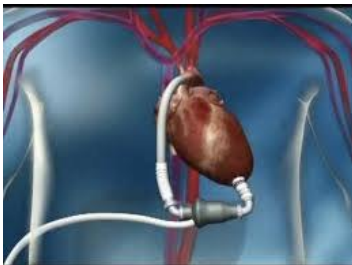


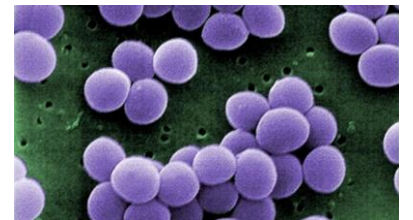
# Infections de câble d'assistance ventriculaire gauche ambulatoire

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Inserm U1230 et CIC-Inserm 1414, Université de Rennes



DES Maladies Infectieuses

01 octobre 2024



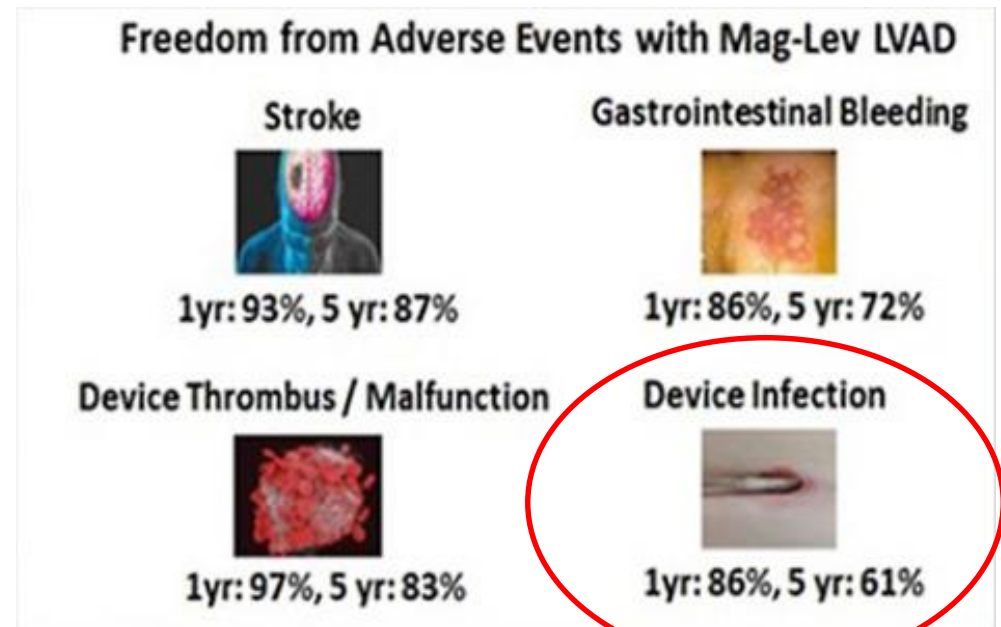
# Conflits d'intérêt

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- **Aucun**

# Introduction

- **LVAD:**
  - En destination
  - Bridge to transplantation
  - Bridge to recovery
- **Complications:**
  - **Infectieuses**
  - Hémorragiques
  - Thrombo-emboliques
  - Défaillances mécaniques
- **Mortalité non négligeable**



# Introduction

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- **Définitions**
- **Est-ce fréquent ?**
- **Est-ce grave ?**
- **Comment prendre en soins ces infections ?**

# De quoi parle-t-on ?

## Working formulation for the standardization of definitions of infections in patients using ventricular assist devices

The Journal of Heart and Lung Transplantation, Vol 30, No 4, April 2011

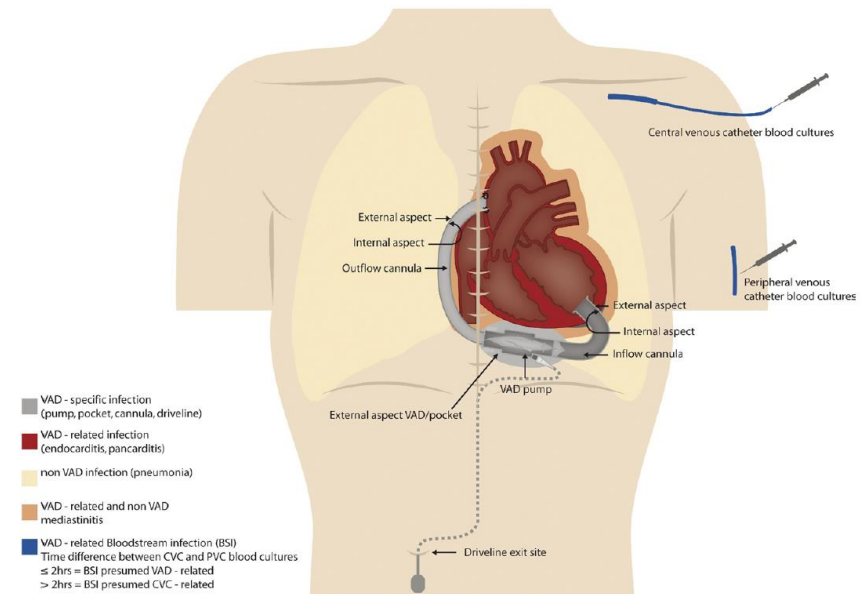
Margaret M. Hannan, MD<sup>l</sup>, Shahid Husain, MD,<sup>b</sup> Frauke Mattner, MD,<sup>c</sup> Lara Danziger-Isakov, MD,<sup>d</sup> Richard J. Drew, MB,<sup>a</sup> G. Ralph Corey, MD,<sup>e</sup> Stephan Schueler, MD, PhD,<sup>g</sup> William L. Holman, MD,<sup>h</sup> Leo P. Lawler, MD,<sup>a</sup> Steve M. Gordon, MD,<sup>d</sup> Niall G. Mahon, MD,<sup>a</sup> John M. Herre, MD,<sup>f</sup> Kate Gould, MB,<sup>g</sup> Jose G. Montoya, MD,<sup>i</sup> Robert F. Padera, MD, PhD,<sup>j</sup> Robert L. Kormos, MD,<sup>k</sup> John V. Conte, MD,<sup>l</sup> and Martha L. Mooney, MD<sup>e</sup>

