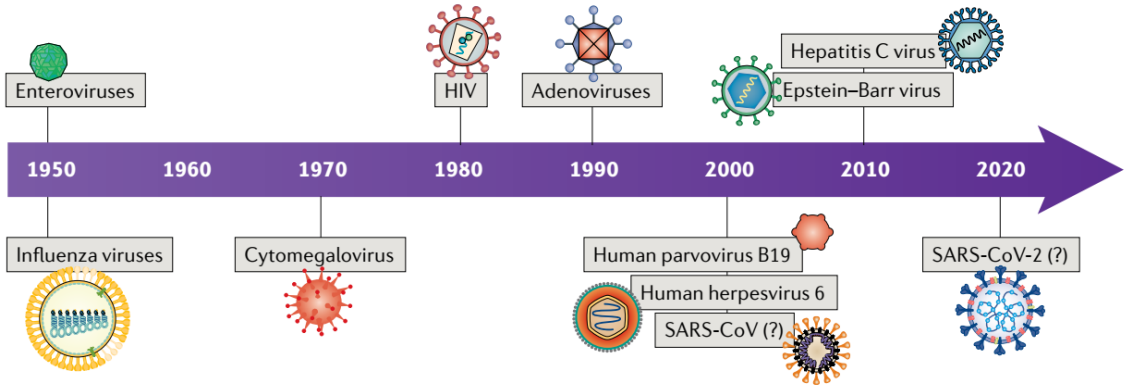
Viral shift

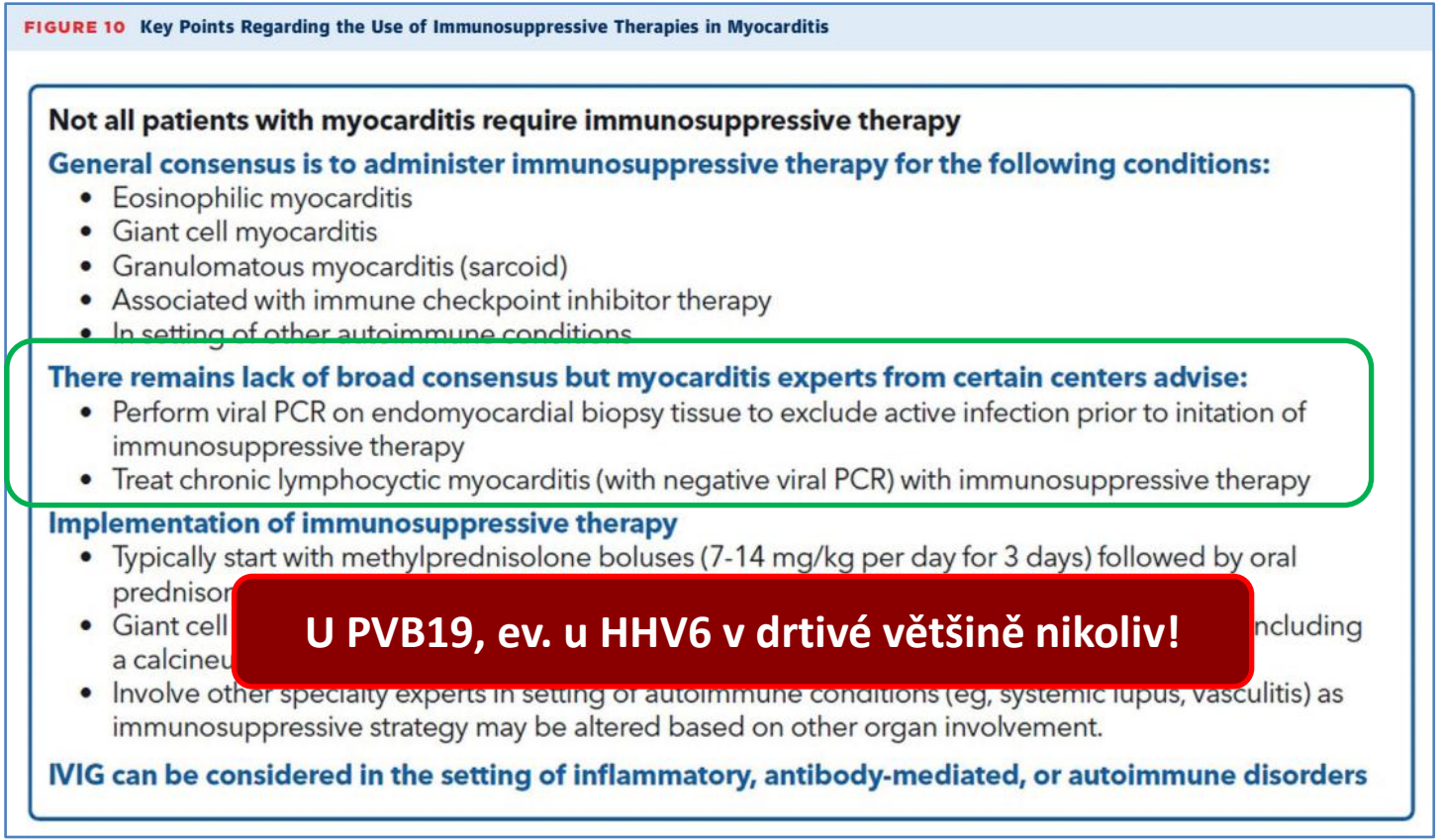
Myocarditis and inflammatory cardiomyopathy: current evidence and future directions

Carsten Tschöpe[1,2,3]✉, Enrico Ammirati[4], Biykem Bozkurt[5,6], Alida L. P. Caforio[7], Leslie T. Cooper[8], Stephan B. Felix[9,10], Joshua M. Hare[11], Bettina Heidecker[12], Stephane Heymans[13,14], Norbert Hübner[2,15,16], Sebastian Kelle[2,3,17], Karin Klingel[18], Henrike Maatz[15], Abdul S. Parwani[3], Frank Spillmann[3], Randall C. Starling[19], Hiroyuki Tsutsui[20], Petar Seferovic[21] and Sophie Van Linthout[1,2]



Tschöpe C et al, Nat Rev Cardiol. 2021 Mar;18(3):169-193

Platí stále „stará dogmata“ z jiné éry?



