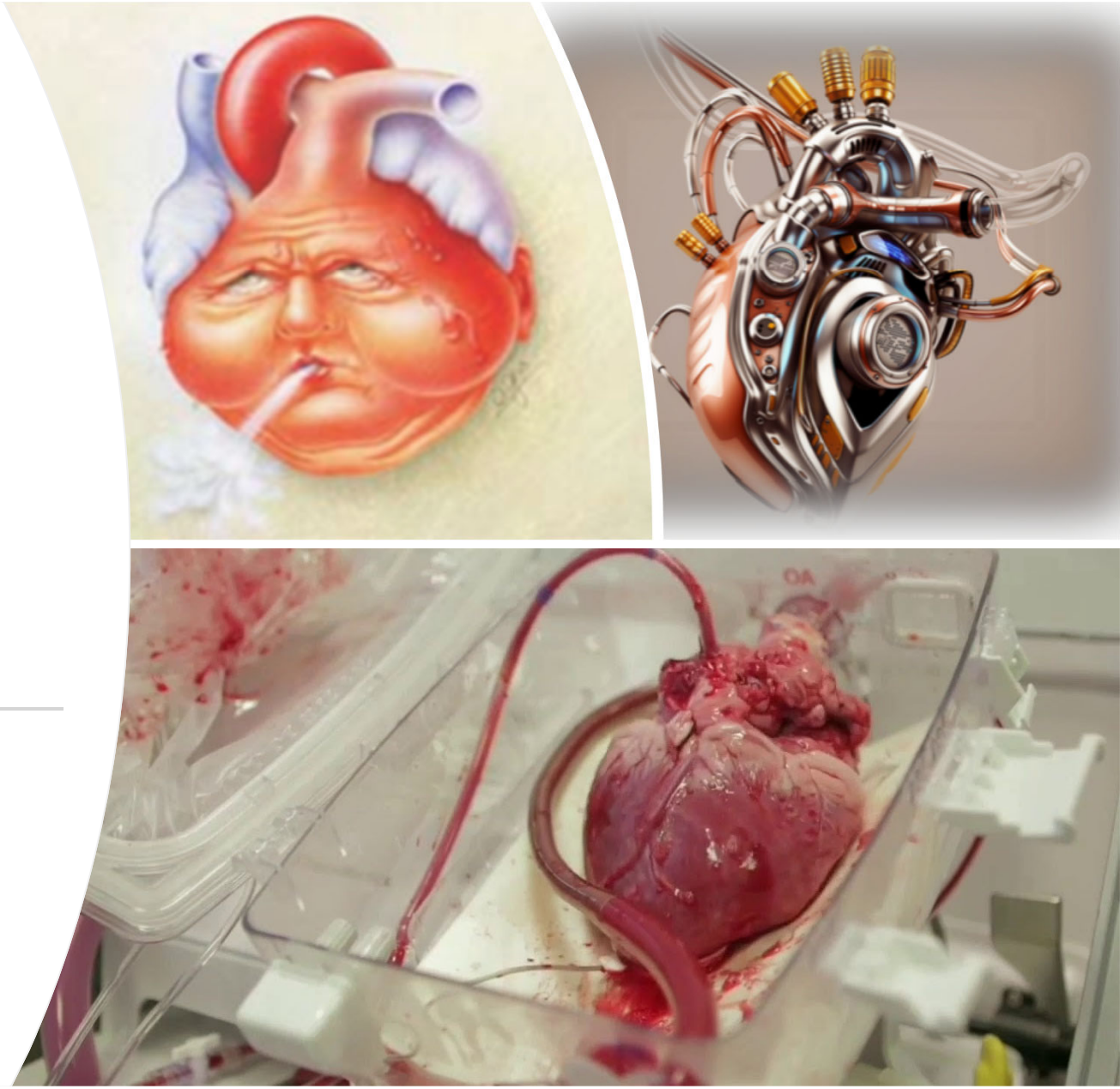
Insuffisance Cardiaque Avancée



Dr Romane Le Bourdon-Carré

Service de Traitement de l'Insuffisance Cardiaque

02/04/2026

Insuffisance cardiaque : définition

3.1 Definition of heart failure

Heart failure is not a single pathological diagnosis, but a clinical syndrome consisting of cardinal symptoms (e.g. breathlessness, ankle swelling, and fatigue) that may be accompanied by signs (e.g. elevated jugular venous pressure, pulmonary crackles, and peripheral oedema). It is due to a structural and/or functional abnormality of the heart that results in elevated intracardiac pressures and/or inadequate cardiac output at rest and/or during exercise.

Table 3 Definition of heart failure with reduced ejection fraction, mildly reduced ejection fraction and preserved ejection fraction

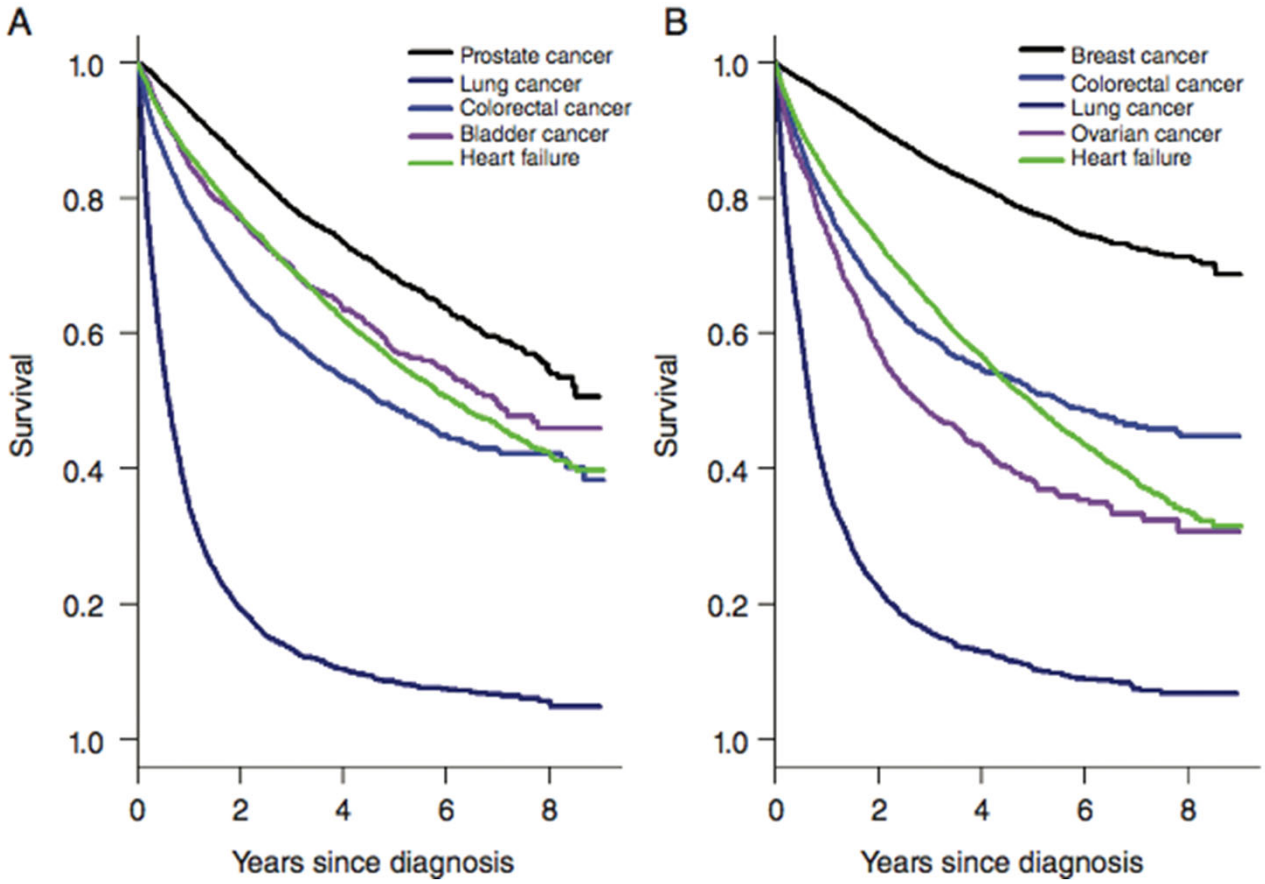
Type of HF		HFrEF	HFmrEF	HFpEF
CRITERIA	1	Symptoms ± Signs[a]	Symptoms ± Signs[a]	Symptoms ± Signs[a]
	2	LVEF ≤40%	LVEF 41–49%[b]	LVEF ≥50%
	3	–	–	Objective evidence of cardiac structural and/or functional abnormalities consistent with the presence of LV diastolic dysfunction/raised LV filling pressures, including raised natriuretic peptides[c]

Etiologies

Cause	Examples of presentations
CAD	Myocardial infarction Angina or "angina-equivalent" Arrhythmias
Hypertension	Heart failure with preserved systolic function Malignant hypertension/acute pulmonary oedema
Valve disease	Primary valve disease e.g., aortic stenosis Secondary valve disease, e.g. functional regurgitation Congenital valve disease
Arrhythmias	Atrial tachyarrhythmias Ventricular arrhythmias
CMPs	All Dilated Hypertrophic Restrictive ARVC Peripartum Takotsubo syndrome Toxins: alcohol, cocaine, iron, copper
Congenital heart disease	Congenitally corrected/repaired transposition of great arteries Shunt lesions Repaired tetralogy of Fallot Ebstein's anomaly
Infective	Viral myocarditis Chagas disease HIV Lyme disease
Drug-induced	Anthracyclines Trastuzumab VEGF inhibitors Immune checkpoint inhibitors Proteasome inhibitors RAF+MEK inhibitors
Infiltrative	Amyloid Sarcoidosis Neoplastic
Storage disorders	Haemochromatosis Fabry disease Glycogen storage diseases
Endomyocardial disease	Radiotherapy Endomyocardial fibrosis/eosinophilia Carcinoid
Pericardial disease	Calcification Infiltrative
Metabolic	Endocrine disease Nutritional disease (thiamine, vitamin B1 and selenium deficiencies) Autoimmune disease
Neuromuscular disease	Friedreich's ataxia Muscular dystrophy

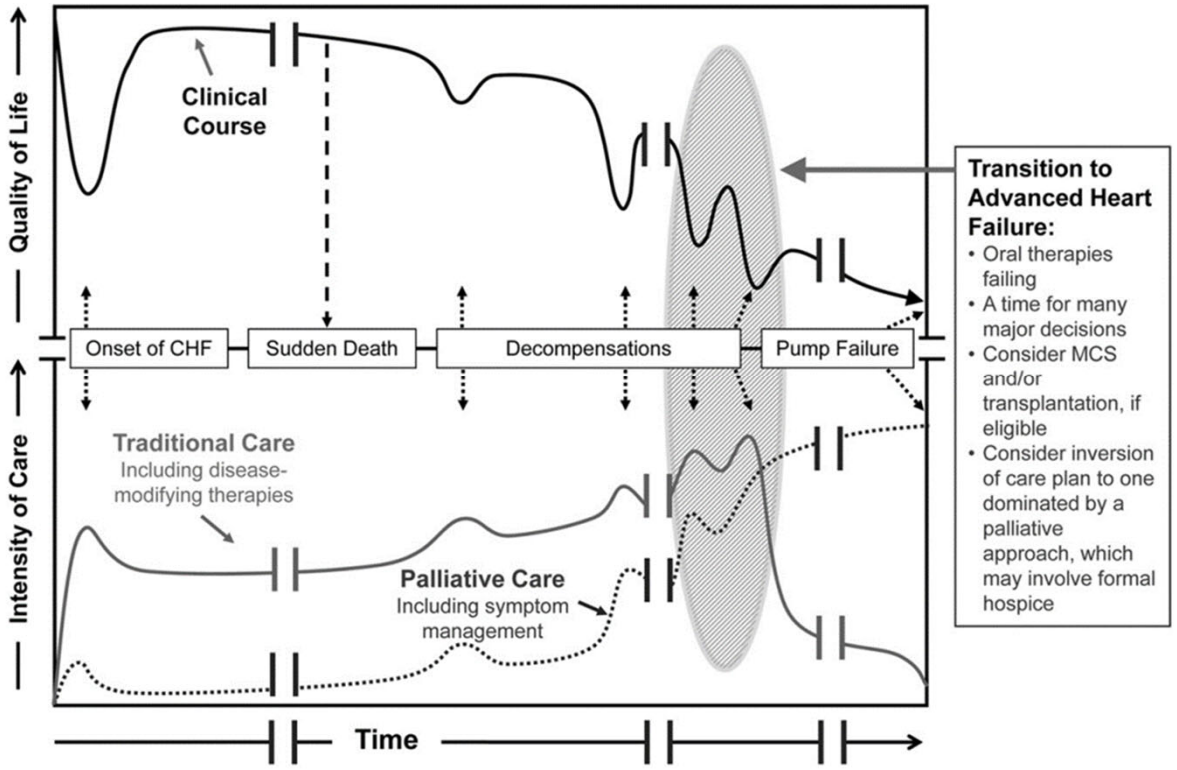
Pronostic de l'IC

Étude écossaise sur 1,75 millions personnes; 56658 pts étudiés



Mamas, EJHF 2017

Evolution naturelle de l'IC



Progression inexorable vers l'IC avancée

Allen LA et al, Circulation. 2012 Apr 17;125(15):1928-52

IC Avancée : définition

ESC European Society of Cardiology
European Heart Journal (2021) 42, 3599–3726
doi:10.1093/eurheartj/ehab368

ESC GUIDELINES

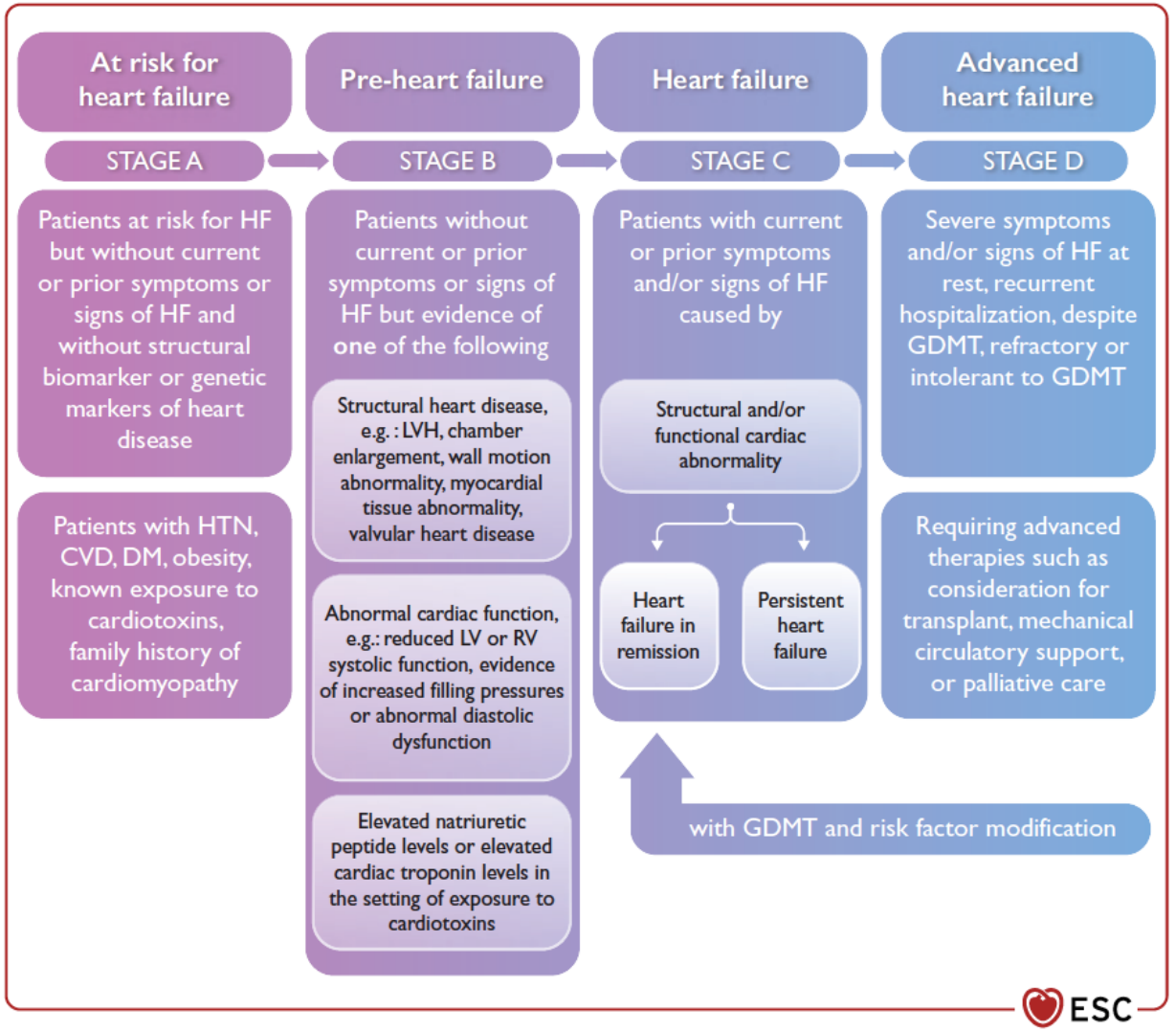
2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