### ■ VAD-specific

- Pump/cannula infections
- Pocket infections
- Percutaneous driveline infections

### ■ VAD-related

- Infective endocarditis
- Bloodstream infections
- Mediastinitis



# Infection de pompe ou de canule ?

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- Major criteria:
  - 2 or more positive blood cultures taken > 12 hours apart
  - Echocardiography positive for infective endocarditis
- Minor criteria:
  - Fever > 38° C
  - Vascular phenomena
  - Immunologic phenomena
  - Positive blood cultures that not meet criteria noticed above
- Proven:
  - 2 major criteria
  - Positive culture of an explanted material
- Probable:
  - 1 major + 3 minor criteria or
  - 4 minor criteria
- Possible:
  - 1 major + 1 minor criteria or
  - 3 minor criteria

# Diagnostic

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**Table 3. Clinical Presentation of Different Left Ventricular Assist Device–Associated Infections**

Variable	Total (n = 78)	Endovascular (n = 41)	Local (n = 37)
Fever	37 (48)	30 (73)	7 (19)

- **Critères INTERMACS:**
  - **Infection clinique**
  - **Et prélèvement microbiologique et/ou nécessité de traitement**



Non infecté



Infecté



**CONSENSUS STATEMENT**

**THE INTERNATIONAL SOCIETY FOR  
HEART AND LUNG  
TRANSPLANTATION (ISHLT): 2024  
INFECTION DEFINITIONS FOR  
DURABLE AND ACUTE MECHANICAL  
CIRCULATORY SUPPORT DEVICES<sup>1</sup>**



Saima Aslam, MD, MS,<sup>a</sup> Jennifer Cowger, MD, MS,<sup>b</sup> Palak Shah, MD,<sup>c</sup> Valentina Stosor, MD,<sup>d</sup> Hannah Copeland, MD, MBA,<sup>e</sup> Anna Reed, MBChB, FRCP, PhD,<sup>f</sup> David Morales, MD,<sup>g</sup> Gerard Giblin, MBBCh,<sup>h</sup> Jacob Mathew, MBBS,<sup>i</sup> Orla Morrissey, MBBCh, FRACP, PhD,<sup>j</sup> Paola Morejon, MD,<sup>k</sup> Alina Nicoara, MD,<sup>l</sup> and Ezequiel Molina, MD<sup>m</sup>

J Heart Lung Transplant 2024;43:1039–1050

Table 1 Mechanical Circulatory Support Devices in Use Worldwide	
Type	Device name
Intracorporeal VADs	Abbott HeartMate 3
	Abbott HeartMate II
	Medtronic HeartWare
	Jarvik 2000
	EVAHEART
	DuraHeart
	Berlin Heart INCOR
Total artificial heart	SynCardia TAH
	Carmat TAH
Paracorporeal VADs	Berlin Heart EXCOR
	Abbott PediMag
	Toyobo-LVAS (Japan)
Nondischargeable acute MCS devices	IABP
	ECMO
	Abbott CentriMag
	Abiomed Impella 2.5
	Abiomed Impella CP
	Abiomed Impella 5.5
	Abiomed Impella RP
	Abiomed Impella RP Flex
	LivaNova TandemHeart
Dischargeable acute MCS devices	Abiomed Impella BTR
	NuPulse IABP