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IVIG can be considered in the setting of inflammatory, antibody-mediated, or autoimmune disorders

U PVB19, ev. u HHV6 v drtivé většině nikoliv!

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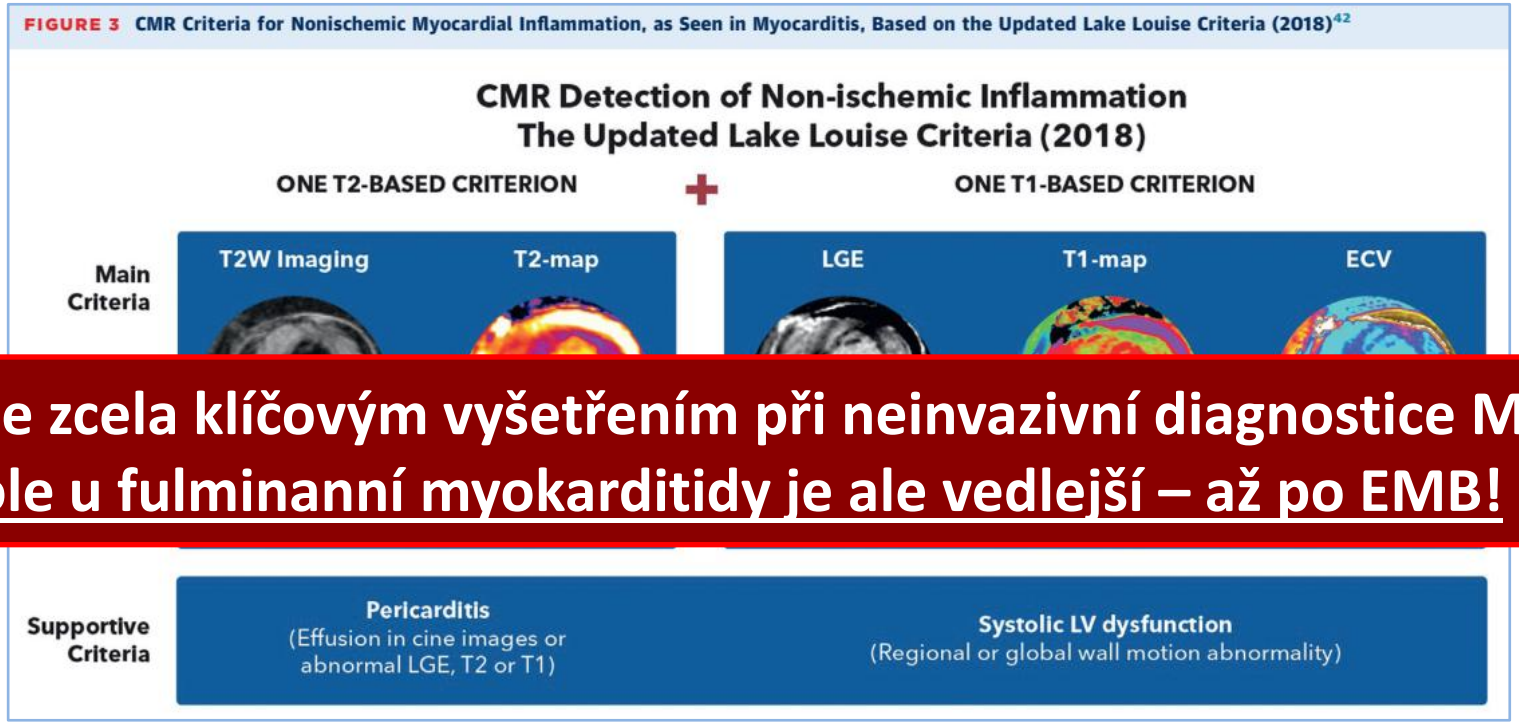
Fulminantní myokarditidida – neinvazivní diagnostika – MRI



MRI je zcela klíčovým vyšetřením při neinvazivní diagnostice MC.
Role u fulminanní myokarditidy je ale vedlejší – až po EMB!

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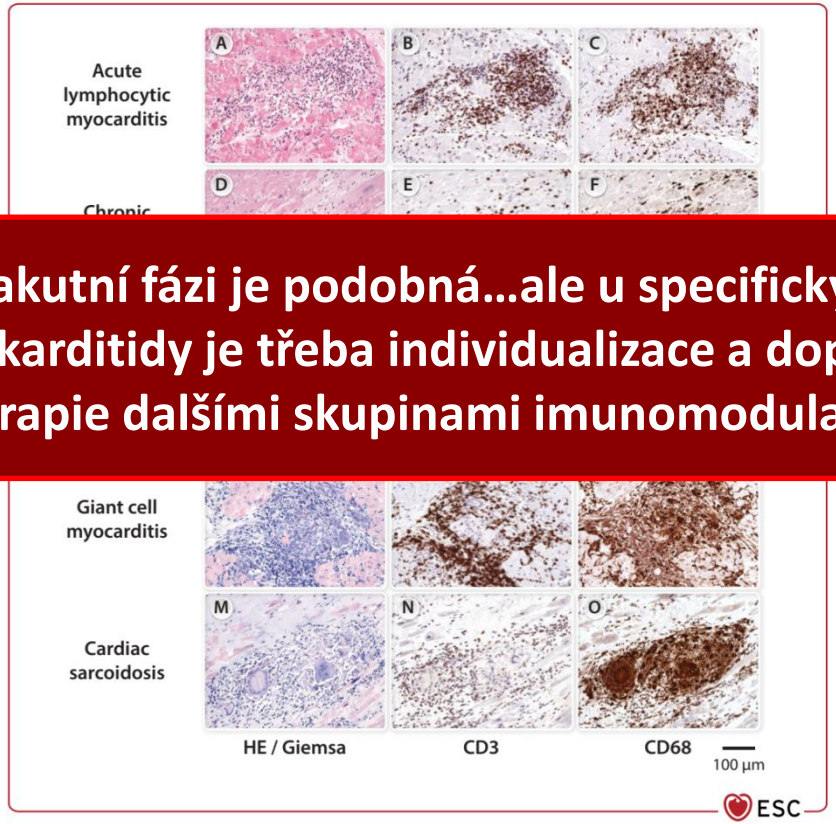
Jen EMB s (imuno)histologií určí podtyp myokarditidy…