Table 13 Criteria for definition of advanced heart failure

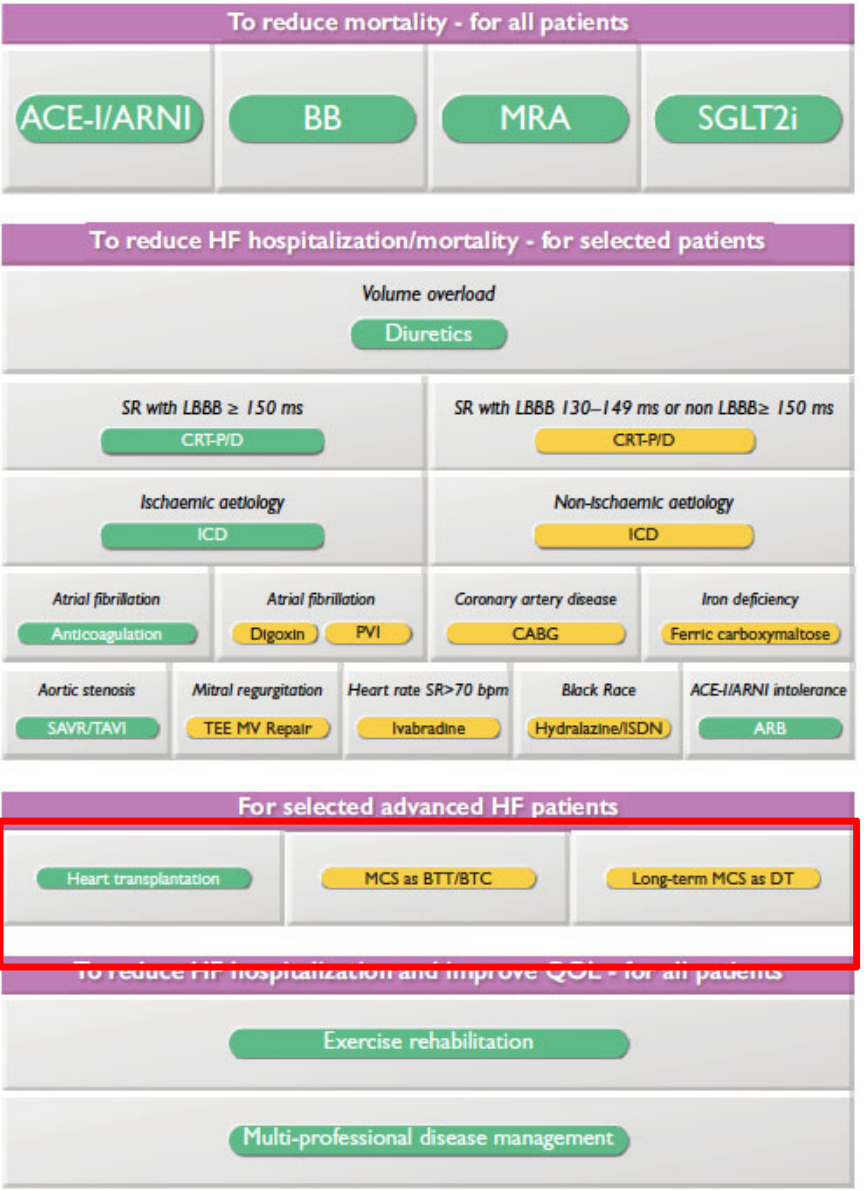
All the following criteria must be present despite optimal medical treatment:
1. Severe and persistent symptoms of heart failure [NYHA class III (advanced) or IV].
2. Severe cardiac dysfunction defined by at least one of the following: • LVEF ≤30% • Isolated RV failure (e.g., ARVC) • Non-operable severe valve abnormalities • Non-operable severe congenital abnormalities • Persistently high (or increasing) BNP or NT-proBNP values and severe LV diastolic dysfunction or structural abnormalities (according to the definitions of HFpEF).
3. Episodes of pulmonary or systemic congestion requiring high-dose i.v. diuretics (or diuretic combinations) or episodes of low output requiring inotropes or vasoactive drugs or malignant arrhythmias causing >1 unplanned visit or hospitalization in the last 12 months.
4. Severe impairment of exercise capacity with inability to exercise or low 6MWT distance (<300 m) or pVO_2 <12 mL/kg/min or <50% predicted value, estimated to be of cardiac origin.

The updated HFA-ESC 2018 criteria for the definition of advanced HF are reported in *Table 13*.[376] A severely reduced LVEF is common but not required for a diagnosis of advanced HF as it may develop in patients with HFpEF as well. In addition to the reported criteria, extra-cardiac organ dysfunction due to HF (e.g. cardiac cachexia, liver or kidney dysfunction) or type II pulmonary hypertension may be present, but are not required for the definition of advanced HF.[376]

Définition : différents stades



Grandes lignes de la prise en charge



Déjà mis en place et insuffisant

- Ttt médicamenteux
- Ttt électrique
- Ttt structurel
- Réadaptation

Projet de LVAD/ de transplantation

	Starting dose	Target dose
ACE-I		
Captopril[a]	6.25 mg *t.i.d.*	50 mg *t.i.d.*
Enalapril	2.5 mg *b.i.d.*	10–20 mg *b.i.d.*
Lisinopril[b]	2.5–5 mg *o.d.*	20–35 mg *o.d.*
Ramipril	2.5 mg *b.i.d.*	5 mg *b.i.d.*
Trandolapril[a]	0.5 mg *o.d.*	4 mg *o.d.*
ARNI		
Sacubitril/valsartan	49/51 mg *b.i.d.*[c]	97/103 mg *b.i.d.*
Beta-blockers		
Bisoprolol	1.25 mg *o.d.*	10 mg *o.d.*
Carvedilol	3.125 mg *b.i.d.*	25 mg *b.i.d.*[e]
Metoprolol succinate (CR/XL)	12.5–25 mg *o.d.*	200 mg *o.d.*
Nebivolol[d]	1.25 mg *o.d.*	10 mg *o.d.*
MRA		
Eplerenone	25 mg *o.d.*	50 mg *o.d.*
Spironolactone	25 mg *o.d.*[f]	50 mg *o.d.*
SGLT2 inhibitor		
Dapagliflozin	10 mg *o.d.*	10 mg *o.d.*
Empagliflozin	10 mg *o.d.*	10 mg *o.d.*
Other agents		
Candesartan	4 mg *o.d.*	32 mg *o.d.*
Losartan	50 mg *o.d.*	150 mg *o.d.*
Valsartan	40 mg *b.i.d.*	160 mg *b.i.d.*
Ivabradine	5 mg *b.i.d.*	7.5 mg *b.i.d.*
Vericiguat	2.5 mg *o.d.*	10 mg *o.d.*
Digoxin	62.5 µg *o.d.*	250 µg *o.d.*
Hydralazine/ Isosorbide dinitrate	37.5 mg *t.i.d.*/20 mg *t.i.d.*	75 mg *t.i.d.*/40 mg *t.i.d.*

Prise en charge palliative :

- Poursuite ttt méd.
- Dialyse palliative
- Inotropes palliatifs

IC avancée : « I NEED HELP »

Supplementary Table 14 **'I Need Help' markers of advanced heart failure**

I	**I**notropes	Previous or ongoing requirement for dobutamine, milrinone, dopamine, or levosimendan
N	**N**YHA class/NP	Persisting NYHA class III or IV and/or persistently high BNP or NT-proBNP
E	**E**nd-Organ Dysfunction	Worsening renal or liver dysfunction in the setting of HF
E	**E**jection Fraction	Very low EF <20%
D	**D**efibrillator shocks	Recurrent appropriate defibrillator shocks
H	**H**ospitalizations	More than 1 hospitalization with HF in the last 12 months
E	**E**dema/Escalating diuretics	Persisting fluid overload and/or increasing diuretic requirement
L	**L**ow blood pressure	Consistently low blood pressure with SBP <90 to 100 mmHg
P	**P**rognostic medication	Inability to uptitrate (or need to decrease/cease) ACE-Is, beta-blockers, ARNIs, or MRAs

Enjeu +++ du timing d'adressage

- Altération progressive état général :
  - Cachexie
  - Défaillances d'organes cibles (rein +++, foie)
  - Gravité de l'atteinte cardiaque : IM, HTP, VD

Trop tard !!!!!

- Transplantation = TTT de choix de l'IC Avancée **mais** :
  - Bilan pré-thérapeutique parfois long
  - Durée d'attente sur liste « aléatoire »
  - Parfois nécessité de passer par le LVAD
- Moins bons résultats de la greffe et de l'assistance en contexte aigu

Quand adresser le patient ?

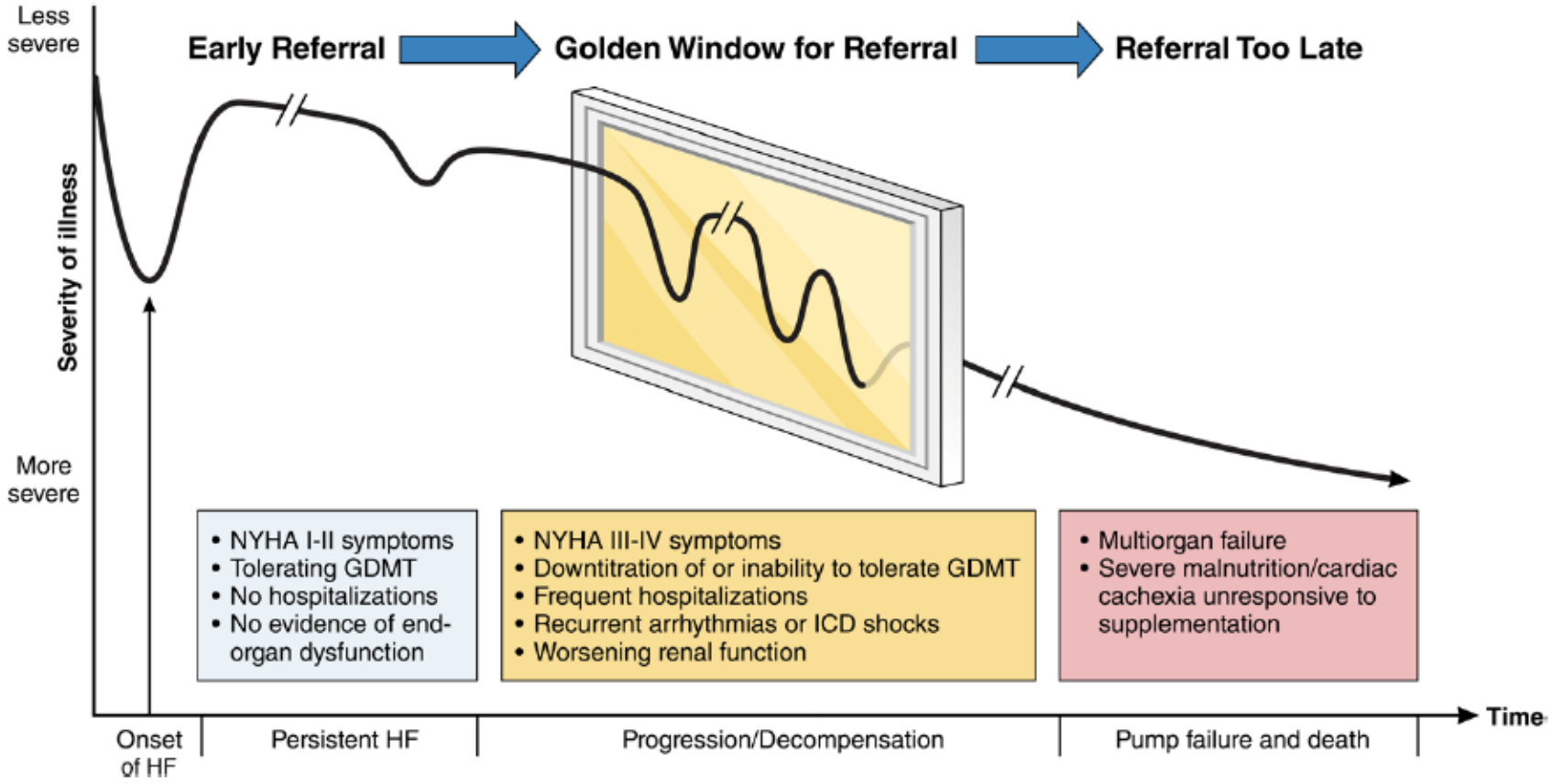
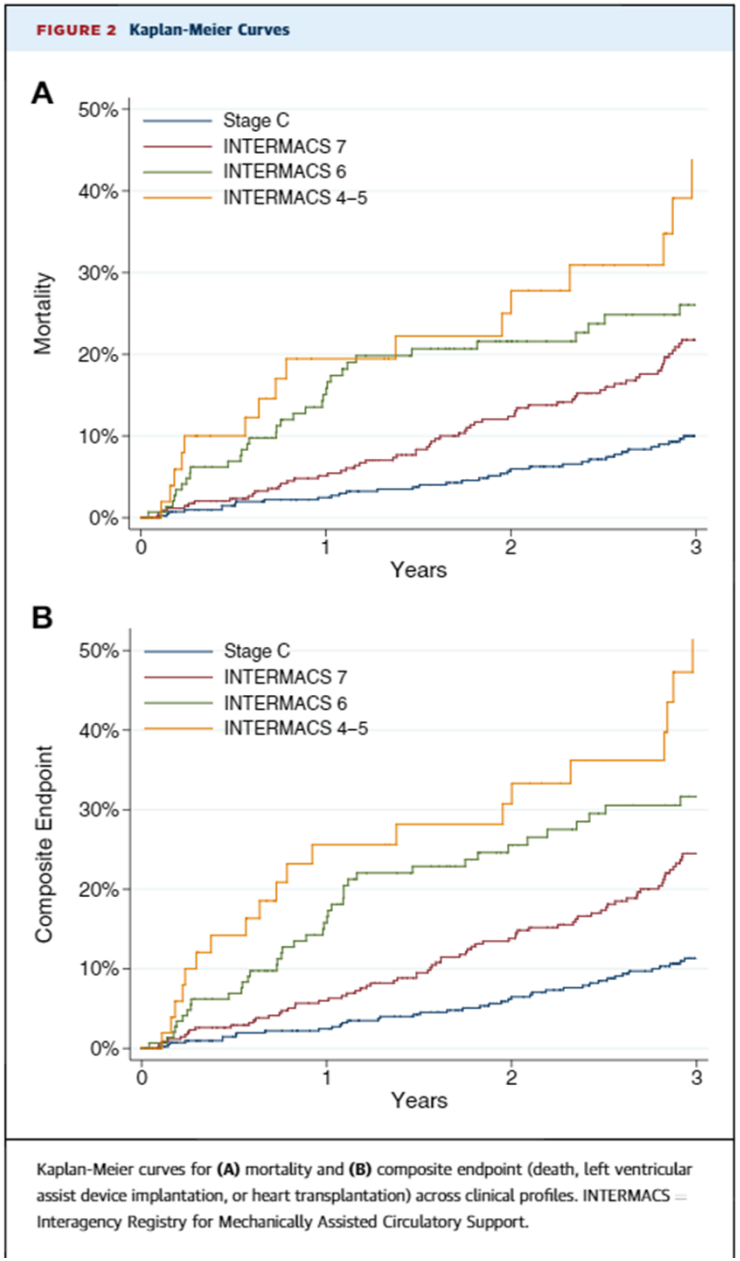


Table 14 **Interagency Registry for Mechanically Assisted Circulatory Support profile descriptions of patients with advanced heart failure**

Profile	Time frame for intervention
Profile 1. Critical cardiogenic shock Patient with life-threatening hypotension despite rapidly escalating inotropic support, critical organ hypoperfusion, often confirmed by worsening acidosis and/or lactate levels. "Crash and burn."	Definitive intervention needed within hours.
Profile 2. Progressive decline Patient with declining function despite i.v. inotropic support, may be manifest by worsening renal function, nutritional depletion, inability to restore volume balance. "Sliding on inotropes." Also describes declining status in patients unable to tolerate inotropic therapy.	Definitive intervention needed within few days.
Profile 3. Stable on inotrope or inotrope-dependent Patient with stable blood pressure, organ function, nutrition, and symptoms on continuous i.v. inotropic support (or a temporary circulatory support device or both) but demonstrating repeated failure to wean from support due to recurrent symptomatic hypotension or renal dysfunction. "Dependent stability."	Definitive intervention elective over a period of weeks to few months.
Profile 4. Frequent Flyer Patient can be stabilized close to normal volume status but experiences daily symptoms of congestion at rest or during activities of daily living. Doses of diuretics generally fluctuate at very high levels. More intensive management and surveillance strategies should be considered, which may in some cases reveal poor compliance that would compromise outcomes with any therapy. Some patients may shuttle between 4 and 5.	Definitive intervention elective over a period of weeks to few months.
Profile 5. Housebound Comfortable at rest and with activities of daily living but unable to engage in any other activity, living predominantly within the house. Patients are comfortable at rest without congestive symptoms, but may have underlying refractory elevated volume status, often with renal dysfunction. If underlying nutritional status and organ function are marginal, patients may be more at risk than INTERMACS 4, and require definitive intervention.	Variable urgency, depends upon maintenance of nutrition, organ function, and activity.
Profile 6. Exertion limited Patient without evidence of fluid overload, comfortable at rest and with activities of daily living and minor activities outside the home but fatigues after the first few minutes of any meaningful activity. Attribution to cardiac limitation requires careful measurement of peak oxygen consumption, in some cases with haemodynamic monitoring, to confirm severity of cardiac impairment. "Walking wounded."	Variable, depends upon maintenance of nutrition, organ function, and activity level.
Profile	**Time frame for intervention**
Profile 7. Advanced NYHA class III symptoms Patient without current or recent episodes of unstable fluid balance, living comfortably with meaningful activity limited to mild physical exertion.	Heart transplantation or MCS may not be currently indicated.