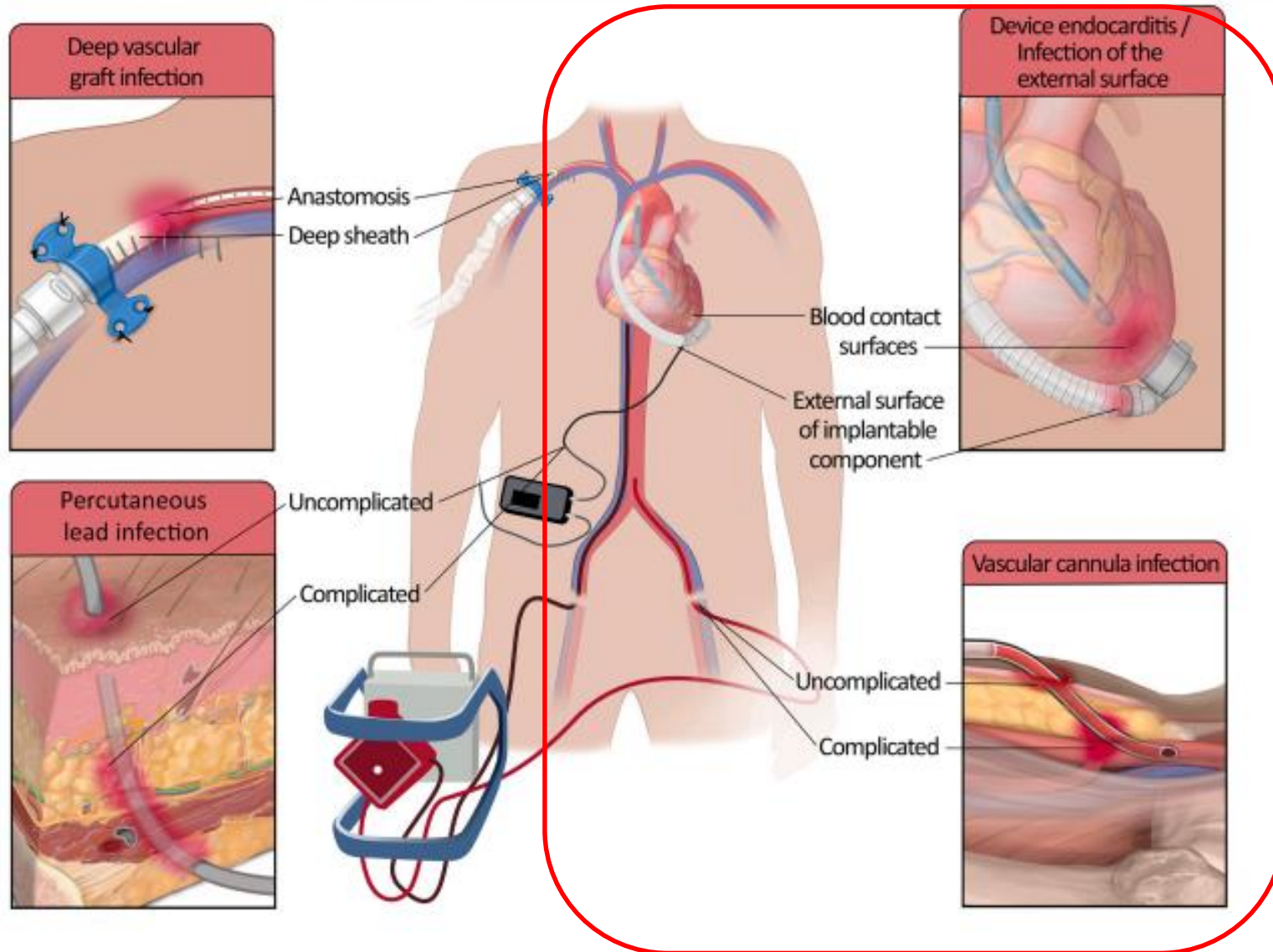
Abbreviations: BTR, bridge to recovery; ECMO, extracorporeal membrane oxygenator; IABP, intra-aortic balloon pump; LVAS, left ventricular assist system; MCS, mechanical circulatory support; TAH, total artificial heart; VAD, ventricular assist device.

**Table 2** Definitions of MCS-Specific Infections Incorporating Both Durable and Acute MCS Devices

Classification	Diagnostic criteria	Investigation
Uncomplicated percutaneous lead infection	<ul style="list-style-type: none"><li>● Pain, tenderness, erythema, drainage, and/or induration at the percutaneous lead (driveline) site</li><li>● Positive drainage culture may be present.</li><li>● Blood cultures are negative.</li><li>● Systemic signs of infection are absent, and imaging is negative for fluid collection/abscess.</li><li>● Clinical improvement or resolution with antibiotics.</li></ul>	<ul style="list-style-type: none"><li>● Drainage sample for bacterial and fungal culture.</li><li>● Bacterial and fungal blood cultures drawn from peripheral sites.</li><li>● Computed tomographic or ultrasound imaging of the affected area to assess for deeper infection/fluid collection.</li><li>● Direct surgical visualization is not needed.</li></ul>
Complicated percutaneous lead infection	<ul style="list-style-type: none"><li>● Pain, tenderness, erythema, drainage, induration, and/or fistulous tract at the percutaneous lead (driveline) site; and/or</li><li>● Fluid collection/abscess at exit site noted on imaging with positive culture; and/or</li><li>● Radiographic evidence of findings consistent with infection along the path of the lead; and/or</li><li>● Presence of systemic signs/symptoms including fever, chills, leukocytosis, systemic inflammatory response syndrome, and sepsis; and/or</li><li>● Positive drainage or blood cultures (bloodstream infection); and/or</li><li>● Cultures demonstrating multidrug-resistant organisms or fungi; and/or</li><li>● Presence of infection of the external surfaces of an implantable component</li></ul>	<ul style="list-style-type: none"><li>● Drainage sample for bacterial and fungal culture.</li><li>● Bacterial and fungal blood cultures drawn from peripheral sites.</li><li>● Computed tomographic or ultrasound imaging of the affected area to assess for deeper infection/fluid collection. FDG/PET or PET/CT can be used as well, if available, in the setting of VAD infections.</li><li>● Direct surgical visualization</li><li>● Tissue, fluid, and/or lead material sample for bacterial and fungal culture (surgical specimen)</li></ul>

Figure 1

Visual representation of the location of mechanical circulatory support-specific infections.