Léčba v akutní fázi je podobná…ale u specifických forem myokarditidy je třeba individualizace a doplnění kortikoterapie dalšími skupinami imunomodulačních léků

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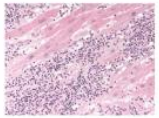
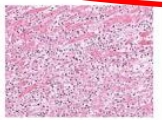
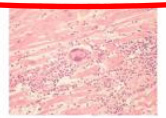
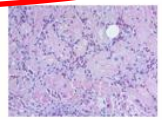
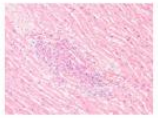
IS/IM terapie u susp. fulminantní myokarditidy

Immunomodulating Therapies in Acute Myocarditis and Recurrent/Acute Pericarditis

SUSPECTED FULMINANT OR COMPLICATED ACUTE MYOCARDITIS

↓

i.v. pulse methylprednisolone 7–14 mg/kg/day for 3 d, then 1 mg/kg/day

	LYMPHOCYTIC	ICI-ASSOCIATED	GIANT CELL	EOSINOPHILIC	SARCOIDOSIS
					
FIRST-LINE					
ADDITIONAL	- If associated systemic autoimmune disorders (eg. SLE and APS): add aggressive treatment of associated conditions	**Hold ICI** therapy Confirm ICI-myocarditis via definitive imaging and/or endomyocardial biopsy	- If hemodynamically unstable pts: **ATG**, from 1 mg/kg, usually single-dose to 300 mg in 3 days or (alternative) i.v. **alemtuzumab** (anti-CD52 antibody) single dose of 30 mg plus oral **CyA**, BID, target through levels 150–250 ng/mL - If hemodynamically stable pts: only oral **CyA**, BID, target trough levels 150–250 ng/mL	- If EGPA: consider i.v. **cyclophosphamide** (especially in ANCA-positive pts), 600 mg*m^2 at days 1, 15, and 30 - If clonal (myeloproliferative) HES: **imatinib** 100–400 mg OD - If helminthic infection: **albendazole** 400 mg BID for 2–4 wk - If hypersensitivity reaction: **withdraw suspected drug**	
SECOND-LINE	**IVIG** (2 g/kg), single continuous infusion in 24–48 h or divided in 4 d or **plasmapheresis**, 3–5 sessions in 5–10 d	i.v. **abatacept** (a CTLA- 4 agonist) or **ATG**, 1 mg/kg, usually single dose or i.v. **alemtuzumab** (anti-CD52 antibody), 30 mg, single dose	i.v. **rituximab** 375 mg×m^2 (BSA) mg (once a wk for 4 wk and then every 4 mo as maintenance therapy) for 1 yr	- If DRESS, EGPA or idiopathic HES: anti-IL5 agents (e.g., **benralizumab** 30 mg s.c./4–8wk or **mepolizumab** 100-300 mg/4wk)	s.c. **methotrexate** 15–20 mg/wk or i.v. **infliximab** 5 mg/kg (up to 500 mg) at time 0 and after 2 and 4 wk and then every 6–8 wk or s.c. **adalimumab** 40 mg/2wk

Front Med (Lausanne). 2022 Mar 7;9:838564.

IS/IM terapie u susp. fulminantní myokarditidy

Table 12 **Therapy for specific forms of myocarditis**

Lymphocytic myocarditis (virus-negative)	
1st line therapy	Non-severe: prednisone 1 mg/kg/day p.o. then tapered Severe: i.v. methylprednisolone 7–14 mg/kg/day for 3 days, then 1 mg/kg/day p.o.
2nd line therapy	Oral corticosteroids + azathioprine[a] or mycophenolate mofetil[b], cyclosporine[c], methotrexate[d]
3rd line therapy	IVIG[e] or plasmapheresis[f]
Eosinophilic myocarditis	
1st line therapy	Same as lymphocytic myocarditis + Treat EM-associated condition if identified
2nd line therapy	Same as lymphocytic myocarditis + Treat EM-associated condition if identified
3rd line therapy	–
Giant-cell myocarditis	
1st line therapy	Non-severe: prednisone 1 mg/kg/day p.o. then tapered Severe: i.v. methylprednisolone 7–14 mg/kg/day for 3 days, then 1 mg/kg/day p.o. + immunosuppressive (azathioprine[a] or mycophenolate mofetil[b], cyclosporine[c])
2nd line therapy	Antithymocyte Globulin (ATG)[g] cyclophosphamide[h], rituximab[i]
3rd line therapy	–
Cardiac sarcoidosis	
1st line therapy	Non-severe: prednisone 1 mg/kg/day p.o., tapering from 40–60 mg daily Severe: i.v. methylprednisolone 7–14 mg/kg/day for 3 days, then 1 mg/kg/day p.o.
2nd line therapy	Methotrexate[d] (1st choice), or azathioprine[a] mycophenolate mofetil[b], cyclophosphamide[h]
3rd line therapy	Infliximab[j] or adalimumab[k], rituximab[i]