IC avancée : Intermacs

- ECLS, Impella
- ECLS, Impella, LVAD?, HTx?
- LVAD, HTx.
- LVAD, HTx.
- LVAD, HTx.
- HTx, LVAD?
- HTx, LVAD?

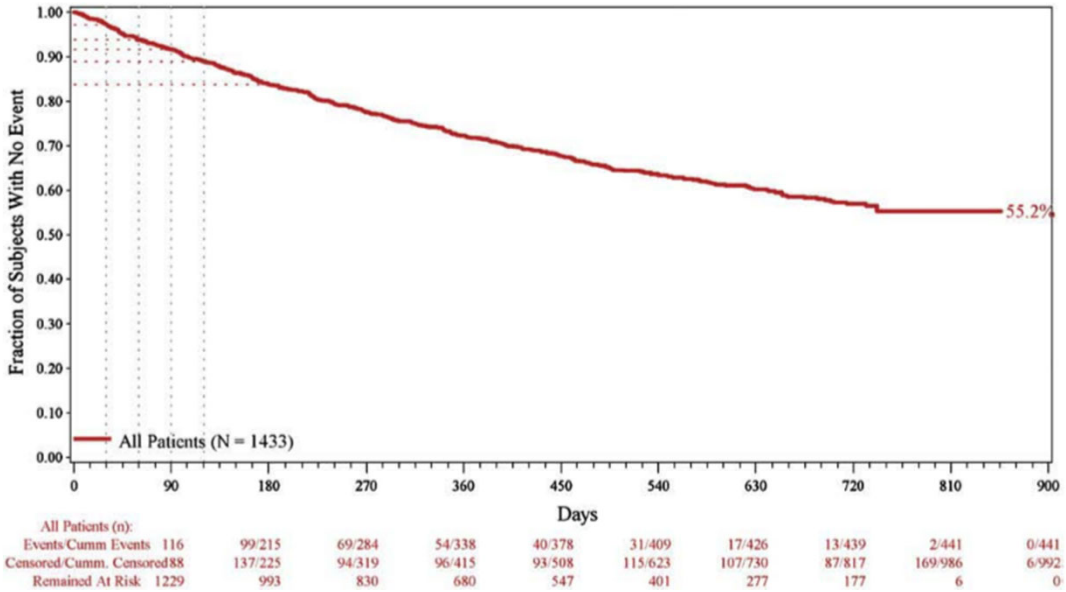


Pronostic mieux discriminé

Mortalité

Composite : mortalité, Htx, LVAD.

IC avancée : pronostic



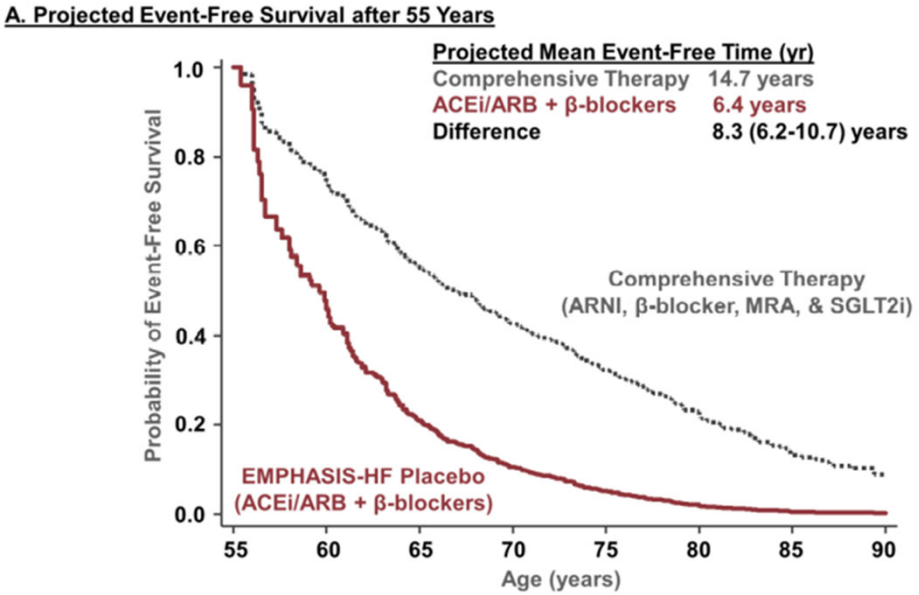
Kaplan-Meier survival curve for all patients in ADHERE LM.

1433 STAGE D HF (2006)

- 1-year survival 71.9%
- 1-year freedom from hospital or death 32,9%
- 2-year survival 55,2 %

➔ Néanmoins en amélioration grâce aux progrès thérapeutiques (principalement ICFER).

Estimation du gain de survie avec les dernières avancées thérapeutiques (Sacubitril-Valsartan et gliflozines)



Vaduganathan M. Lancet 2020;396:121-28.

Scores pronostiques existants

Table 5 Prognostic scores

Score	Components	Comments
HFSS[133]	• Presence/absence coronary artery disease • Resting heart rate • Left ventricular ejection fraction • Mean arterial blood pressure • Presence/absence of intraventricular conduction delay • Serum sodium • Peak oxygen uptake HFSS = [(0.0216 * resting HR) + (−0.0255 * mean BP) + (−0.0464 * LVEF) + (−0.047 * serum sodium) + (−0.0546 * peak VO_2) + (0.608 * presence or absence of IVCD) + (0.6931 * presence or absence of ischaemic heart disease)]	Score is based on a sum of these variables multiplied by defined coefficients Low risk: ≥8.1 Medium-risk: HFSS 7.20 to 8.09 High-risk: HFSS ≤7.1
SHFM[109]	• Demographics • Clinical characteristics • Medications • Laboratory data • Devices www.seattleheartfailuremodel.org	Incorporates impact of interventions (medical and device) and provides estimates of 1, 2, and 5-year survival
MECKI[134–136]	• Percent predicted peak VO_2 • V_E/V_{CO2} slope • Haemoglobin • Serum sodium • LVEF • eGFR by MDRD	Incorporates data from the CPET as well as kidney function
MAGGIC[105]	• Age • Gender • LVEF • Systolic blood pressure • Body mass index • Serum creatinine • NYHA class • Smoking history • Co-morbidities (e.g. diabetes, COPD) • Length of heart failure diagnosis • Medications www.heartfailurerisk.org	Risk model converted into integer score Generalizable to a broad spectrum of patients

The 2016 International Society for Heart Lung Transplantation listing criteria for heart transplantation: A 10-year update

1.2. Use of heart failure prognosis scores

Heart failure prognosis scores should be performed along with cardiopulmonary exercise test to determine prognosis and guide listing for transplantation for ambulatory patients. An estimated 1-year survival as calculated by the Seattle Heart Failure Model (SHFM) of < 80% or a Heart Failure Survival Score (HFSS) in the high/medium risk range should be considered as reasonable cut points for listing (Class IIb, Level of Evidence: C).

Listing patients solely on the criteria of heart failure survival prognostic scores should not be performed (Class III, Level of Evidence: C).

- Scores dérivés de cohortes mono centriques anciennes sur pts sélectionnés
- Ne concernent pas des pts en IC avancée
- Pas BNP, rarement DFG !!!
- Fiabilité / Pertinence ???

IC avancée : évaluation fonctionnelle

- TM6' : simple, rapide, fiable pour le suivi.
  - < 300 mètres = mauvais pronostic
- VO2 : élément de sélection des patients, élément de suivi
  - Pic de VO2 < 12 mL/kg/min ou < 50% de la théorique
  - Pente VE/VCO2 > 35

Table 13 Criteria for definition of advanced heart failure

All the following criteria must be present despite optimal medical treatment:
1. Severe and persistent symptoms of heart failure [NYHA class III (advanced) or IV].
2. Severe cardiac dysfunction defined by at least one of the following: • LVEF ≤30% • Isolated RV failure (e.g., ARVC) • Non-operable severe valve abnormalities • Non-operable severe congenital abnormalities • Persistently high (or increasing) BNP or NT-proBNP values and severe LV diastolic dysfunction or structural abnormalities (according to the definitions of HFpEF).
3. Episodes of pulmonary or systemic congestion requiring high-dose i.v. diuretics (or diuretic combinations) or episodes of low output requiring inotropes or vasoactive drugs or malignant arrhythmias causing >1 unplanned visit or hospitalization in the last 12 months.
4. Severe impairment of exercise capacity with inability to exercise or low 6MWT distance (<300 m) or pVO_2 <12 mL/kg/min or <50% predicted value, estimated to be of cardiac origin.

Table 1 A Comparison of the 2006 vs 2016 Guidelines for Section I (General Considerations)

2006 Guideline recommendation	2016 Guideline recommendation
1.1. Cardiopulmonary stress testing to guide transplant listing	**1.1. Cardiopulmonary stress testing to guide transplant listing**
A maximal cardiopulmonary exercise test is defined as one with a respiratory exchange ratio (RER) > 1.05 and achievement of an anaerobic threshold on optimal pharmacologic therapy (**Class I, Level of Evidence: B**).	Continuing approval without change.
	The presence of a CRT device does not alter the current peak Vo_2 cutoff recommendations (Class I, Level of Evidence: B).
In patients intolerant of a β-blocker, a cutoff for peak oxygen consumption (Vo_2) of ≤ 14 ml/kg/min should be used to guide listing (**Class I, Level of Evidence: B**).	Continuing approval without change.
In the presence of a β-blocker, a cutoff for peak Vo_2 of ≤ 12 ml/kg/min should be used to guide listing (**Class I, Level of Evidence: B**).	Continuing approval without change.
In young patients (< 50 years) and women, it is reasonable to consider using alternate standards in conjunction with peak Vo_2 to guide listing, including percent of predicted (≤ 50%) peak Vo_2 (**Class IIa, Level of Evidence: B**).	Continuing approval without change.
In the presence of a sub-maximal cardiopulmonary exercise test (RER < 1.05), use of ventilation equivalent of carbon dioxide (V_E/Vco_2) slope of > 35 as a determinant in listing for transplantation may be considered (**Class IIb, Level of Evidence: C**).	Continuing approval without change.
In obese (body mass index [BMI] > 30 kg/m^2) patients, adjusting peak Vo_2 to lean body mass may be considered. A lean body mass–adjusted peak Vo_2 of < 19 ml/kg/min can serve as an optimal threshold to guide prognosis (**Class IIb, Level of Evidence: B**).	Continuing approval without change.
Listing patients based solely on the criterion of a peak Vo_2 measurement should not be performed (**Class III, Level of Evidence: C**).	Continuing approval without change.

IC avancée: marqueurs biologiques

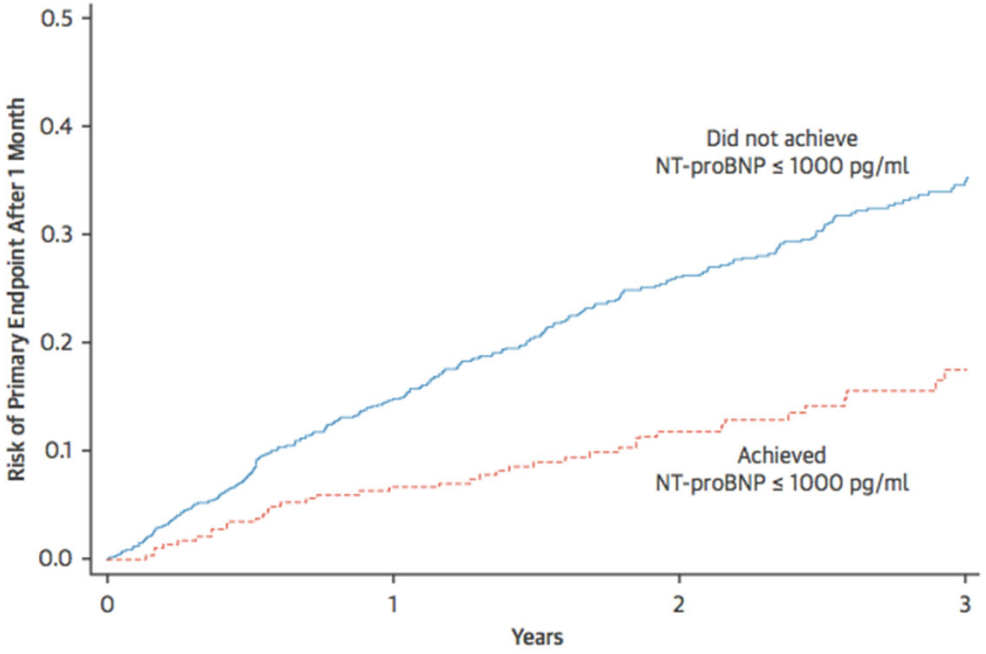
10. Advanced heart failure

Supplementary Table 13 **Suggested clinical, laboratory, and echocardiographic criteria to trigger referral to a specialized heart failure or advanced heart failure unit**

Clinical	Laboratory	Imaging	Risk score data
• >1 HF hospitalization in last year • NYHA class III–IV • Intolerant of optimal dose of any GDMT HF drug • Increasing diuretic requirement • SBP ≤90 mmHg • Inability to perform CPET • 6MWT <300 m • CRT non responder clinically • Cachexia, unintentional weight loss • KCCQ decrease >5 units	• eGFR <45 mL/min • SCr ≥160 micromoles/L • K^+ >5.2 or <3.5 mmol/L • Hyponatraemia • Hb ≤120 g/L • Persistently elevated high BNP/NT-proBNP, e.g. NT-proBNP ≥1000 pg/mL • Abnormal liver function test • Low albumin	• LVEF ≤30% • Large area of akinesis/dyskinesis or aneurysm • Moderate[a]-severe mitral regurgitation • RV dysfunction • Systolic PA pressure ≥50 mmHg • Moderate-severe tricuspid regurgitation • Difficult to grade aortic stenosis • IVC dilated or without respiratory variation	• MAGGIC predicted survival ≤80% at 1 year • SHFM predicted survival ≤80% at 1 year • MECKI predicted survival ≤80% at 1 year

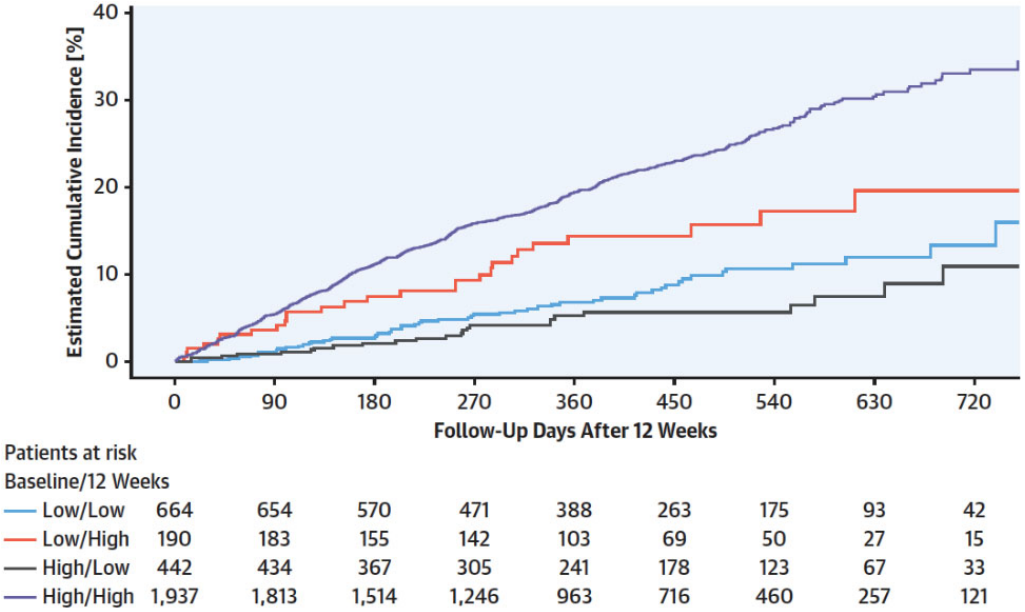
Valeur pronostique de l'évolution du NT-proBNP

PARADIGM-HF



Zile M. J Am Coll Cardiol 2016;68:2425–36

EMPEROR-Reduced



Patients at risk
Baseline/12 Weeks

Low/Low	664	654	570	471	388	263	175	93	42
Low/High	190	183	155	142	103	69	50	27	15
High/Low	442	434	367	305	241	178	123	67	33
High/High	1,937	1,813	1,514	1,246	963	716	460	257	121

Januzzi J. J Am Coll Cardiol 2021;78:1321–1332)

IC Avancée : évaluation

- KT droit :
  - Intérêt diagnostique.