# Types d'infection en résumé

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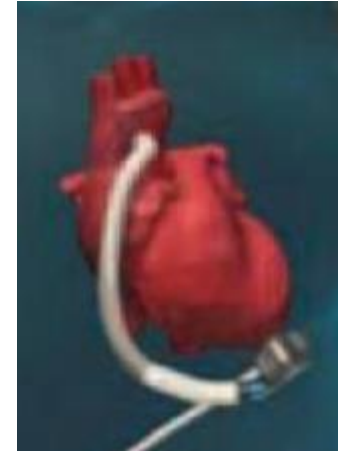
- **Infection de câble:**
  - Non compliquée:
    - Ecoulement local
    - +/- douleurs, signes inflammatoires locaux
    - Pas de fièvre ou autre signe systémique
  - Compliquée:
    - Ecoulement local
    - Tunnellite
    - Infiltration profonde
    - Fièvre possible

# Diagnostic: infections profondes

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- **Infections profondes**

- Poche (qui contient la pompe)
- De canule
- De pompe



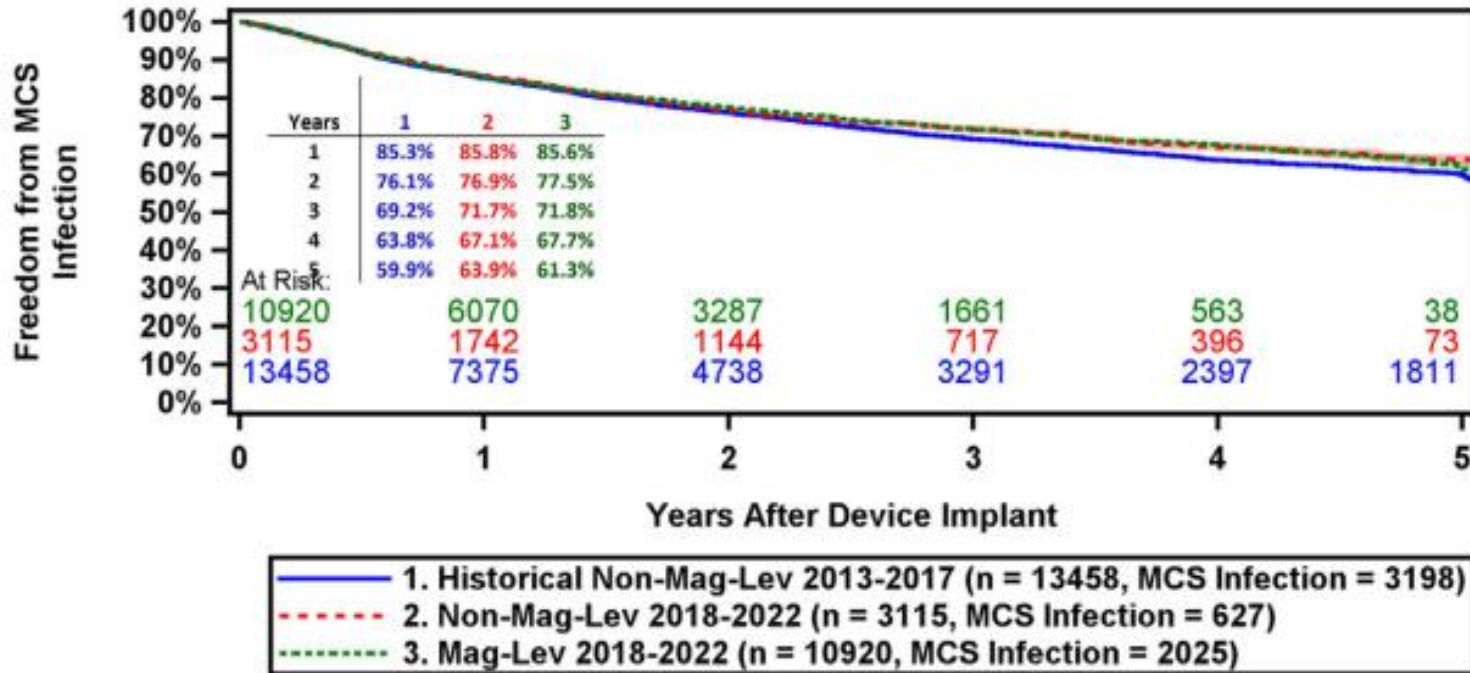
- **Quand hémocultures positives: infection de pompe !**
- **Quand endocardite valvulaire: infection de pompe !**
- **Quand médiastinite: infection de pompe !**



# Epidémiologie

D

Time to First MCS Infection by Era and Device Type  
Intermacs: January 1, 2013 - December 31, 2022