Myokarditidy a ZKMP – IS léčba

2025 ESC Guidelines for the management of myocarditis and pericarditis

Developed by the task force for the management of myocarditis and pericarditis of the European Society of Cardiology (ESC)

Endorsed by the Association for European Paediatric and Congenital Cardiology (AEPC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Immunosuppressive therapy		
Corticosteroids should be considered in patients with fulminant, non-infectious forms of myocarditis to stabilize the patients.	IIa	C
Corticosteroids may be considered in patients with acute myocarditis with impaired LVEF if refractory to standard HF therapy to stabilize patients.	IIb	C
Routine use of immunosuppressive therapy is not recommended in acute myocarditis with preserved LV function because no outcome benefit has been shown.	III	C

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ESC European Society of Cardiology
European Heart Journal (2023) **44**, 5110–5124
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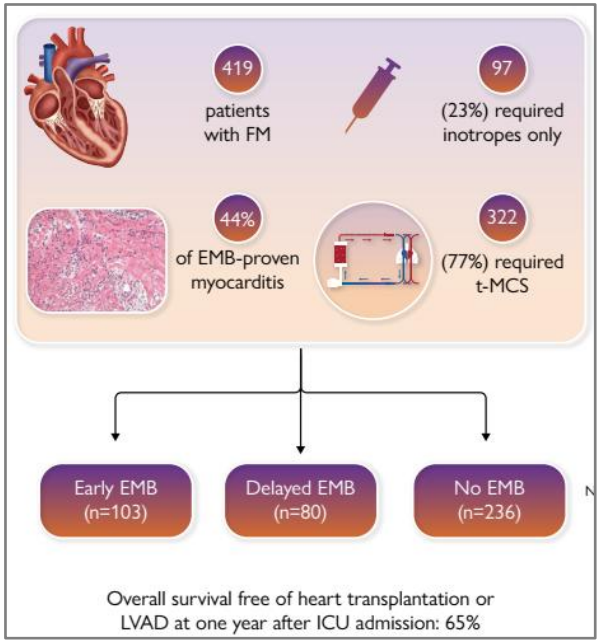
CLINICAL RESEARCH
Acute cardiovascular care

Fulminant myocarditis proven by early biopsy and outcomes

Background and Aims While endomyocardial biopsy (EMB) is recommended in adult patients with fulminant myocarditis, the clinical impact of its timing is still unclear.

Methods Data were collected from 419 adult patients with clinically suspected fulminant myocarditis admitted to intensive care units across 36 tertiary centres in 15 countries worldwide. The diagnosis of myocarditis was histologically proven in 210 (50%) patients, either by EMB ($n = 183$, 44%) or by autopsy/explanted heart examination ($n = 27$, 6%), and clinically suspected cardiac magnetic resonance imaging confirmed in 96 (23%) patients. The primary outcome of survival free of heart transplantation (HTx) or left ventricular assist device (LVAD) at 1 year was specifically compared between patients with early EMB (within 2 days after intensive care unit admission, $n = 103$) and delayed EMB ($n = 80$). A propensity score-weighted analysis was done to control for confounders.



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Histologická charakteristika

Table 1 Baseline characteristics, clinical, echocardiography, and biological findings at intensive care unit admission according to endomyocardial biopsy timing after intensive care unit admission

	Available data, *N*	All patients (*N* = 419)	EMB ≤ 2 days (*n* = 103)	EMB > 2 days (*n* = 80)	No EMB (*n* = 236)	*P*-value
Age, years	419	40 (29–52)	44 (31–55)	41 (28–52)	38 (28–49)	.091
Woman, *n* (%)	419	220 (53)	58 (56)	33 (41)	129 (55)	.078
EMB finding consistent with myocarditis[b]	183	183 (44)				
Lymphocytic infiltrate		125 (68)	71 (69)	54 (68)	-	.836
Giant cell infiltrate		20 (11)	11 (11)	9 (11)	-	.902
Eosinophilic infiltrate		20 (11)	11 (11)	9 (11)	-	.902
Other infiltrate[c]		18 (10)	10 (10)	8 (10)	-	.948
Histologic demonstration of myocarditis on autopsy/explanted heart/myocardial specimen after LVAD	419	27 (6)	0 (0)	0 (0)	27 (11)	**<.001**
Myocarditis proven by CMRI	419	158 (38)	36 (35)	22 (28)	100 (42)	**.048**

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Jaká byla léčba?

Table 2 In-intensive care unit management, complications, and outcomes according to endomyocardial biopsy timing after intensive care unit admission

	Available data, *N*	All patients (*N* = 419)	EMB ≤ 2 days (*n* = 103)	EMB > 2 days (*n* = 80)	No EMB (*n* = 236)	*P-value*
Inotropes/vasopressors						
Inotropes/vasopressors duration, days	419	7 (3–14)	8 (4–13)	16 (7–25)	6 (2–10)	**<.001**
Dobutamine	419	332 (79)	80 (78)	65 (81)	187 (79)	.839
Norepinephrine	419	316 (75)	77 (75)	60 (75)	179 (76)	.973
Epinephrin	419	159 (38)	42 (41)	30 (38)	87 (37)	.789
Levosimendan	419	45 (11)	11 (11)	14 (18)	20 (9)	.079
Only inotropes/vasopressors without t-MCS	419	97 (23)	24 (23)	14 (18)	59 (25)	.389
Temporary MCS						
Any t-MCS	419	322 (77)	79 (77)	66 (82)	177 (75)	.389
IABP stand-alone	419	27 (6)	16 (16)	1 (1)	10 (4)	**<.001**
VA-ECMO/Impella®	419	295 (70)	63 (61)	65 (81)	167 (71)	**.013**
t-MCS duration, days	322	6 (4–11)	6 (4–10)	12 (7–19)	5 (3–8)	**<.001**
Invasive mechanical ventilation	419	334 (80)	73 (71)	64 (80)	197 (84)	**.030**
Duration, days	334	7 (4–15)	7 (5–15)	14 (8–24)	7 (3–13)	**<.001**