Recommendations	Class
Recommendations for the diagnosis of HF	
Right heart catheterization should be considered in patients where HF is thought to be due to constrictive pericarditis, restrictive cardiomyopathy, congenital heart disease, and high output states.	IIa
Right heart catheterization may be considered in selected patients with HFpEF to confirm the diagnosis.	IIb

  - Pas d'intérêt pour la sélection des patients…
  - …Mais intérêt si discussion de projet

Right heart catheterization is recommended in patients with severe HF being evaluated for heart transplantation or MCS.	I	C

Contraindications	1. Active infection 2. Severe peripheral arterial or cerebrovascular disease 3. Pharmacologic irreversible pulmonary hypertension (LVAD should be considered with subsequent re-evaluation to establish candidacy) 4. Cancer (a collaboration with oncology specialists should occur to stratify each patient as to their risk of tumour recurrence) 5. Irreversible renal dysfunction (e.g. creatinine clearance <30 mL/min) 6. Systemic disease with multiorgan involvement 7. Other serious co-morbidity with poor prognosis 8. Pre-transplant BMI >35 kg/m^2 (weight loss is recommended to achieve a BMI <35 kg/m^2) 9. Current alcohol or drug abuse 10. Any patient for whom social supports are deemed insufficient to achieve compliant care in the outpatient setting

HTP

1.3. Role of diagnostic right-heart catheterization

Right heart catheterization (RHC) should be performed on all candidates in preparation for listing for cardiac transplantation and annually until transplantation (**Class 1, Level of Evidence: C**).

RHC should be performed at 3- to 6-month intervals in listed patients, especially in the presence of reversible pulmonary hypertension or worsening of heart failure symptoms (**Class I, Level of Evidence: C**).

A vasodilator challenge should be administered when the pulmonary artery systolic pressure is ≥ 50 mm Hg and either the transpulmonary gradient is ≥ 15 or the pulmonary vascular resistance (PVR) is > 3Wood units while maintaining a systolic arterial blood pressure > 85 mm Hg (**Class I, Level of Evidence: C**).

When an acute vasodilator challenge is unsuccessful, hospitalization with continuous hemodynamic monitoring should be performed, as often the PVR will decline after 24 to 48 hours of treatment consisting of diuretics, inotropes and vasoactive agents such as inhaled nitric oxide (**Class I, Level of Evidence: C**).	Continuing approval without change.
If medical therapy fails to achieve acceptable hemodynamics, and if the left ventricle cannot be effectively unloaded with mechanical adjuncts, including an intra-aortic balloon pump (IABP) and/or left ventricular assist device (LVAD), it is reasonable to conclude that the pulmonary hypertension is irreversible (**Class IIb, Level of Evidence: C**).	If medical therapy fails to achieve acceptable hemodynamics and if the left ventricle cannot be effectively unloaded with mechanical adjuncts, including an intra-aortic balloon pump (IABP) and/or left ventricular assist device (LVAD), it is reasonable to conclude that the pulmonary hypertension is irreversible. **After LVAD, reevaluation of hemodynamics should be done after 3 to 6 months to ascertain reversibility of pulmonary hypertension (Class IIA, Level of Evidence: C).**

- PAPs >50mmHg, RVP>3UW (ou gradient TP élevé): faire test de réversibilité (TNT immédiate, si PAS « correcte », ou inotropes sur 24-48h).
- Si échec et HTAP post-capillaire pure, discuter LVAD avant la transplantation pour normalisation des pressions pulmonaires.

The 2016 International Society for Heart Lung Transplantation listing criteria for heart transplantation: A 10-year update

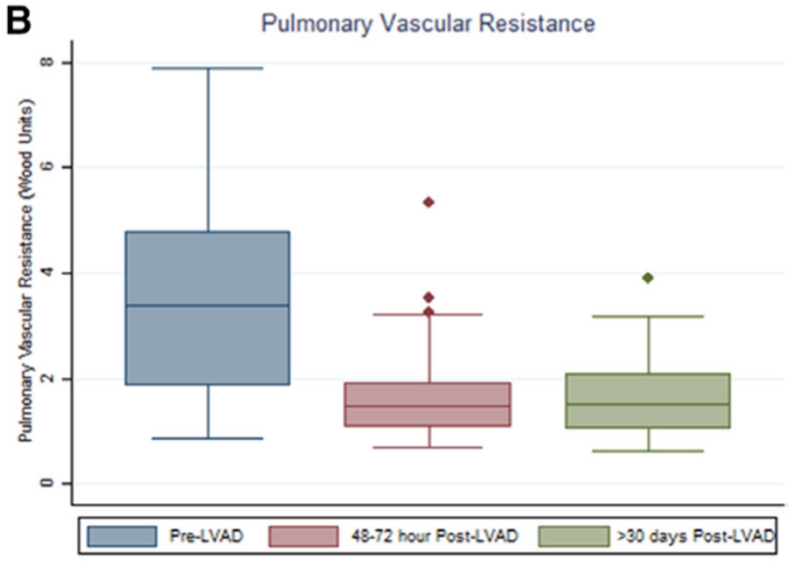
Cas clinique KT droit

- Homme de 64 ans, CMI diagnostiquée en 2017.
  - Projet discuté en 2018 : Htx.
  - Passage en FA, dégradation HD malgré ablation et maintien RS.
  - LVAD en bridge to transplantation fin 2018, HTx en 2021.

	07/2018	11/2018	11/2018	03/2019
AP	61/34/45	66/30/42	66/28/43	35/10/21
Pcap	37	30	30	10
OD	6	10	6	4
IC	2,5	1,8	2,3	2,8
RVP	1,8	3,8	3,2	2
Test		Levo/furo	TNT 3mg	
Post test			66/23/37, Cap 26, IC 2,1. RVP 3	

Amélioration HTP par LVAD

Hemodynamic Variables	Pre-LVAD n = 64	Within 72 Hour Post-LVAD n = 64	*p*
Right atrial pressure (mm Hg)	11.8±6.5	10.1±5.4	0.07
PA mean pressure (mm Hg)	35.9±9.9	23.3±7.7	<0.0001
Pulmonary capillary wedge pressure (mm Hg)	23.2±7.6	14.9±7.3	<0.0001
Cardiac index (ml/min/m^2)	1.9±0.5	2.6±0.5	<0.0001
Heart rate (beats per minute)	84±18	87±16	0.31
Pulmonary vascular resistance (Wood units)	3.5±1.9	1.7±0.84	<0.0001



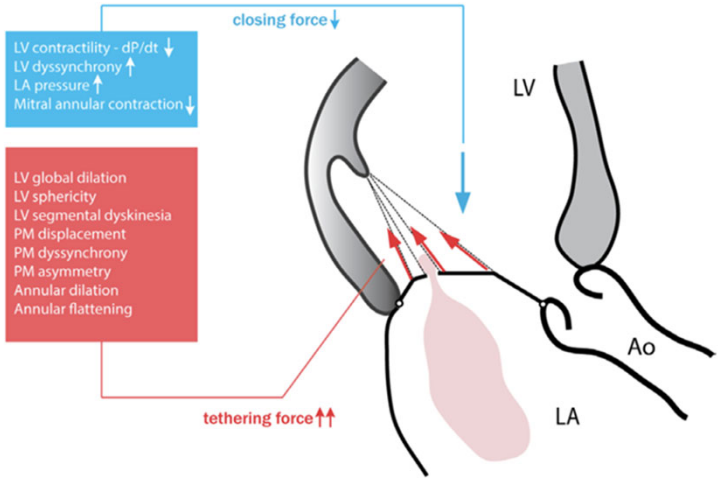
64 pts implantés LVAD entre 2001 et 2007;
KT pré-op, entre J2 et J2 et > J30

Amélioration précoce RVP dès J2-J3

Masri S. ASAIO Journal 2017; 63:139–143.

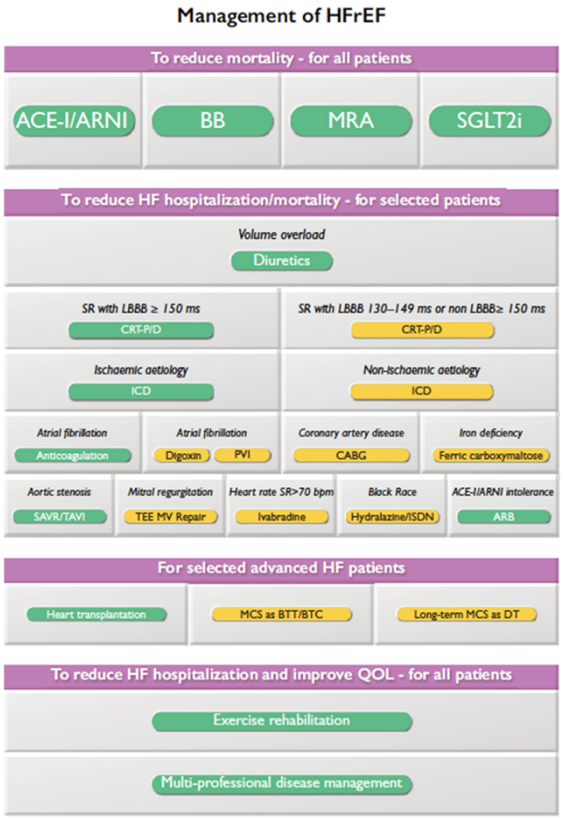
Tournants évolutifs dans l'IC

- Apparition d'arythmies (FA, TV/FV)
- Insuffisance mitrale secondaire
  - Dilatation VG, asynchronisme papillaire et tenting sous valvulaire
  - Élévation POG
- Apparition d'un syndrome cardio-rénal
  - Congestion veineuse +++
  - Bas débit, vasoconstriction artériolaire et activation SRAA
- Altération cardio-hépatique
  - Hépatopathie congestive (cholestase), ischémie hépatique (cytolyse), jusqu'à cirrhose cardiaque
- Hypertension pulmonaire post-capillaire
  - Isolée puis mixte pré et post capillaire (RVP >3)
- Défaillance VD
  - Élévation PAP et RVP, élévation PVC, altération contractile et IT



Bertrand P. Circ. 2017;135:297–314.

IC avancée : que peut-on (encore) faire ?



- TTT médicamenteux ? compliqué car svt TA basse et insuffisance rénale, souvent nécessité de ↘ TTT.
- Réadaptation pré-chirurgicale?
- CRT ? Peu utile en cas de dysfonction VD, d'ATCD d'utilisation d'inotropes ou classe NYHA 4
- **LVAD et/ou transplantation ? Place clairement établie**
- Mitraclip ou nouvelles techniques percutanées de PEC de valvulopathies 2^{ndr} ? Place encore à déterminer
- Ultrafiltration ou dialyse péritonéale palliative ?
- Prise en charge multidisciplinaire palliative ?

Options chirurgicales

- LVAD
- Transplantation

Bridge to decision (BTD)/ Bridge to bridge (BTB)	Use of short-term MCS (ECMO or Impella) in patients with cardiogenic shock until haemodynamics and end-organ perfusion are stabilized, contraindications for long-term MCS are excluded (brain damage after resuscitation) and additional therapeutic options including long-term VAD therapy or heart transplant can be evaluated.
Bridge to candidacy (BTC)	Use of MCS (usually LVAD) to improve end-organ function and/or to make an ineligible patient eligible for heart transplantation.
Bridge to transplantation (BTT)	Use of MCS (LVAD, BiVAD or TAH) to keep a patient alive who is otherwise at high risk of death before transplantation until a donor organ becomes available.
Bridge to recovery (BTR)	Use of MCS (short-term or long-term) to keep a patient alive until cardiac function recovers sufficiently to remove MCS.
Destination therapy (DT)	Long-term use of MCS (LVAD) as an alternative to transplantation in patients with end-stage HF ineligible for transplantation.

Table 17 Heart transplantation: indications and contraindications

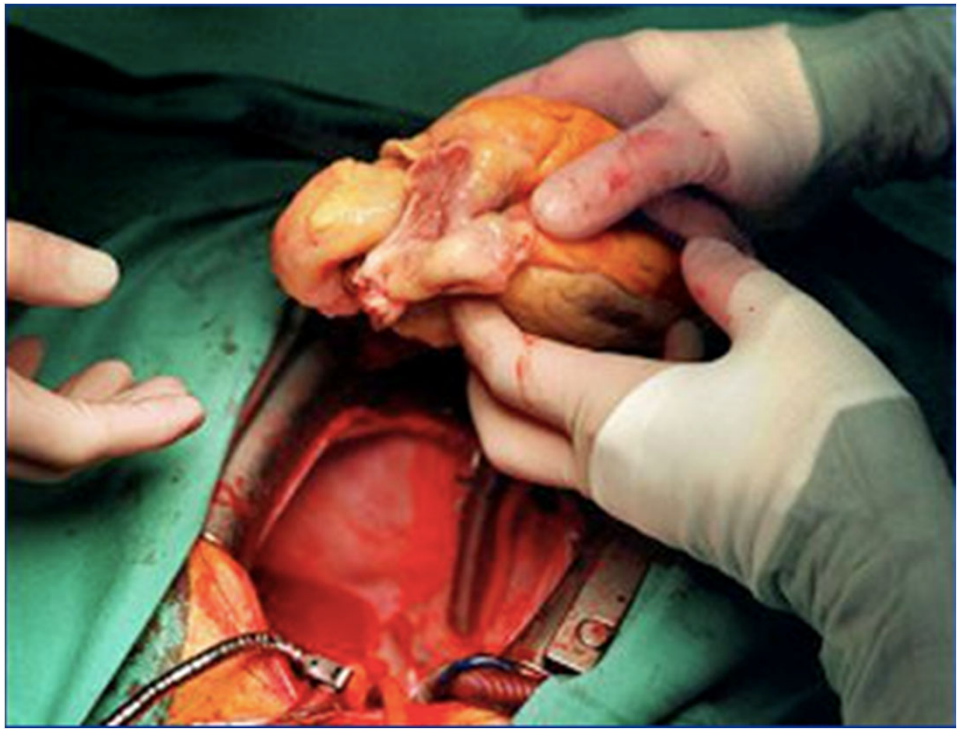
Indications
Advanced HF[376]
No other therapeutic option, except for LVAD as BTT
Contraindications
Active infection[a]
Severe peripheral arterial or cerebrovascular disease
Pharmacologic irreversible pulmonary hypertension (LVAD should be considered to reverse elevated pulmonary vascular resistance with subsequent re-evaluation to establish candidacy)
Malignancy with poor prognosis (a collaboration with oncology specialists should occur to stratify each patient as regards their risk of tumour progression or recurrence which increases with the use of immunosuppression)
Irreversible liver dysfunction (cirrhosis) or irreversible renal dysfunction (e.g. creatinine clearance <30 mL/min/1.73 m^2). Combined heart-liver or heart-kidney transplant may be considered
Systemic disease with multiorgan involvement
Other serious comorbidity with poor prognosis
Pre-transplant BMI >35 kg/m^2 (weight loss is recommended to achieve a BMI <35 kg/m^2)
Current alcohol or drug abuse
Psychological instability that jeopardizes proper follow-up and intensive therapeutic regime after heart transplantation
Insufficient social supports to achieve compliant care in the outpatient setting

CI :
-infectieuses
-vasculaires
-oncologiques
-hémodynamiques
-organiques (rein, foie,…)
-obésité (IMC 35)
-addictologie
-situation psy, sociale, observance…
-AGE.