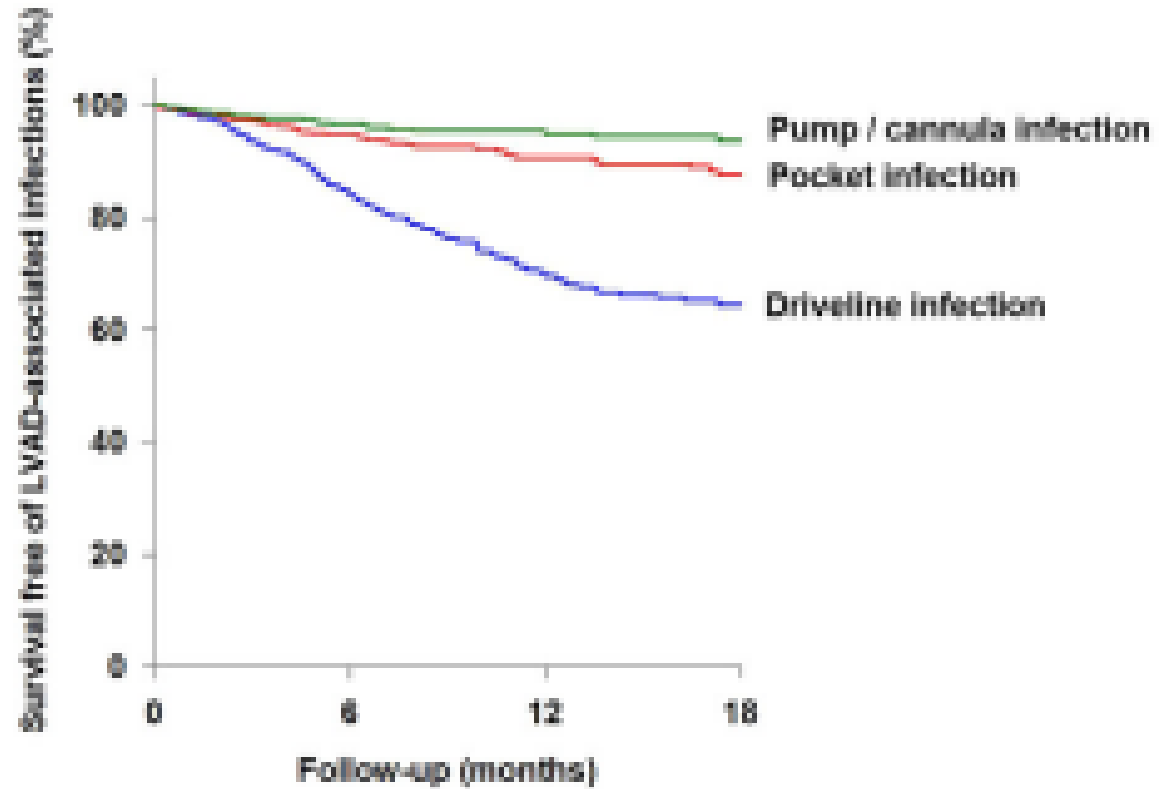


Entre 25 et 40%

Shaded areas indicate 70% confidence limits  
 p (log-rank) = 0.0139  
 Event: MCS Infection (censored at death, tx, cess. of supp)