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CLINICAL RESEARCH
Acute cardiovascular care

Fulminant myocarditis proven by early biopsy and outcomes

Table 5 Immunomodulatory therapy and one-year outcome in the group of endomyocardial biopsy-proven myocarditis ($n = 183$) according to main histologic subtypes

	One-year outcome		*P*-value
	Alive without HTx or LVAD	Death, HTx or LVAD	
Lymphocytic myocarditis ($n = 125$)	**$n = 78$**	**$n = 47$**	
Any IMT	54 (69)	26 (55)	.117
Early use of IMT[a]	50 (64)	16 (34)	**.001**
Corticosteroids	54 (69)	23 (49)	**.024**
Pulse therapy	50 (64)	18 (38)	**.005**
Other IMT[b]	10 (13)	6 (13)	.993
Intravenous immunoglobulins	9 (12)	6 (13)	.838
Multiple IMT	15 (19)	8 (17)	.757
Intravenous immunoglobulins	2 (40)	4 (27)	.573
Multiple IMT	4 (80)	11 (73)	.766

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CLINICAL RESEARCH
Acute cardiovascular care

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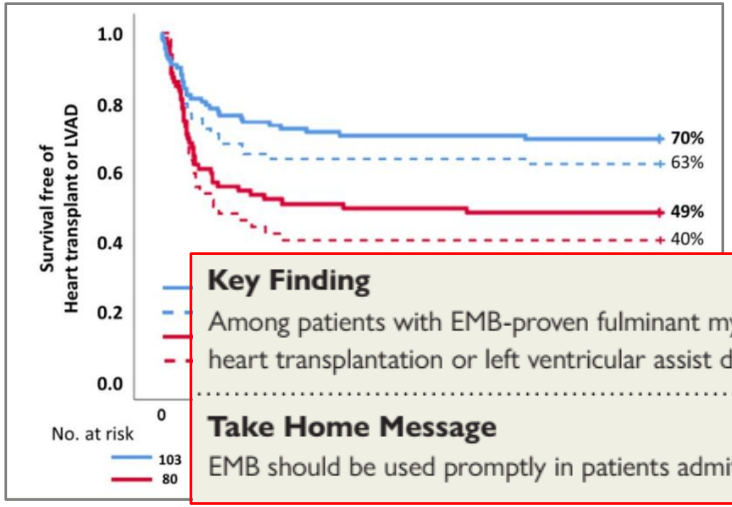

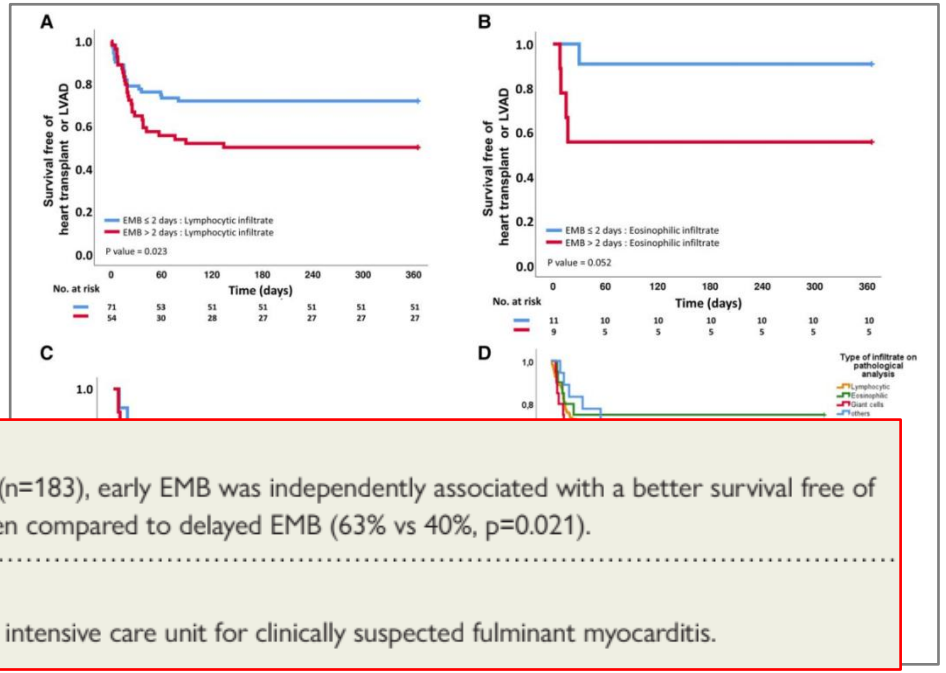

Key Finding

Among patients with EMB-proven fulminant myocarditis (n=183), early EMB was independently associated with a better survival free of heart transplantation or left ventricular assist device, when compared to delayed EMB (63% vs 40%, p=0.021).

Take Home Message

EMB should be used promptly in patients admitted to an intensive care unit for clinically suspected fulminant myocarditis.