Recommendations for the treatment of patients with advanced heart failure

Recommendations	Class[a]	Level[b]
Patients being considered for long-term MCS must have good compliance, appropriate capacity for device handling and psychosocial support.[414–416]	I	C
Heart transplantation is recommended for patients with advanced HF, refractory to medical/device therapy and who do not have absolute contraindications.	I	C
Long-term MCS should be considered in patients with advanced HFrEF despite optimal medical and device therapy, not eligible for heart transplantation or other surgical options, and without severe right ventricular dysfunction, to reduce the risk of death and improve symptoms.[378,396,397,401,402,404,417]	IIa	A
Long-term MCS should be considered in patients with advanced HFrEF refractory to optimal medical and device therapy as a bridge to cardiac transplantation in order to improve symptoms, reduce the risk of HF hospitalization and the risk of premature death.[398–400,402,404]	IIa	B
Renal replacement therapy should be considered in patients with refractory volume overload and end-stage kidney failure.	IIa	C
Continuous inotropes and/or vasopressors may be considered in patients with low cardiac output and evidence of organ hypoperfusion as bridge to MCS or heart transplantation.[389,390]	IIb	C
Ultrafiltration may be considered in refractory volume overload unresponsive to diuretic treatment.[391,392]	IIb	C

Transplantation



- Âge ≤ 65 ans
- Recul > 30 ans
- ≈ 450 /an en France
- Pénurie greffon (1 greffon pour 2 candidats)
- Médiane survie 12 ans (14 si survivant à 1 an)
- Accès au greffon selon score cœur
- Contraintes immunologiques et risque du traitement IS

Transplantation

- Nécessité d'**éliminer une contre-indication éventuelle**

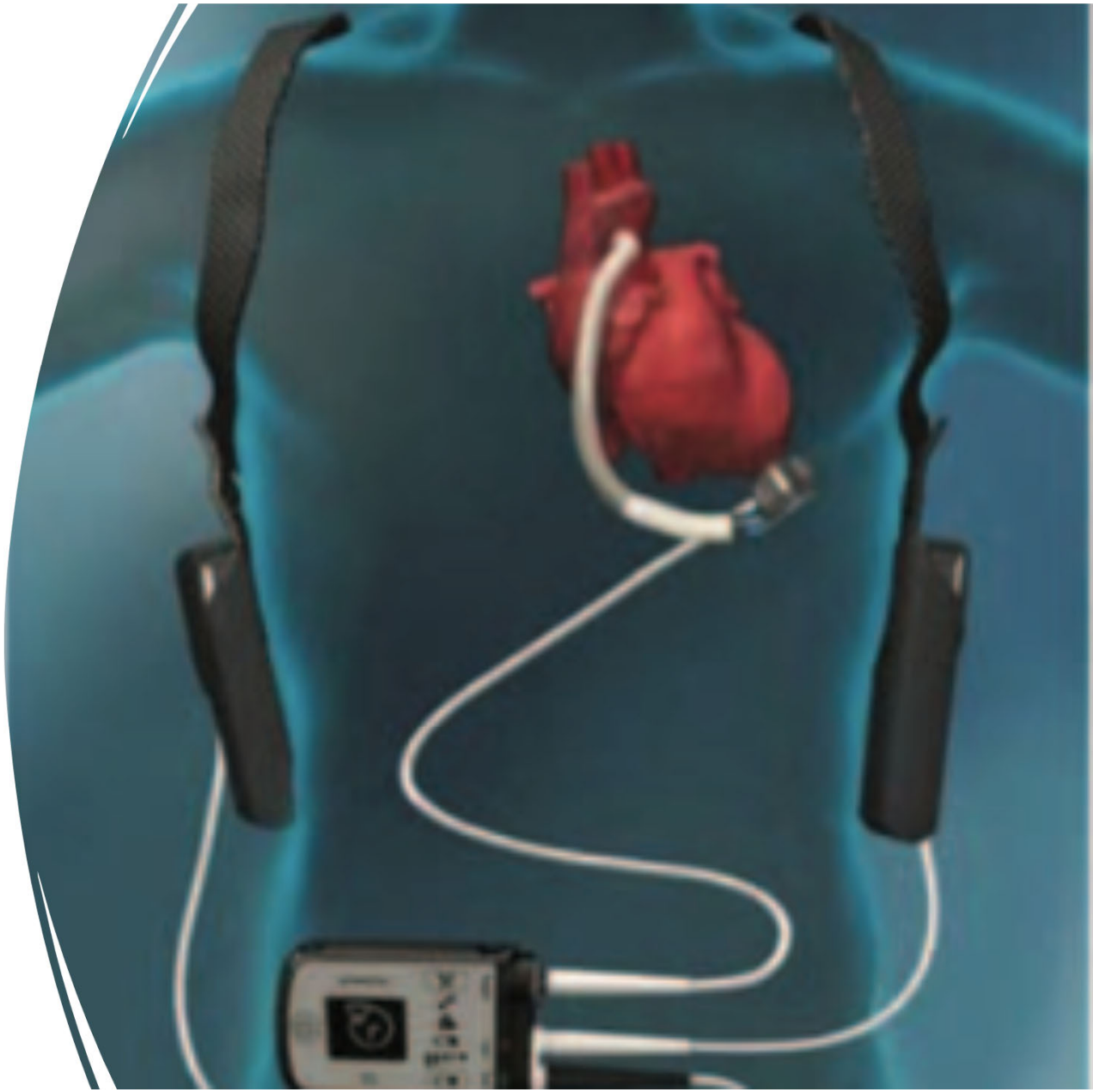
  - Infection (CTAP, biologie)
  - Cancer (scanner, endoscopies digestives, biologie)
  - AOMI (doppler)
  - HTP (cathétérisme)
  - + autres atteintes d'organe (discussion parfois de greffes-combinées)

  → **Donc parfois long !**

  => Bilan parfois plus restreint quand patient instable et aigu (bio, scanner)

LVAD

- < 75 ans, BTT/BTD/DT
- Pompe centrifuge à flux continu
- amélioration des résultats avec le temps par amélioration dispositifs (réduction +++ du taux d'AVC, de saignements digestifs et de thromboses pompes)
- Complications spécifiques : infection driveline, IAo, défaillance VD…

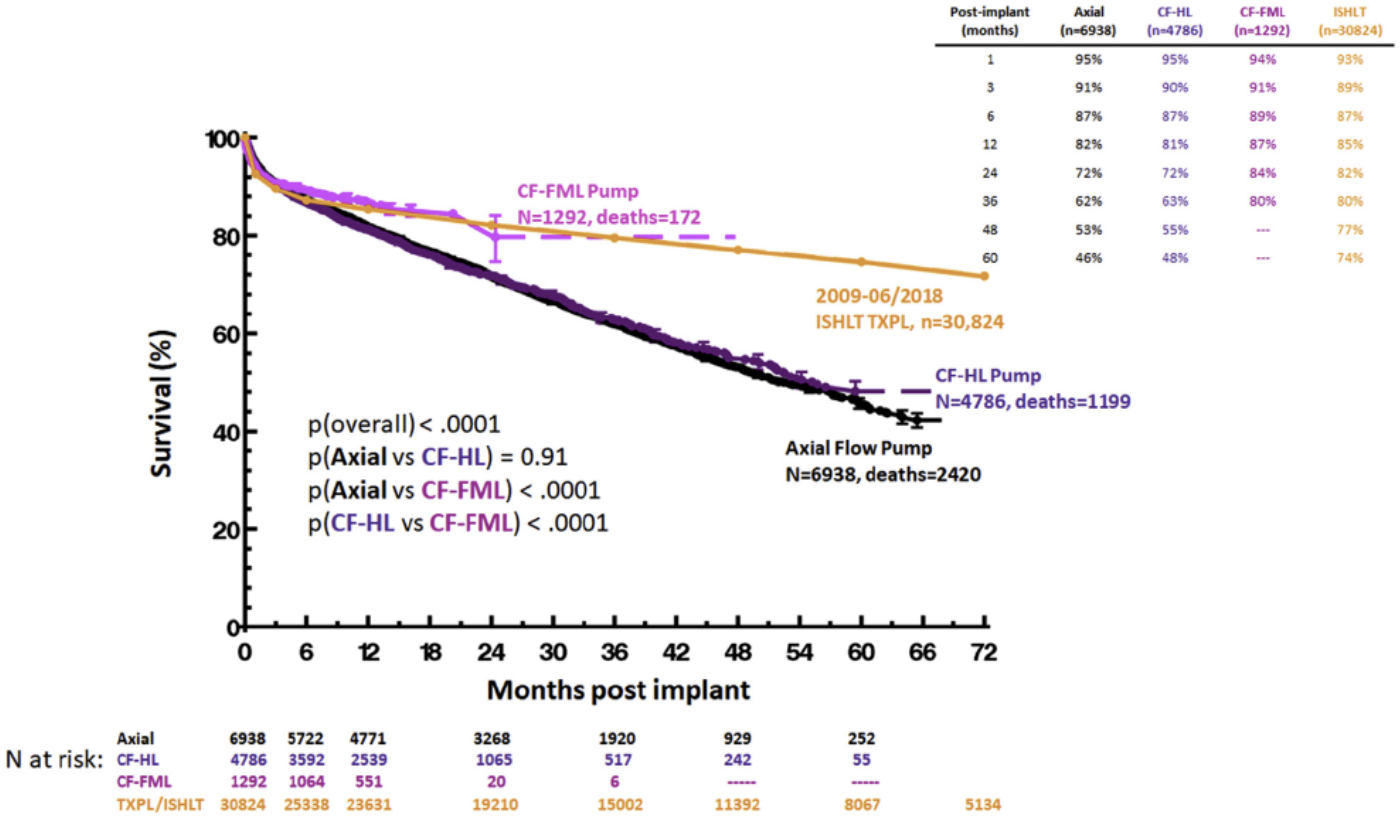


Transplantation ou LVAD ?

- Avantages différents :
  - HTx : pas driveline, meilleure qualité de vie, possible si RVAo méca
  - LVAD : post-op moins lourd
- Complications spécifiques de chacune des stratégies :
  - HTx : rejet, cancers, infections, détérioration rénale, coronaropathie, diabète, protocole de suivi strict (biopsies)…
  - LVAD : thrombose de pompe, obstruction canule, défaillance VD précoce et tardive, IAo, infection driveline, hémorragies GI,TDR…
- Pronostic moyen/long terme différent :
  - **Résultats précoces assez similaires (≈ 80% survie à 1 an)**
  - LVAD : **effet lune de miel 1 à 2 ans avec puis ↗ complications**

Survie greffe et LVAD

13 016 LVAD implantés entre jan 2014 et déc 2018



Post-implant (months)	Axial (n=6938)	CF-HL (n=4786)	CF-FML (n=1292)	ISHLT (n=30824)
1	95%	95%	94%	93%
3	91%	90%	91%	89%
6	87%	87%	89%	87%
12	82%	81%	87%	85%
24	72%	72%	84%	82%
36	62%	63%	80%	80%
48	53%	55%	---	77%
60	46%	48%	---	74%

INTERMACS registry

Teuteberg J. Ann Thorac Surg 2020;109:649-60

Transplantation cardiaque

- 2 candidats pour 1 greffon

Tableau C2. Évolution des principaux indicateurs de pénurie en greffe cardiaque

Tableau C2. Évolution des principaux indicateurs de pénurie en greffe cardiaque

	2015	2016	2017	2018	2019	2020
Nouveaux inscrits pour un greffon	1,3	1,2	1,2	1,4	1,4	1,5
Receveurs en attente en liste active au 1er janvier pour un greffon*	0,5	0,6	0,5	0,4	0,6	0,7

Tableau C6. Evolution sur les trois premières années du devenir des malades inscrits pour la première fois en liste d'attente cardiaque en 2017 (N=534)

Tableau C6. Evolution sur les trois premières années du devenir des malades inscrits pour la première fois en liste d'attente cardiaque en 2017 (N= 534)

Statut sur liste d'attente (%)	à 3 mois	à 6 mois	à 12 mois	à 18 mois	à 24 mois	à 30 mois	à 36 mois
En liste inactive depuis l'inscription	1,5	0,9	0,9	0,4	0,4	0,4	0,4
En liste inactive	8,2	5,1	3,6	2,6	2,1	2,2	1,1
En liste active	25,8	20,2	13,5	8,8	6,2	5,2	5,4
Greffé	56,2	64,4	70,2	74	76	76,8	77
Décédé en attente	5,6	6,4	7,7	8,8	8,8	8,8	9,2
Sorti de la liste d'attente pour aggravation	1,5	1,5	2,1	2,2	2,4	2,4	2,6
Sorti de la liste d'attente hors aggravation	0,9	1,3	1,9	3	3,9	3,9	4,1
En liste inactive depuis l'inscription et décédé ou sorti pour aggravation	0,2	0,2	0,2	0,2	0,2	0,2	0,2

Certaines contre-indications sont communes

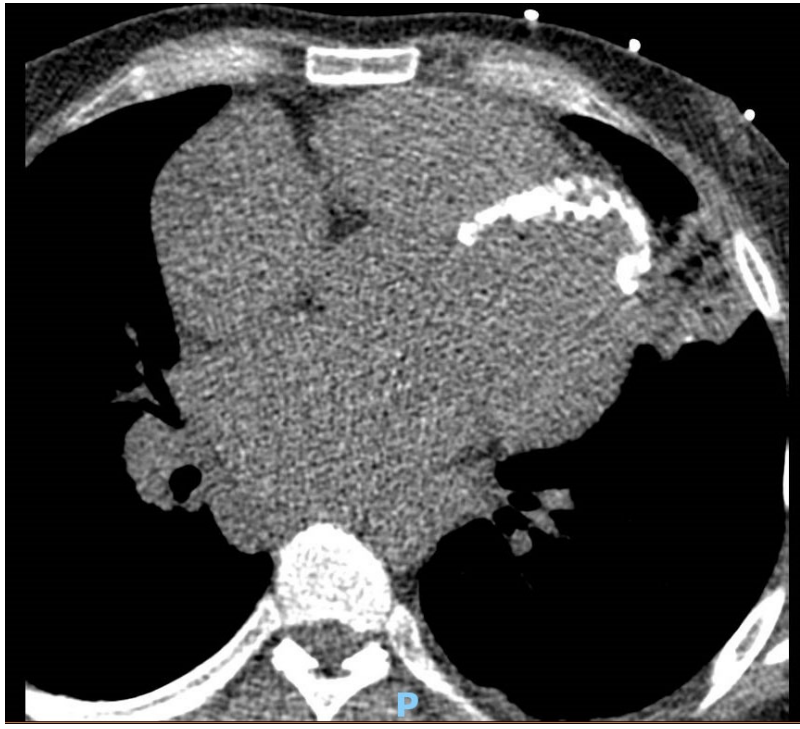
- Patient non compliant
- **Instabilité psychologique**, démence ou trouble cognitif ou neurologique significatif
- Infection bactérienne ou fongique active
- **Artériopathie périphérique sévère** ou maladie cérébro-vasculaire invalidante
- **Atteinte sévère d'organe (foie,** rein, hors projet double greffe) ou maladie multi-systémique évoluée
- **Addiction non sevrée : alcool, tabac, drogue**
- Cancer non curable avec espérance de vie < 1 an (LVAD)
- Diabète multi-compliqué avec atteinte irréversible d'organes