# Epidémiologie

**A**

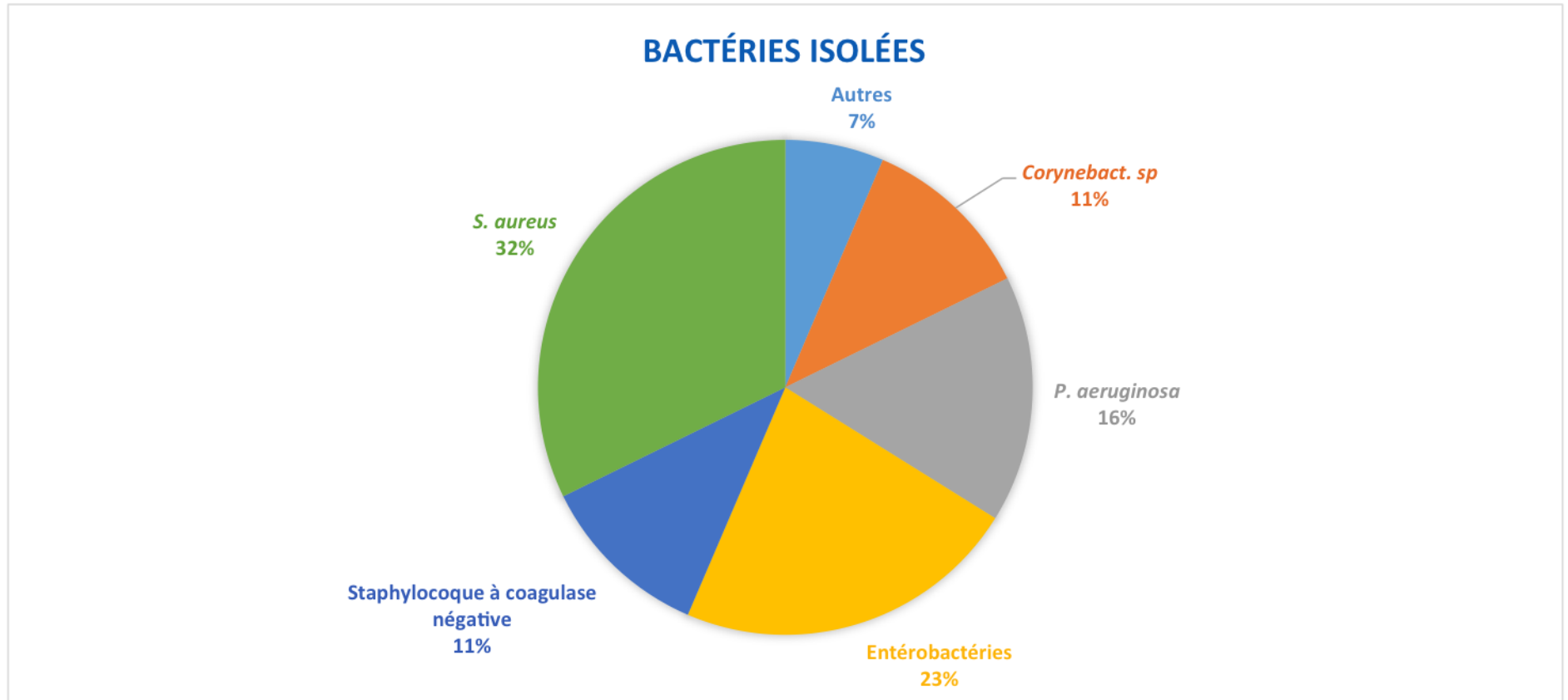


Number patients at risk    652            402            267            194

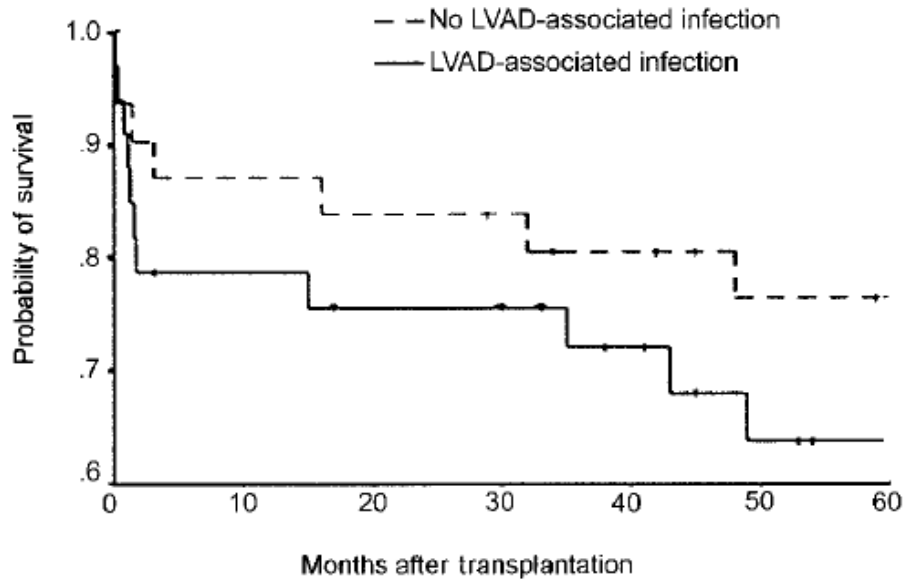


# Microbiologie

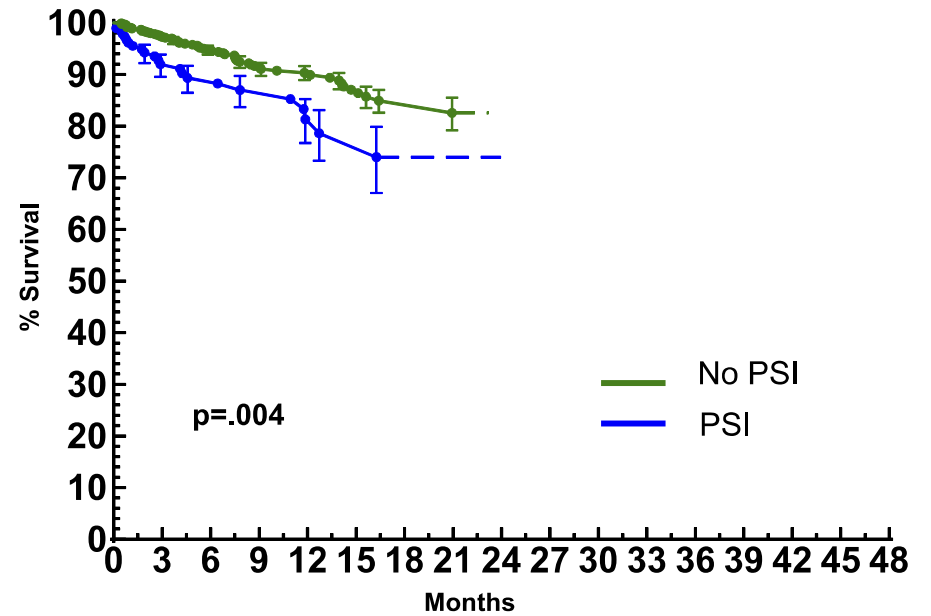
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# Gravité ?