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Léčba fulminantní myokarditidy

Recommendations	Class[a]	Level[b]
A timely and dedicated Shock Team discussion is recommended in patients with myocarditis in the presence of haemodynamic compromise, to decide on the need for escalation to MCS and to determine a long-term management plan.	I	C
Temporary MCS[c] should be considered in patients with myocarditis and cardiogenic shock or acute decompensation in chronic myocarditis to stabilize the patients.	IIa	C

6.3. Interventional techniques including circulatory support

6.3.1. Myocarditis

6.3.1.1. Short-term mechanical circulatory support

Myocarditis patients who present with rapid deterioration in haemodynamic status and rapidly progressive myocardial dysfunction are amongst those who respond best to temporary MCS.[293] Among temporary MCS, veno-arterial extracorporeal membrane oxygenation (VA-ECMO) represents the most frequently applied or recommended approach, ranging from 75% to 85% of AM cases.[75,294–296] Despite the

Léčba fulminantní myokarditidy

Diagnosis and management of patients with fulminant myocarditis

Nicoletta D'Ettore [1]*, Kaveh Eghbalzadeh[2], Mehmet Oezkur [3], Letizia F. Bertoldi[4], Matthias Bossard[5], and Federico Pappalardo [6]

Ventricular unloading via MCS devices can play a crucial role in mitigating the adverse effects of viral injury and autoimmune responses in myocarditis. The benefits of ventricular unloading include the following:

(1) Decreased workload of the heart: Ventricular unloading reduces myocardial stress and oxygen demand, which can limit further myocyte damage caused by the inflammatory response and preserve myocardial function.

(2) Improved coronary perfusion: Devices like microaxial flow pumps enhance coronary blood flow, ensuring better oxygen and nutrient delivery to the myocardium, which aids in the repair of damaged myocardial tissue, and reduces the extent of injury.

(3) Modulation of the immune response: Reducing myocardial stress and improving perfusion can indirectly modulate the immune response by decreasing the levels of stress-related inflammatory cytokines, mitigating the autoimmune component of myocarditis, and preventing further myocardial damage.

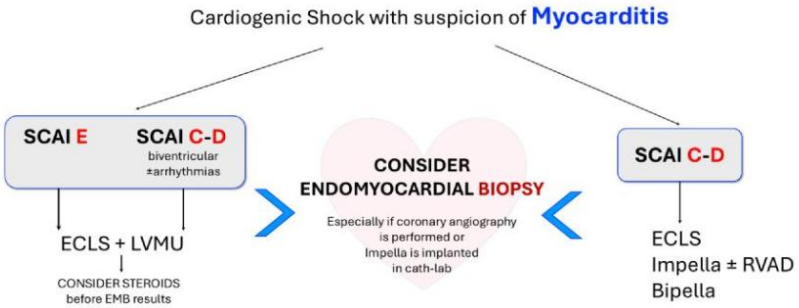
(4) Enhanced recovery environment: Ventricular unloading creates a more favourable environment for myocardial recovery by minimizing further injury and providing the heart with a chance to heal. This can be particularly beneficial in the context of viral myocarditis, where ongoing viral replication and immune-mediated injury are common.

European Heart Journal Supplements (2025) **27** (Supplement 4), iv23-iv30

Léčba fulminantní myokarditidy – kterou st-MCS použít?

Diagnosis and management of patients with fulminant myocarditis

Nicoletta D'Ettore [1]*, Kaveh Eghbalzadeh[2], Mehmet Oezkur [3], Letizia F. Bertoldi[4], Matthias Bossard[5], and Federico Pappalardo [6]



experience. The most frequently used short-term MCS in FM patients is VA-ECMO. However, during VA-ECMO support, LV distention and increased afterload may cause pulmonary oedema and hinder myocardial recovery. An early and effective unloading strategy should be associated. The combined ECMELLA (VA-ECMO + Impella) provides potent haemodynamic support, oxygenation, and ventricular unloading and is associated with lower mortality compared to VA-ECMO alone, despite higher complication rates. The combination in ECMELLA or BIPELLA should be considered when the right ventricular function is compromised.[31,32]