D’autres sont spécifiques

- Transplantation :
  - Cancer en cours ou avec rémission récente
  - Hypertension pulmonaire considérée irréversible
  - Diabète non contrôlé
  - Obésité (IMC > 35 kg/m^2)
- LVAD :
  - Valve aortique mécanique ou IAo non traitée
  - Rétrécissement mitral non traité
  - Défaillance droite (VD très altéré, IT)

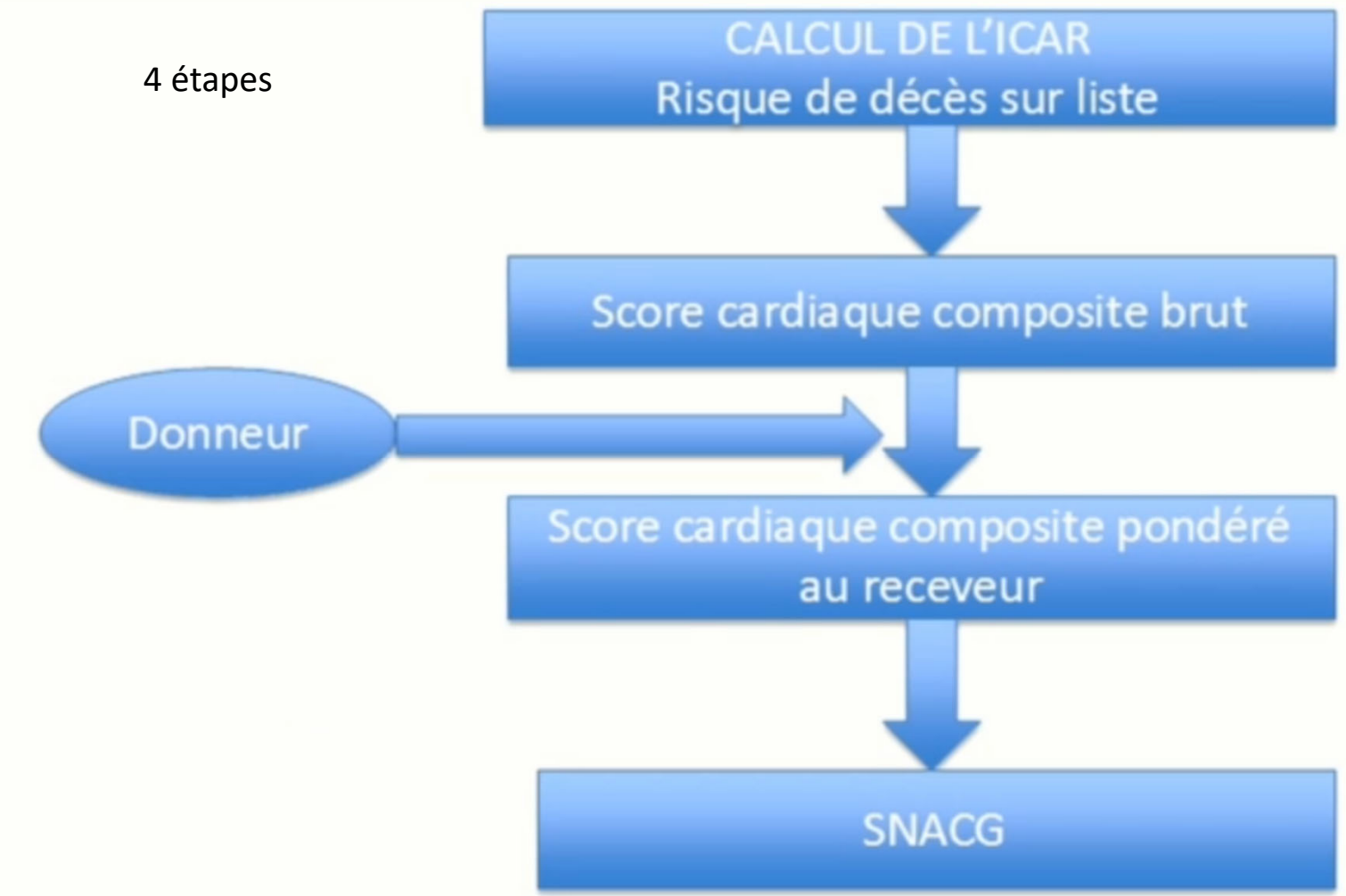
  - Calcification extensive de l’apex VG
  - Certaines formes de CMH/CMR/cardiopathies congénitales

Pour Tx :
CI souvent temporaires, parfois associées, et à réévaluer régulièrement



Score cœur = Score National d'Attribution des Greffons Cardiaques (SNAGC).

4 étapes



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Guide du Score Cœur

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Score cœur : ICAR

Calcul de l'Index de Risque Cardiaque : ICAR

Evaluation du risque de décès sur liste d'attente.

- Assistance de courte durée.
- BNP ou Nt-proBNP.
- DFG par MDRD.
- Bilirubine totale.

→ Sous inotropes ou assistance : valeurs AVANT implantation ou mise sous inotropes.

→ MISES A JOUR:

- Tous les 3 jours sous ECLS ou inotropes.
- Tous les 3 mois sinon.

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Score cœur: Score Cardiaque Composite Brut

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Le Score Cardiaque Composite comporte quatre composantes mutuellement exclusives *(voir : ANNEXES 3.3)* :

- Composante Adulte Standard
- Composante Expert Adulte (XPCA)
- Composante Pédiatrique Standard
- Composante Expert Pédiatrique (XPCP)

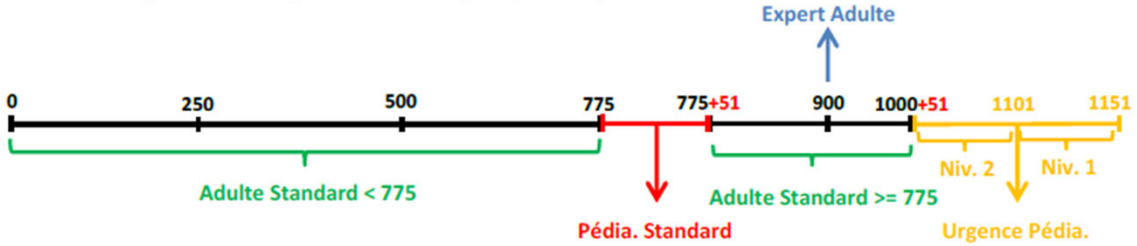


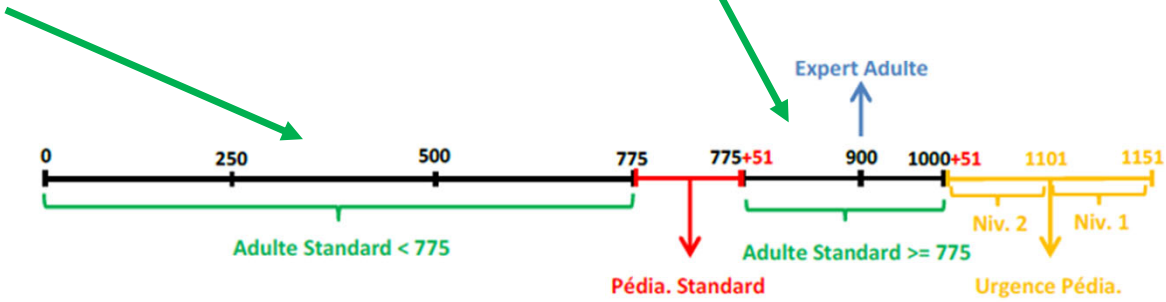
Tableau des composantes du Score Cardiaque Composite Brut

Composantes du score cardiaque	Nombre de points	Demande de priorité
Adulte Standard	→ 0 – 775 → 826 – 1051	Ø
Pédiatrique Standard	→ 776 – 825	Ø
Expert Adulte (XPCA)	→ 900	→nécessaire
Expert Pédiatrique (XPCP)→Niveau1 (XPCP1) →Niveau2 (XPCP2)	→ 1102 - 1151 → 1051 - 1101	→nécessaire

Score CCB : composantes standard

1 : Adulte standard ambulatoire. 0-775 points.

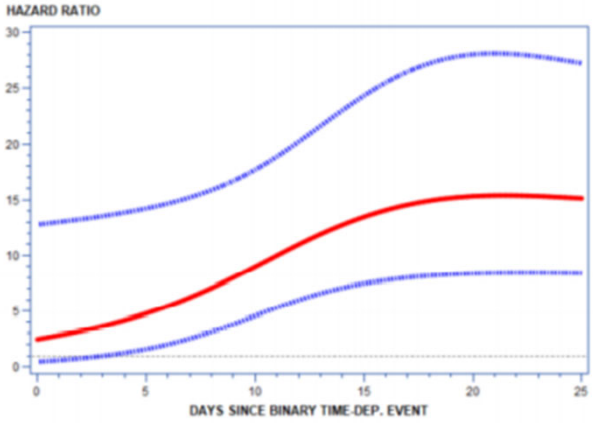
3 : Adulte standard en choc (notamment ECLS) 826 – 1051 points.



2 : Pédiatrique standard ambulatoire. (<18 ans).

776 à 825 points, augmente avec la durée d'attente sur liste.

Risque de décès en attente en fonction de la durée d'ECMO (2018)



Attention pour les patients adultes sous ECMO, les points du Score seront minorés à partir de **12** jours d'implantation (-10% par jour) et annulés dès le **16**ème jour (Score=0).

Score CCB : composantes expert

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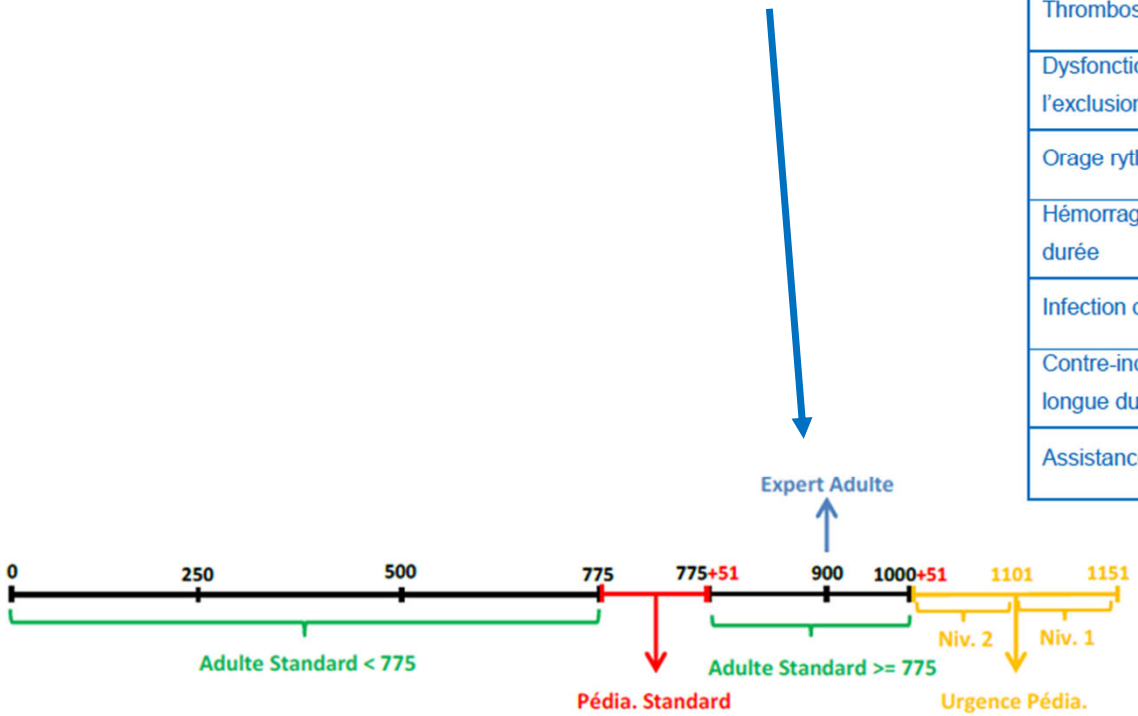
Adulte expert

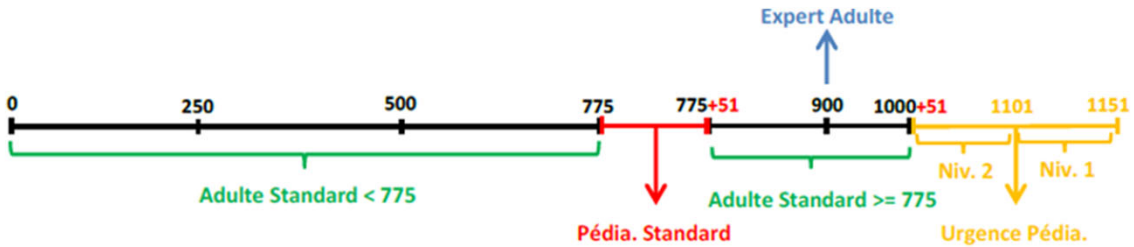


Délai d'attribution du maximum de points pour la Composante Expert Adulte (XPCA) selon la situation clinique du patient

Situations cliniques pouvant faire l'objet d'une demande XPCA	Nombre de points max.	Délai d'attribution
Thrombose d'assistance circulatoire mécanique de longue durée	900	immédiat
Dysfonction d'assistance circulatoire mécanique de longue durée à l'exclusion des thromboses	900	immédiat
Orage rythmique ventriculaire non contrôlé	900	immédiat
Hémorragie chez les porteurs d'assistance circulatoire mécanique de longue durée	900	3 mois
Infection du dispositif d'assistance circulatoire mécanique de longue durée	900	3 mois
Contre-indication à l'implantation d'une assistance circulatoire mécanique de longue durée	900	3 mois
Assistance circulatoire mécanique bi ventriculaire ou cœur artificiel total	900	3 mois

Attribution croissante linéaire de 0 à 900 points

Score CCB : composantes expert



Pédiatrique expert : 2 niveaux.

Composante Expert Pédiatrique - Niveaux de priorité selon la situation clinique

Situations cliniques pouvant faire l'objet d'une demande XPCP1	Situations cliniques pouvant faire l'objet d'une demande XPCP2
Assistance circulatoire de longue durée compliquée	Assistance circulatoire de longue durée non compliquée
ECMO compliquée	ECMO non compliquée
Contre-indication à la mise en place d'un Berlin Heart	Perfusion d'inotrope

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Appariement au donneur : âge, GS, S^2, filtrage

Age

Si le donneur est plus jeune que le receveur :

- ✓ différence d'âge ≤ **15 ans** : → 100% des points
- ✓ différence d'âge ≥ **15 et ≤ 40 ans** : → un pourcentage des points décroissant à partir de 100% jusqu'à 0%
- ✓ différence d'âge > **40 ans** : → 0% points

Si le donneur est plus âgé que le receveur :

- ✓ différence d'âge ≤ **40 ans** : → 100% des points
- ✓ différence d'âge ≥ **40 et ≤ 65 ans** : → un pourcentage des points décroissant à partir de 100% jusqu'à 0%
- ✓ différence d'âge > **65 ans** : → 0% points

Attribuer les greffons « jeunes » au receveurs « jeunes ».

Score Cardiaque Composite Pondéré

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Groupage

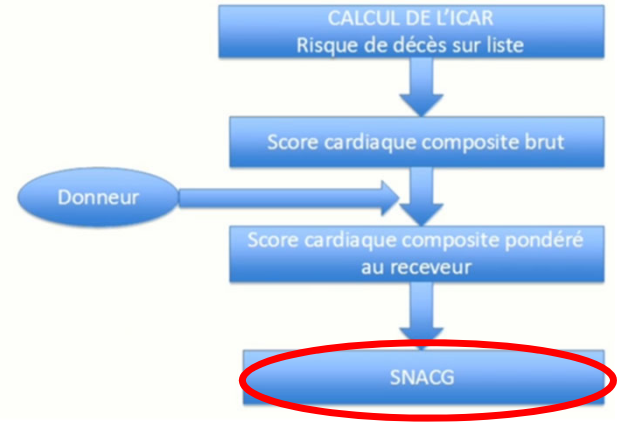
Age Receveur	ABO Donneur	ABO Receveur
≥ 18 ans	A	→ A, AB
	AB	→ AB
	B	→ B, AB(1)
	O	→ O, B
< 18 ans	A	→ Groupe compatible
	AB	
	B	
	O	

(1) Les receveurs de groupe B sont prioritaires par rapport aux receveurs de groupe AB

Surface corporelle

Type de receveur	Critères morphologiques donneur
Adulte	SCD* > 80% SCR** ou Homme ≥ 70 Kg
Pédiatrique	SCD ∈ [80% ; 300%] SCR ou Homme ≥ 70 Kg

SCD : Surface corporelle donneur*
*SCR** : Surface corporelle receveur*



Calcul du SNAGC

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Guide du Score Cœur

Pôle Qualité des Données

18/04/2019

→ Calcul de la durée de trajet entre le prélèvement et la transplantation.