Simon et al, CID, 2005



Goldstein et al, J Heart Lung Transplant, 2012

# Gravité ?

**TABLE 3 Causes of Death Comparison by Era**

<b>Primary Cause of Death</b>	<b>Historical Non-Mag-Lev 2013-2017 (n = 5245)</b>	<b>Non-Mag-Lev 2018-2022 (n = 1210)</b>	<b>Mag-Lev 2018-2022 (n = 2343)</b>	<b>P Value</b>
				<.0001
Circulatory, other	354 (6.7)	78 (6.4)	146 (6.2)	
Device malfunction	107 (2.0)	35 (2.9)	12 (0.5)	
Heart failure	640 (12.2)	143 (11.8)	333 (14.2)	
Major bleeding	99 (1.9)	17 (1.4)	49 (2.1)	
Major infection	357 (6.8)	63 (5.2)	150 (6.4)	
Multisystem organ failure	803 (15.3)	167 (13.8)	375 (16.0)	
Neurologic dysfunction	924 (17.6)	154 (12.7)	226 (9.6)	
Other	749 (14.3)	199 (16.4)	418 (17.8)	
Respiratory	279 (5.3)	52 (4.3)	129 (5.5)	
Sudden death	176 (3.4)	50 (4.1)	64 (2.7)	
Withdrawal of support	757 (14.4)	252 (20.8)	441 (18.8)	

# Pronostic après transplantation

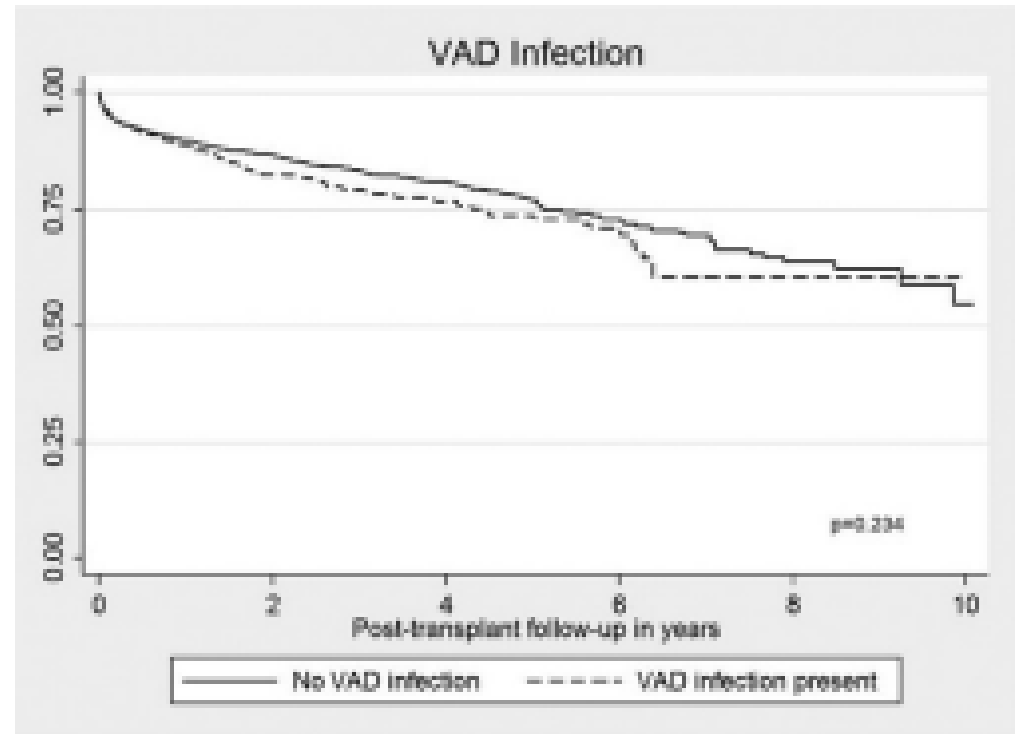
## Impact of Left-Ventricular Assist Device–Related Complications on Posttransplant Graft Survival

Dhaval Chauhan, MD, Alexis K. Okoh, MD, Setri Fugar, MD, Rivandra Karanam, MD, David Baran, MD, Mark Zucker, MD, Magarita Camacho, MD, and Mark J. Russo, MD

(Ann Thorac Surg 2017;104:1947–52)

3,877 patients

Subgroup	Type	n (%)
B1	Thrombosis	374 (9.65)
B2	Infection	869 (22.4)
B3	Malfunction	400 (10.3)
B4	Life-threatening arrhythmia	135 (3.5)
B5	Others	510 (13.2)