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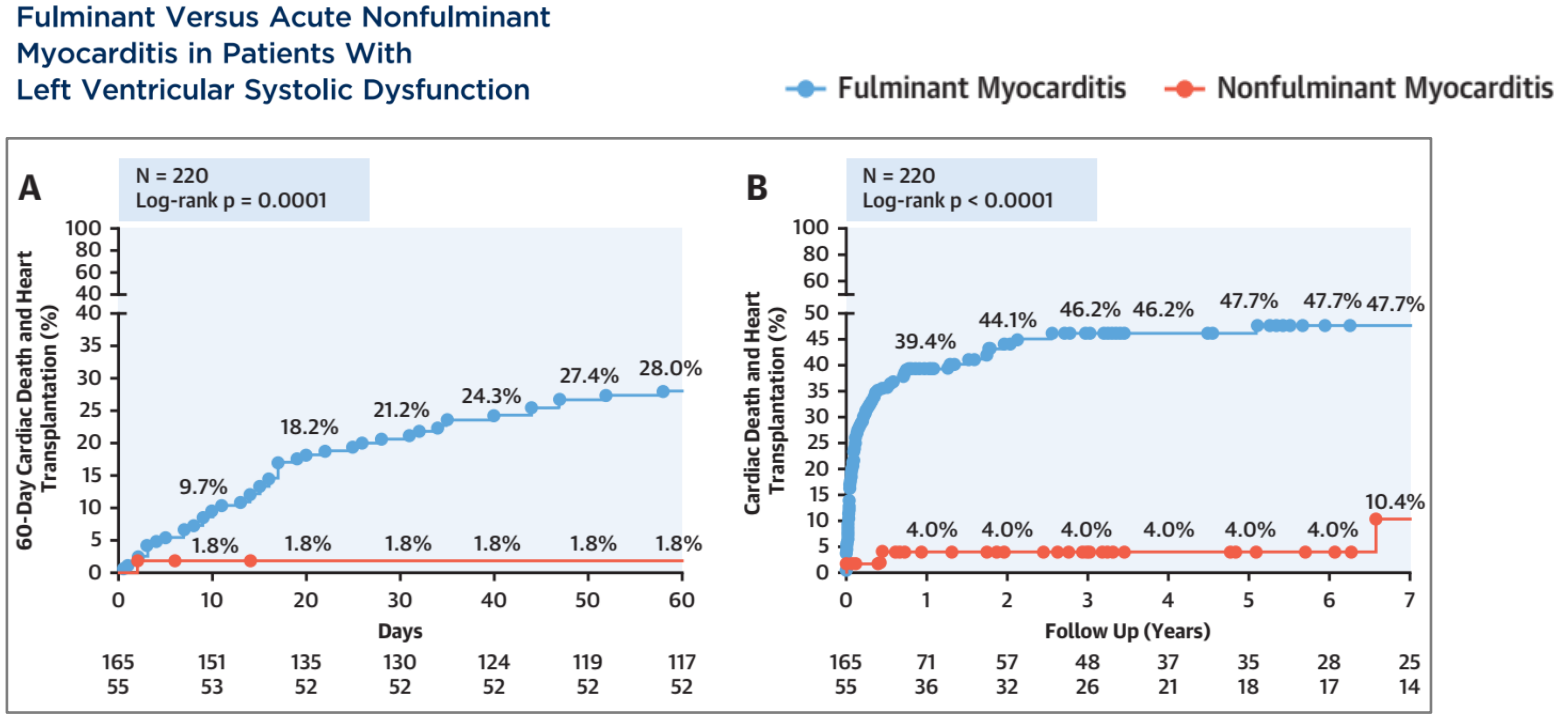
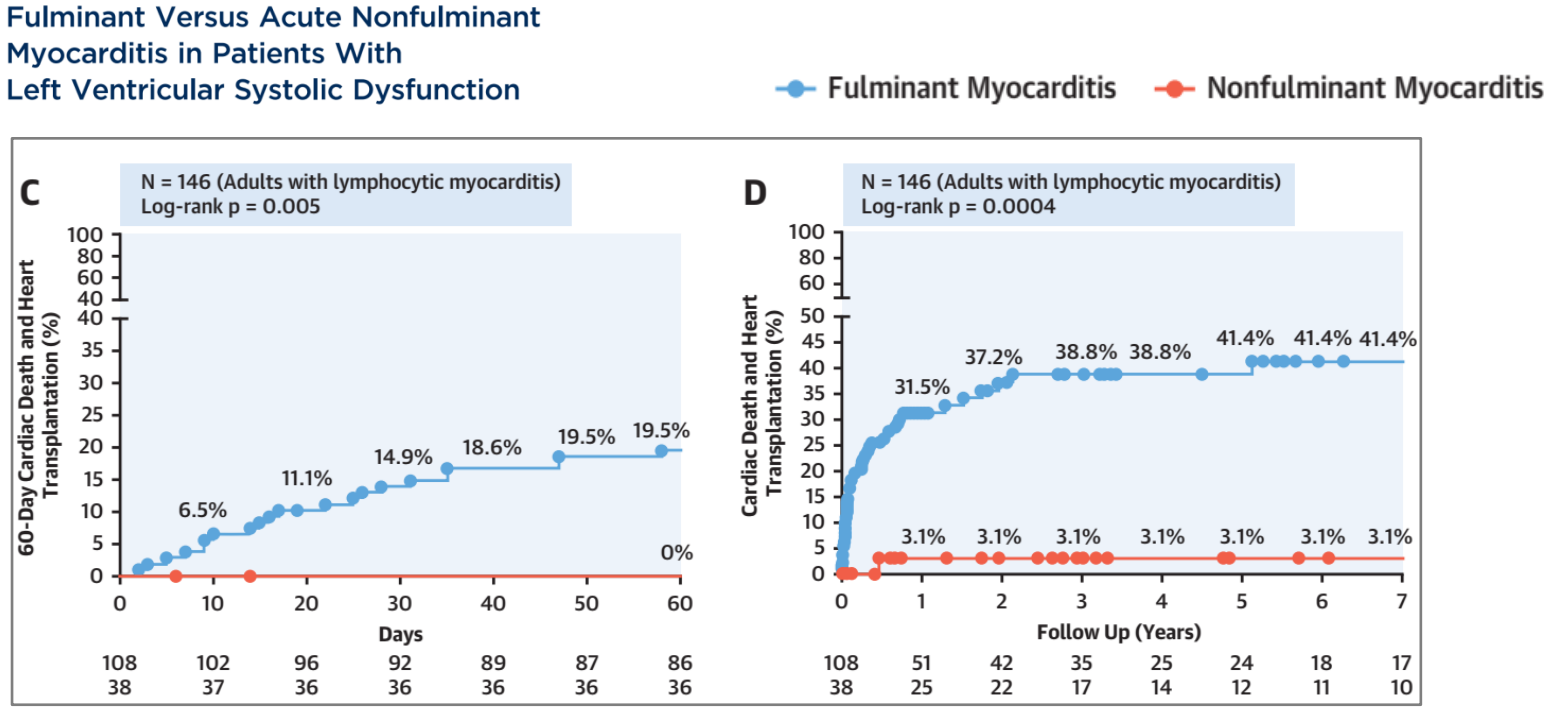
Prognóza fulminantní vs nefulminantní myokarditidy



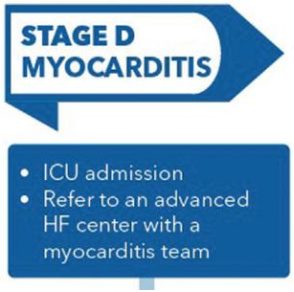
Ammirati, E. et al. J Am Coll Cardiol. 2019;74(3):299-311.