→ SNAGC « final » → Appel de l'ABM par ordre de SNAGC

Score Cardiaque Composite Pondéré

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Guide du Score Cœur

Pôle Qualité des Données

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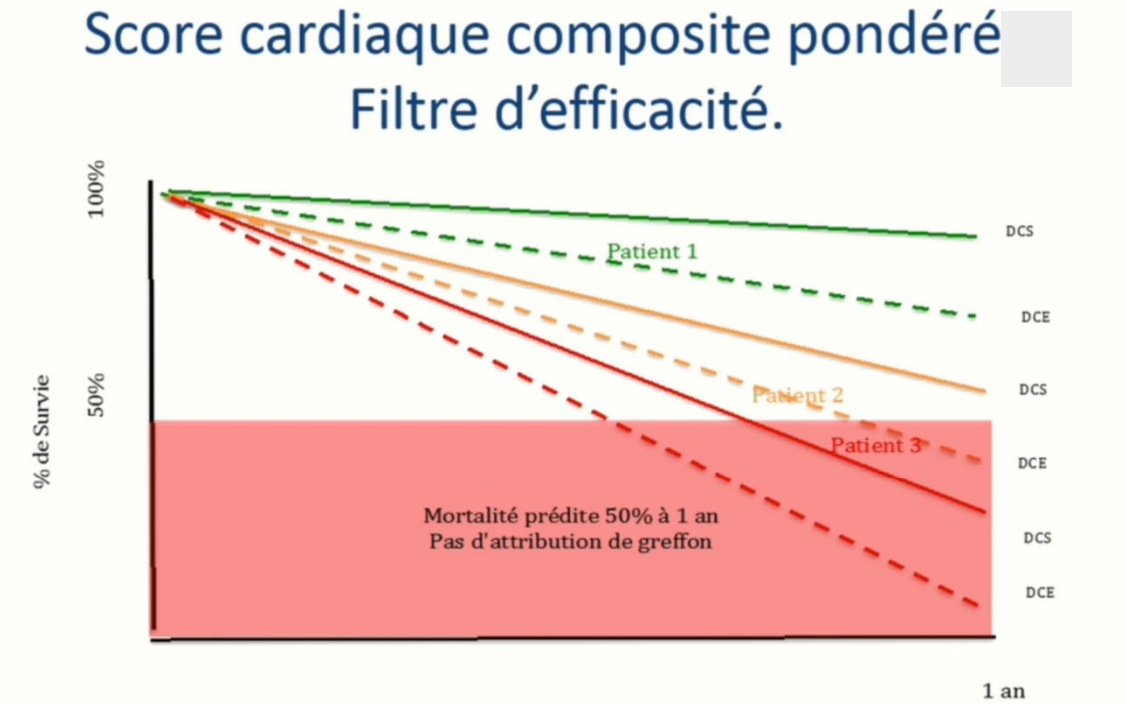
DCS : Donneur Critères Standard : (<55 ans)
DCE : Donneur Critères Elargis : (>55 ans).

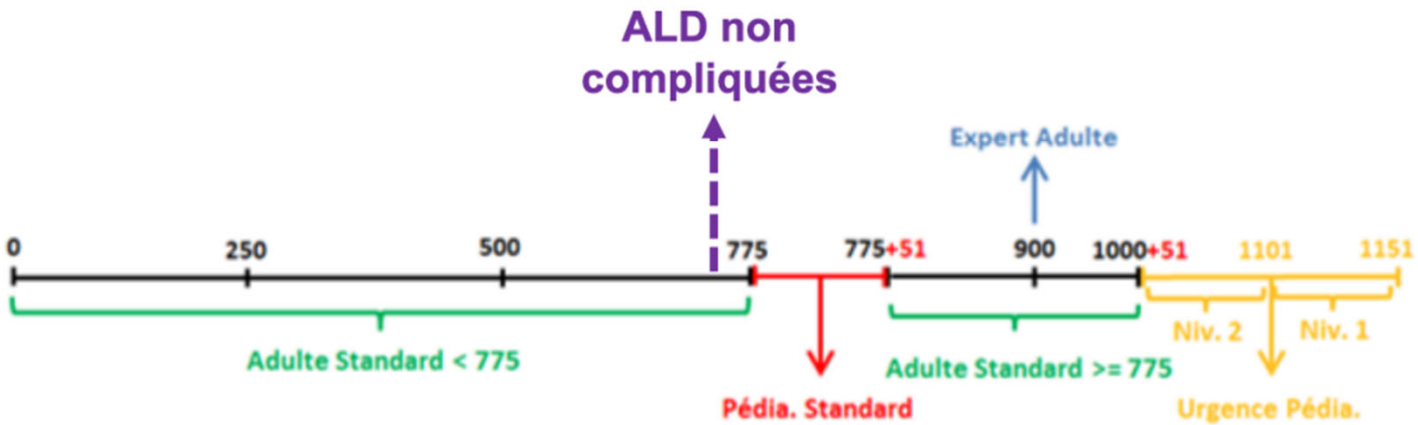


Mortalité post transplantation prédite sur: âge du donneur, appariement sur le sexe entre donneur et receveur, âge du receveur, cardiopathie du receveur et DFG et bili du receveur

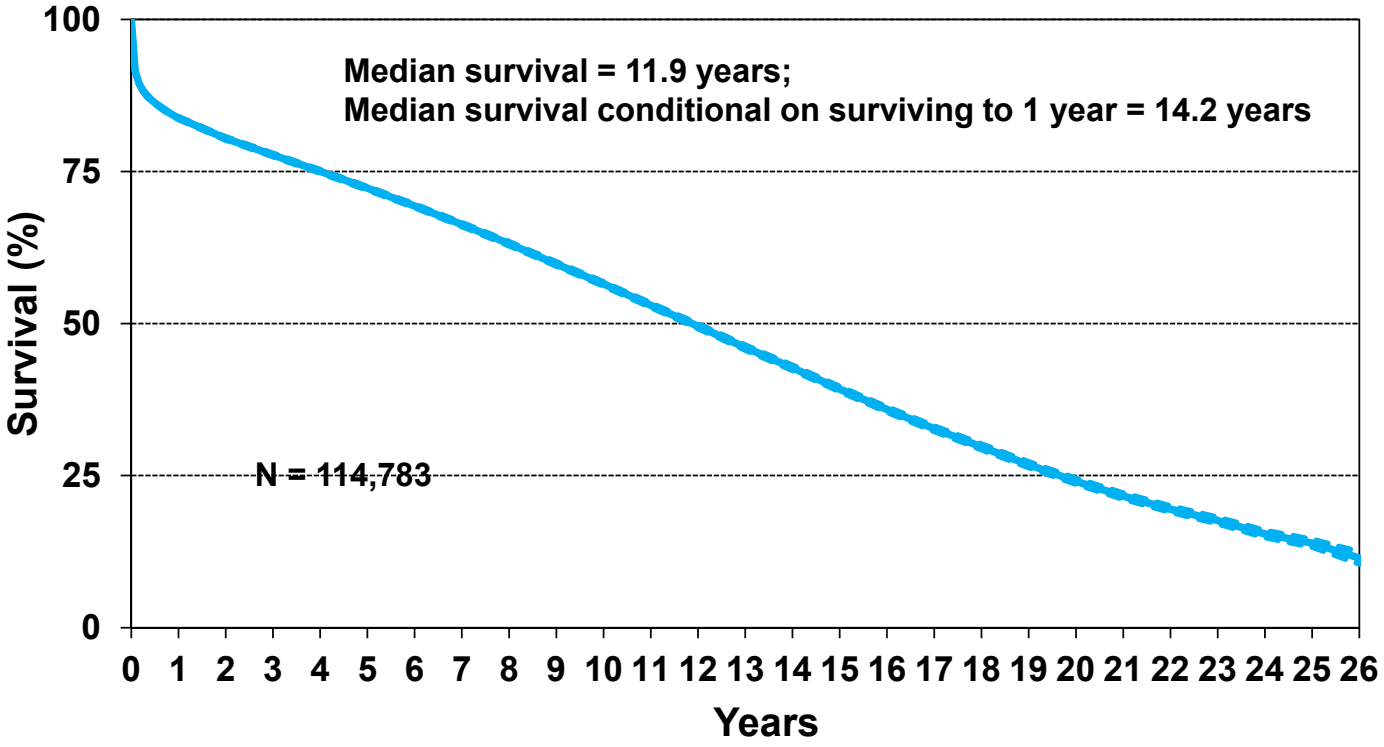
Prénom	ABO	CIT	Date insc	Age	Alerte	AgeD<=55 SexeD=M	AgeD<=55 SexeD=F	AgeD>55 SexeD=M	AgeD>55 SexeD=F	Date dernier calcul
Abdoulaye-Pene	B	Non	08/11/2019	37		92%	89%	88%	84%	09/11/2019 17:00:03
Marie	A	Non	10/09/2019	65		54%	54%	39%	39%	10/11/2019 21:00:03
Eric	A	Non	10/09/2019	55		65%	53%	51%	38%	10/11/2019 16:00:03
Diana	A	Non	29/05/2019	6		87%	87%	81%	81%	11/11/2019 16:00:03

Solution proposée pour les assistances de longue durée non compliquées

Pour les patients sous LVAD non compliqué, tous les X greffons proposés à un candidat avec moins de 750 points, octroi de 750 points au score hors appariement donneur (classement en fonction de la durée d'implantation)



Adult and Pediatric Heart Transplants
Kaplan-Meier Survival
(Transplants: January 1992 – June 2017)



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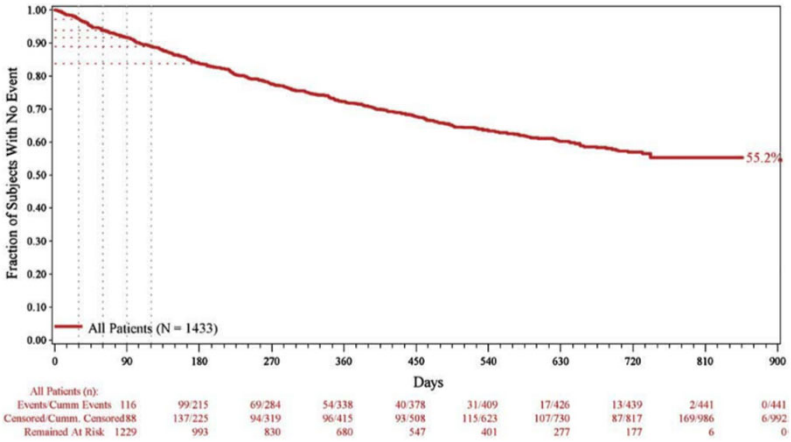
2019

citation

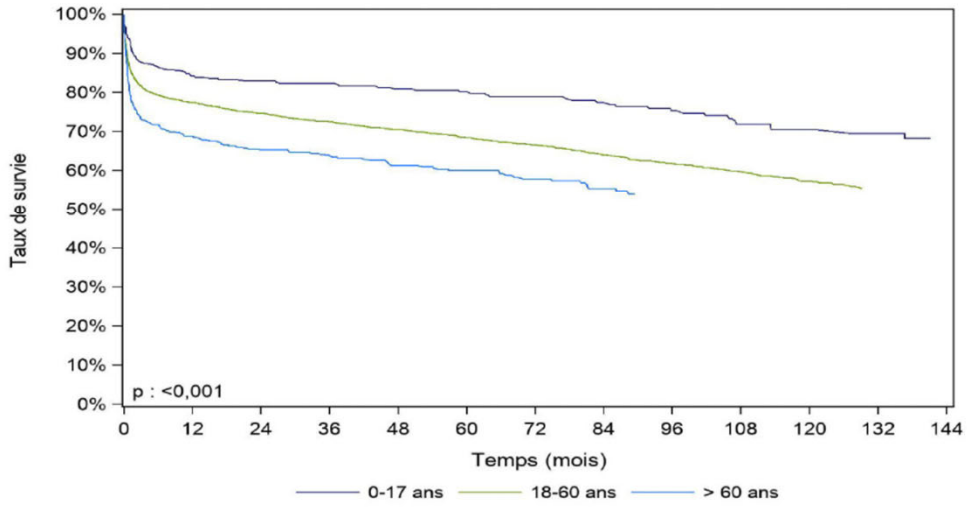


Kaplan-Meier survival curve for all patients in ADHERE LM.

Figure C9. Courbe de survie du receveur après première greffe cardiaque selon l'âge du donneur (2004-juin 2018)

Figure C9. Courbe de survie du receveur après première greffe cardiaque selon l'âge du donneur (2004-juin 2018)

Classe d'âge du donneur (ans)	N	Survie à 1 mois	Survie à 1 an	Survie à 5 ans	Survie à 10 ans	Survie à 15 ans	Médiane de survie (mois)
0-17 ans	342	93.6% [90.4% - 95.7%]	84.2% [79.9% - 87.7%]	80.1% [75.4% - 84.1%]	70.4% [64.1% - 75.8%]	NO	NO
nombre de sujets à risque*		320	285	193	78	8	
18-60 ans	4705	86.4% [85.4% - 87.4%]	77.4% [76.2% - 78.6%]	68.4% [67.0% - 69.8%]	57.3% [55.5% - 59.0%]	NO	NO
nombre de sujets à risque*		4047	3552	2168	850	59	
> 60 ans	527	80.0% [76.3% - 83.2%]	68.8% [64.6% - 72.5%]	60.0% [55.4% - 64.2%]	NO	NO	NO
nombre de sujets à risque*		420	355	170	42	0	



Conclusion

- ICA = pronostic sombre.

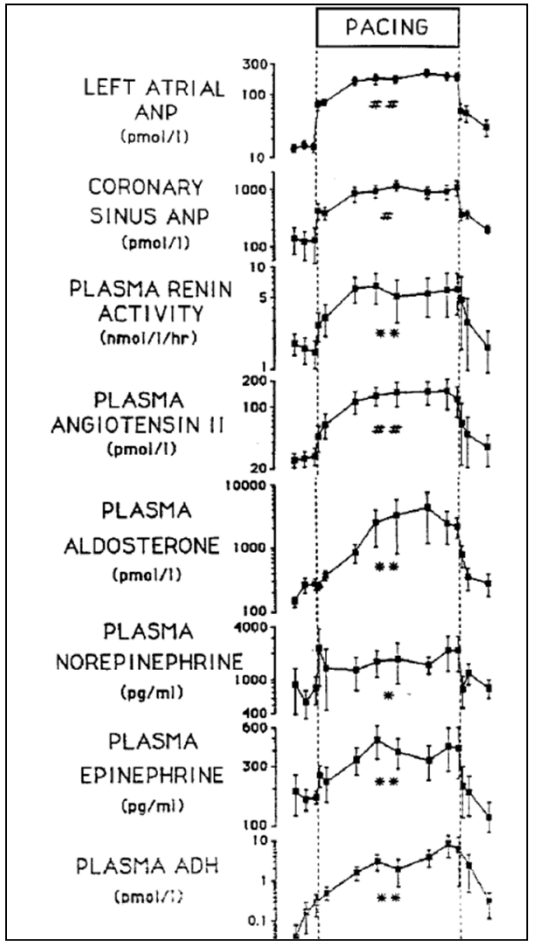
- Options thérapeutiques limitées, lourdes et projets complexes.
- Problématique de la pénurie de greffons, de la sélection des patients

- Caractère perfectible du score cœur (CM restrictives, LVAD non compliqués…)

- Savoir parfois accompagner les patients dans un projet palliatif

Merci pour votre attention

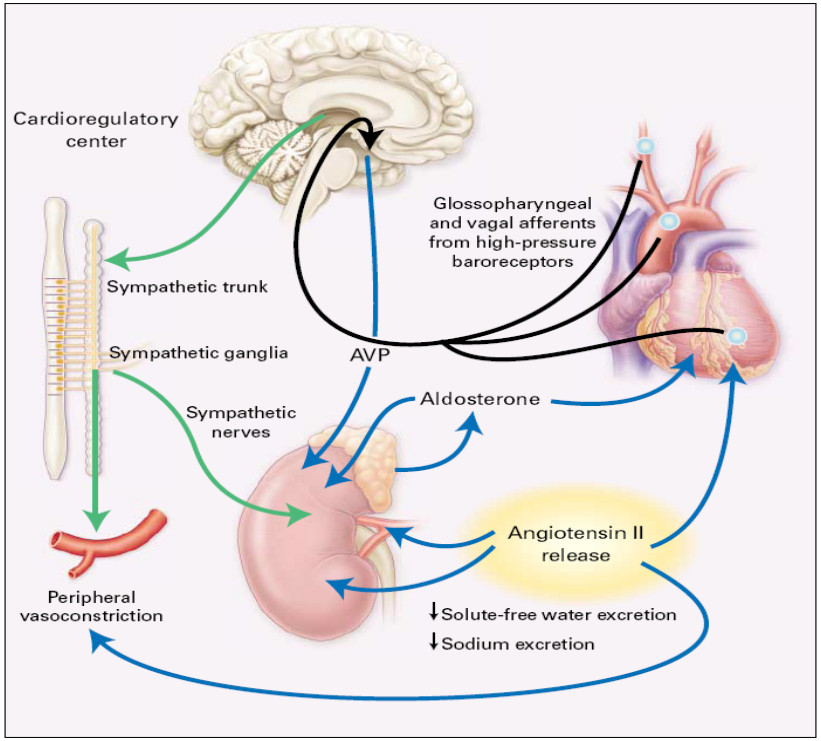
IC = maladie neuro-hormonale



Exemple d'IC expérimentale

Maladie neuro-hormonale

Pathophysiologie de l'IC: rôle des adaptations neurohormonales barorécepteurs-dépendantes



AVP=arginine vasopressin; PRA=plasma renin activity

Schrier, Abraham. N Engl J Med 1999;341:577–85
Brewster et al. Am J Med Sci 2003;326:15–24
Schmeider. Am J Hypertens 2005;18:720–30

- Tôt dans l'IC, le SRAA est activé en tant que mécanisme compensateur
- La sévérité croissante de la maladie est associée à une augmentation de l'activité du SRAA
  - ↑ PRA, ↑ aldostérone, ↑ Ang II
- L'activation prolongée du SRAA a des effets délétères:
  - Vasoconstriction
  - ↑ pression sanguine
  - ↑ tonus sympathique
  - ↑ aldostérone
  - ↑ sodium
  - Fibrose
  - Hypertrophie myocardique

Beta-bloquants dans l'IC

Therapeutic modality	Mechanism(s) of action in HF	Effect on ANS function	Effect(s) on HF phenotype	Clinical outcome(s)-indication(s) in HF	Other Notes
β-blockers	Cardiac β_1AR antagonism-ANS neuronal β_2AR antagonism-↓ Cardiac & adrenal GRK2-↑ PNS outflow/activity	↓ Outflow/activity	Reversed adverse remodeling; ↓ arrhythmias; ↑ cardiac blood flow; protection against CA toxicity; ↓ cardiac oxygen, metabolic & energy demand/supply ratio	↓ all-cause & cardiac mortalities; ↑ adrenergic & inotropic reserves-Chronic HF, especially after MI	Contraindicated in acute HF; Certain polymorphisms in cardiac β_1AR & GRK5 genes affect response; individual agents not equal: carvedilol-metoprolol appear superior in HF

	Starting dose	Target dose
Beta-blockers		
Bisoprolol	1.25 mg *o.d.*	10 mg *o.d.*
Carvedilol	3.125 mg *b.i.d.*	25 mg *b.i.d.*[e]
Metoprolol succinate (CR/XL)	12.5–25 mg *o.d.*	200 mg *o.d.*
Nebivolol[d]	1.25 mg *o.d.*	10 mg *o.d.*

A beta-blocker is recommended for patients with stable HFrEF to reduce the risk of HF hospitalization and death.[114–120] | I | A

Circ Res. 2013 August 30; 113(6): . doi:10.1161/CIRCRESAHA.113.300308.

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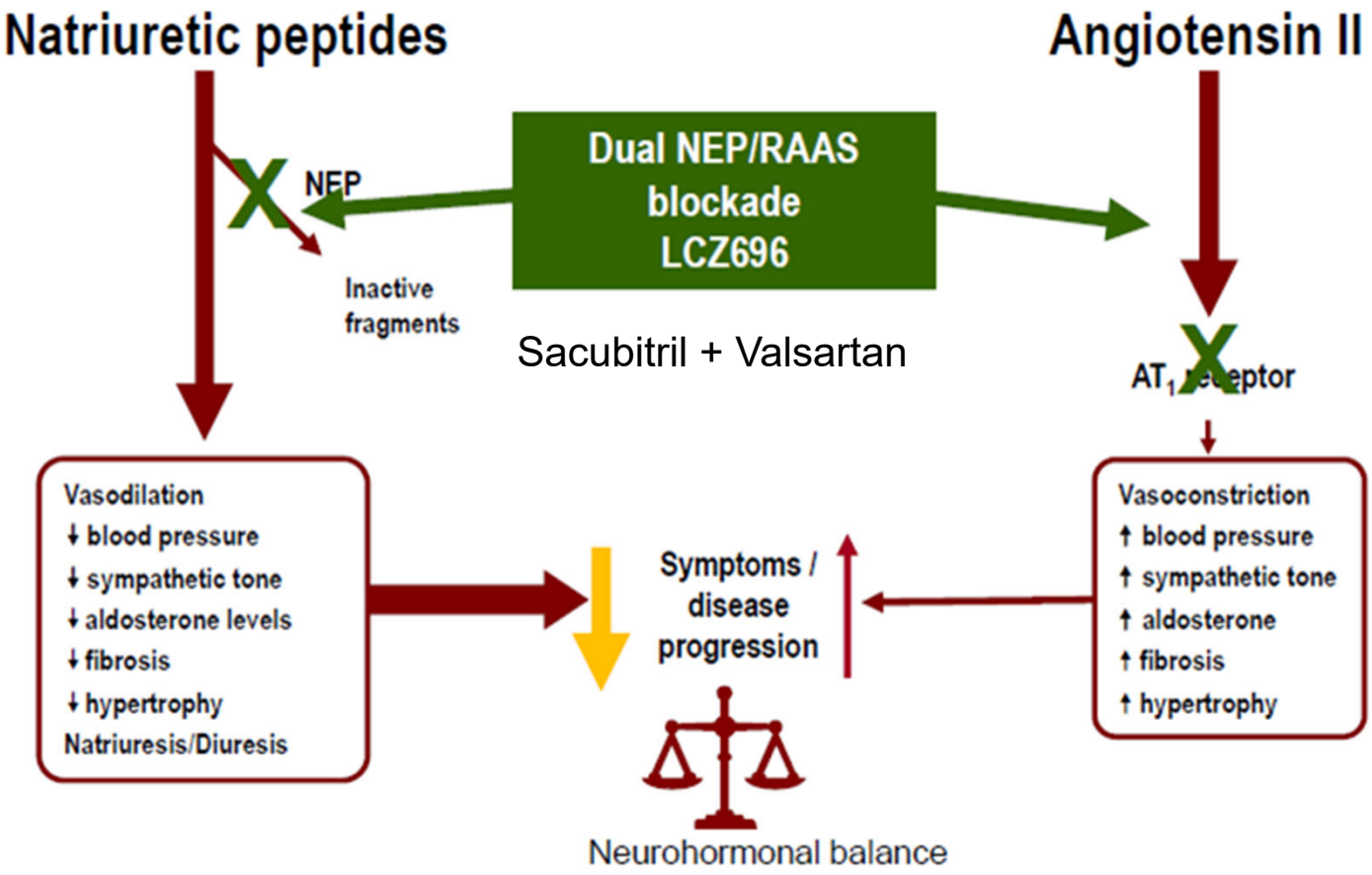
Bloqueurs du SRAA dans l'IC

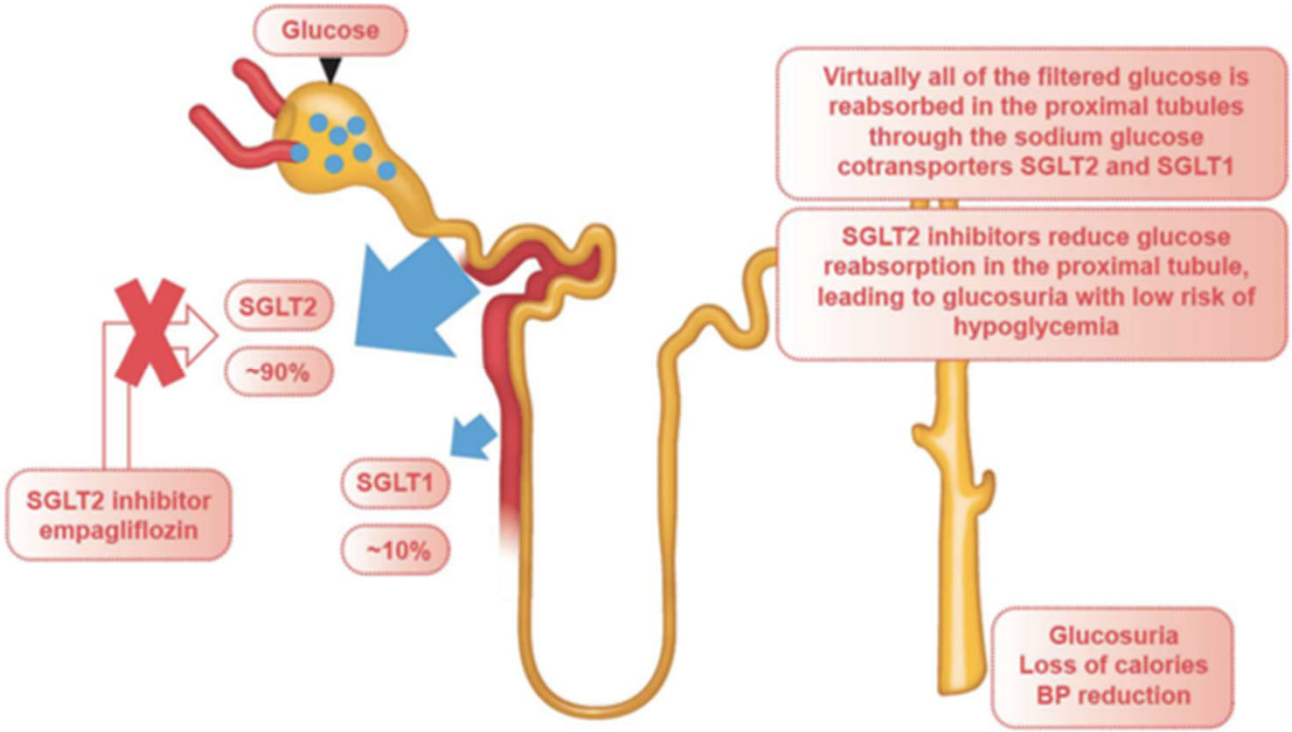
	Starting dose	Target dose
ACE-I		
Captopril[a]	6.25 mg *t.i.d.*	50 mg *t.i.d.*
Enalapril	2.5 mg *b.i.d.*	10–20 mg *b.i.d.*
Lisinopril[b]	2.5–5 mg *o.d.*	20–35 mg *o.d.*
Ramipril	2.5 mg *b.i.d.*	5 mg *b.i.d.*
Trandolapril[a]	0.5 mg *o.d.*	4 mg *o.d.*
MRA		
Eplerenone	25 mg *o.d.*	50 mg *o.d.*
Spironolactone	25 mg *o.d.*[f]	50 mg *o.d.*

An ACE-I is recommended for patients with HFrEF to reduce the risk of HF hospitalization and death.[110–113]	I	A
An MRA is recommended for patients with HFrEF to reduce the risk of HF hospitalization and death.[121,122]	I	A

ARNi – sacubitril/valsartan



Inhibiteurs du SGLT-2 (gliflozines)



Inhibit° réabsorpt° 30-50% du Gc filtré (-80 à 100g/j soit 300-400kcal/j)

➔ -0.6 à -0,9% HbA1C indpdmt fct° β sans hypoGc (perte d'action qd Gc filtré baisse)

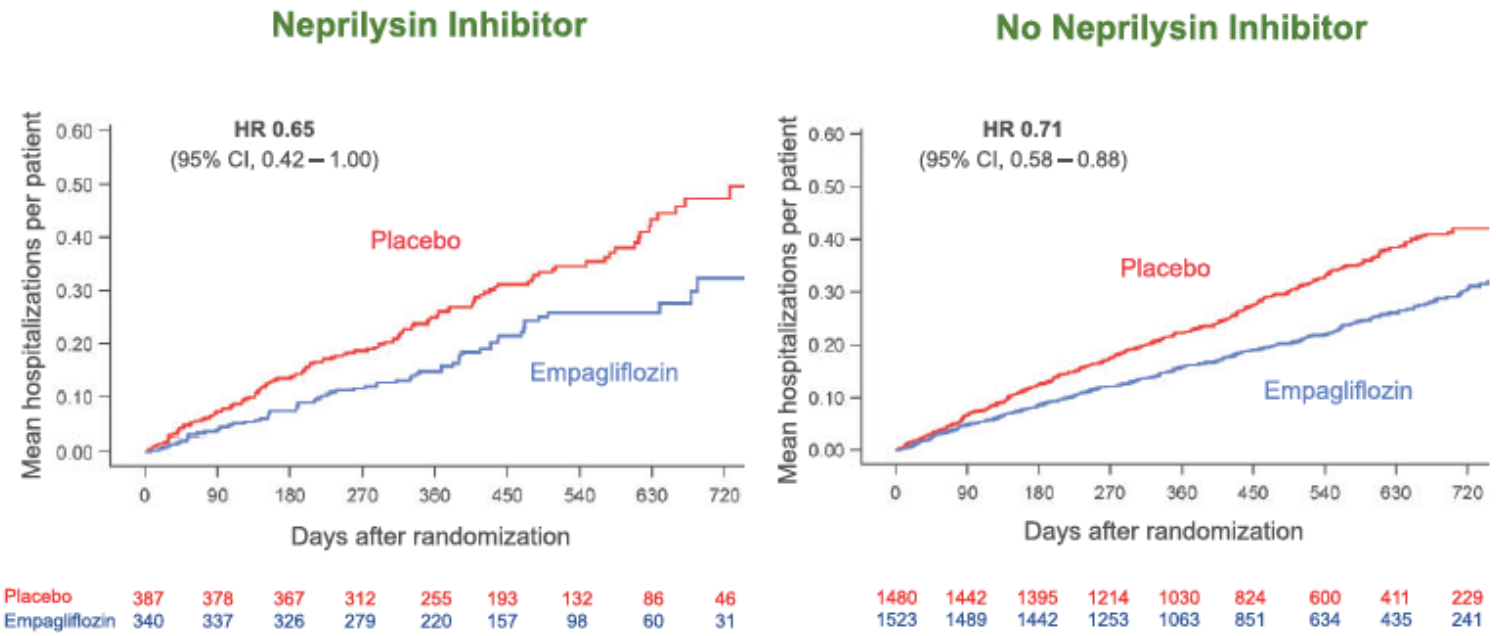
➔ Perte 2 à 3kg

➔ Natriurèse et diurèse osmotique

➔ Baisse TAS - 4mmHg sans ↗ FC

Butler J. Eur J Heart Fail. 2017;19(11):1390-1400.

Efficacité synergique avec ARNi



EMPEROR-Reduced

Packer M. Eur Heart J. 2021

Gliflozines et IC

- Bascule progressive du diabète vers IC et néphroprotection
- Véritable révolution en cours dans toutes les formes d'IC (et d'insuff. rénale)
- Utilité **qu'il y ait ou non diabète**
- Efficacité indépendante du DFG
- Effet synergique avec autres TTT de l'IC (ou de l'IRn)
- Mécanismes d'action encore incertains

IC avancée : traitements

- 1) les 4 classes
- +- le fer
- 2) le ttt électrique
- 3) le structurel
- 4) la ré-adaptation

- Définition : guidelines ESC :
  - déf IC/Déf ICA
  - Déf étiologies/types de cardiopathies (avec diapos d'épidémio si possible).
- Epidémiologie.
- Pronostic de l'ICA.
- Sélection des patients:
    - I Need Help : algorithme pour adresser en centre tertiaire.
    - Sélection des patients pour le projet de transplantation, de LVAD:
      - Aigu : intermacs?
      - Chronique : critères ISHLT, guidelines ESC.
      - Un petit mot sur la VO2? Le KT droit?
- Traitements :
  - Algorithme des recos.
  - Puis détailler un peu chaque classe de ttt.
- Problématique du score cœur.