Prognóza fulminantní vs nefulminantní lymfocytární myokarditidy



Ammirati, E. et al. J Am Coll Cardiol. 2019;74(3):299-311.

Restrikce fyzické zátěže



- Treat arrhythmia
- Hemodynamic support including temporary circulatory support, as needed
- Endomyocardial biopsy
- Pharmacological treatment
  - Immunosuppression
  - Directed at etiology
- GDMT for HF and shock
- Consider durable LVAD or heart transplant if no recovery
- Restrict strenuous physical activity for 3-6 months (avoid excessive sedentary behavior)

Recommendation	Class[a]	Level[b]
Restriction of physical exercise until remission, for at least 1 month, is recommended in athletes and non-athletes after IMPS using an individualized approach to accelerate recovery.	I	C

Prevence SCD u nemocných s akutní myokarditidou

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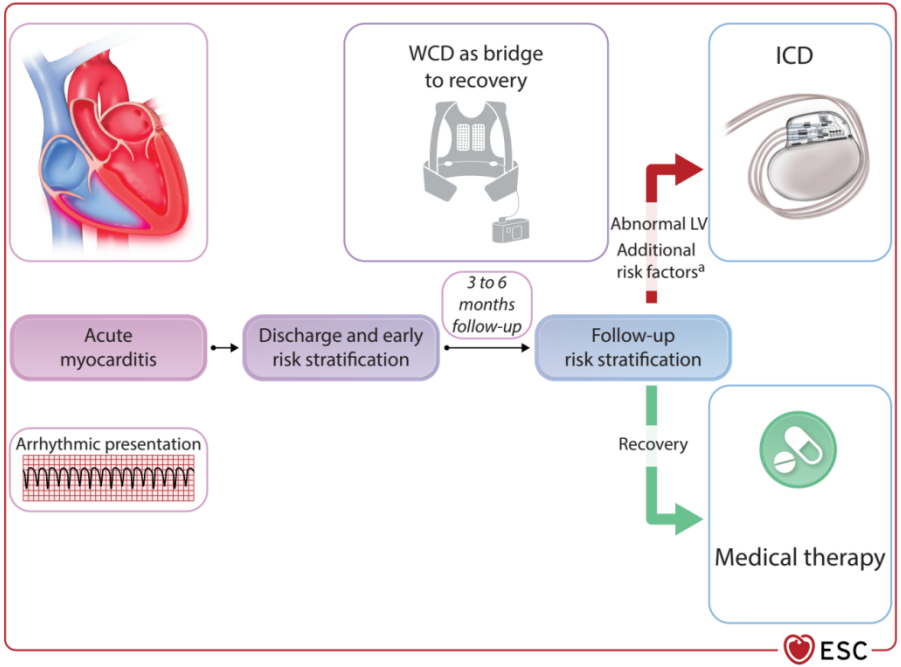
ICD in myocarditis		
Secondary prevention		
ICD implantation is recommended in patients with non-active[c] myocarditis and haemodynamically not-tolerated sustained VT to prevent SCD.[78,79,322,336]	I	C
ICD implantation should be considered in patients with non-active[c] myocarditis and haemodynamically tolerated sustained VT to prevent SCD.[78,79,322,336]	IIa	C
ICD implantation may be considered in patients with acute myocarditis and sustained VA (VT/VF) in the acute phase to prevent SCD.[71,79,89,222,323–325]	IIb	C
Primary prevention		
ICD implantation may be considered in patients with myocarditis after the acute phase (3–6 months) and persistent risk factors for VA[d] to prevent SCD.[89,332–334,336]	IIb	C



…snaha o zdrženlivost v akutní fázi myokarditidy…

Dlouhodobé sledování nemocných po FM je nezbytné!

Recommendations	Class[a]	Level[b]
Follow-up with clinical assessment, biomarkers[c], ECG, exercise test, Holter-ECG monitoring, echocardiography, and CMR at least within 6 months after the index hospitalization is recommended in all patients with myocarditis to identify a potential progression or new risk factors.[62]	I	C
Long-term follow-up is recommended for patients with complicated myocarditis[d] to identify a potential progression or new complications.[28,74]	I	C

		Within 1 month	Within 3–6 months	12 months	>1 year and long-term FU[a]
Clinical evaluation and ECG	Myocarditis	X	X	X	X
Biomarkers (TnI, C-reactive protein)	Myocarditis	X	X	(X)	(X)
Rhythm (stress and/or Holter-ECG)	Myocarditis	–	X	(X)	(X)
Imaging myocarditis	TTE		X[b]	X[c]	X[c]
	CMR		X[b]	X[c]	X[c]

FAKULTNÍ NEMOCNICE U SV. ANNY V BRNĚ

Závěry

- **Fulminantní myokarditida je onemocnění s vysokou krátko- i dlouhodobou mortalitou a morbiditou.**
- **Invazivní diagnostický přístup a komplexní farmakologická i nefarmakologická léčba může pomoci překlenout akutní fázi onemocnění.**
- **V post-akutní fázi je třeba kardiologický follow-up zaměřený na stratifikaci rizika SCD a včasné detekce progrese onemocnění vyžadující LVAD / HTx.**
- **Nezbytná je koncentrace závažných forem MC do terciálních center s dostupností komplexní diagnostiky a přístrojové léčby, ale také se zkušeností s IS / IM léčbou a s návazností na LVAD/HTx programy.**

Děkuji za pozornost!