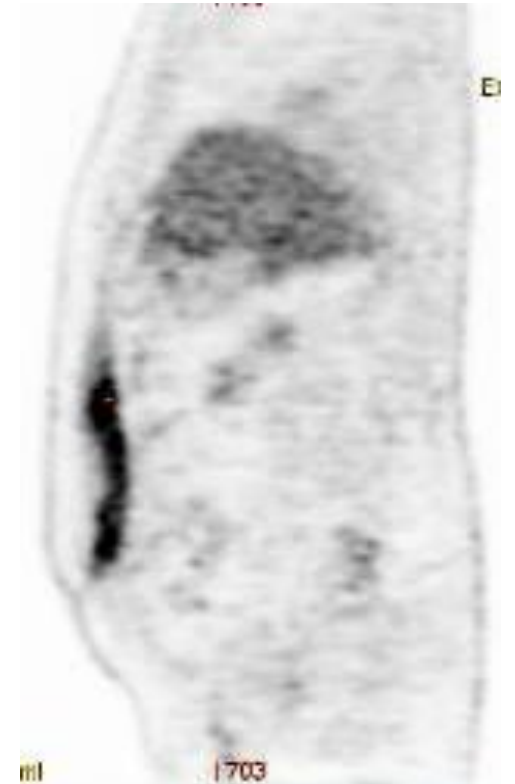
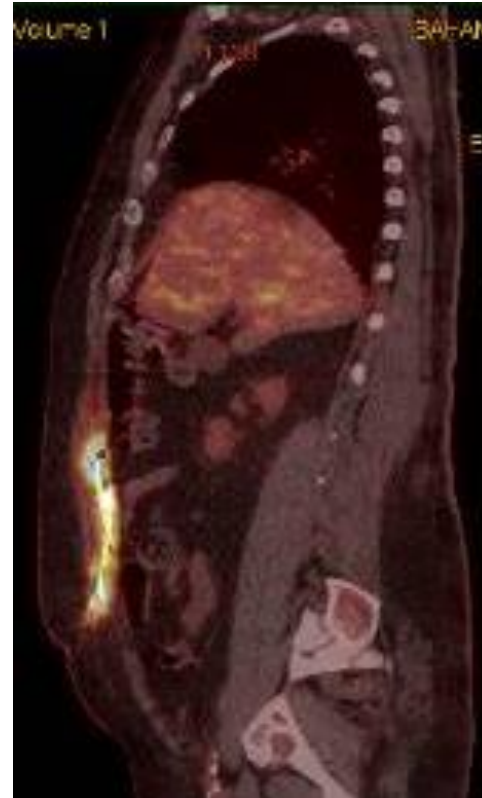


# Bilan suspicion infection LVAD

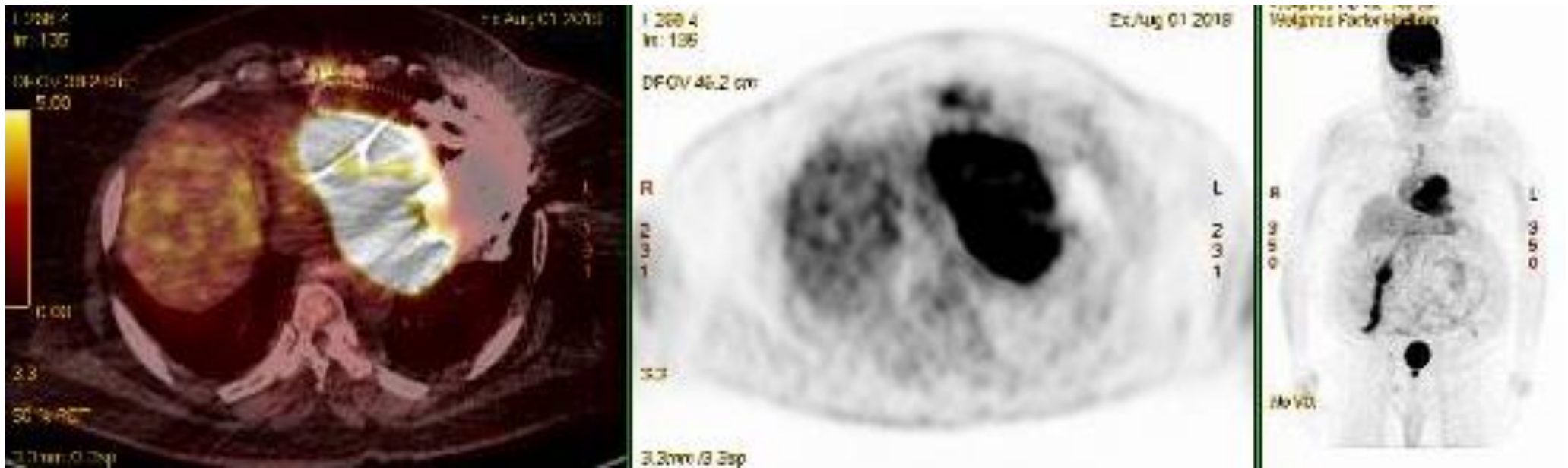
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- **Prélèvement local (une fois n'est pas coutume)**
- **Hémocultures systématiques**
- **INR**
- **Scanner abdominal: suspicion infection profonde**
- **Echographie cardiaque si hémocultures positives**
- **Place du TEP ?**

# TEP-scanner juillet 2019



# TEP-scanner Aout 2019



# Comment traiter ?

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- PEC hospitalière initiale ou au décours : 80 %
- ATB seule (53%), ATB + chirurgie (47%), re-intervention chirurgicale (18%)
- 94 % d'ATB suspensive
- Evolutions cliniques : inchangée (46%) ou aggravation (46%)
- Ablation du DAVG : 21 (60%)
  - Transplantation : 17 (81%)
  - Récupération : 4 (19%)



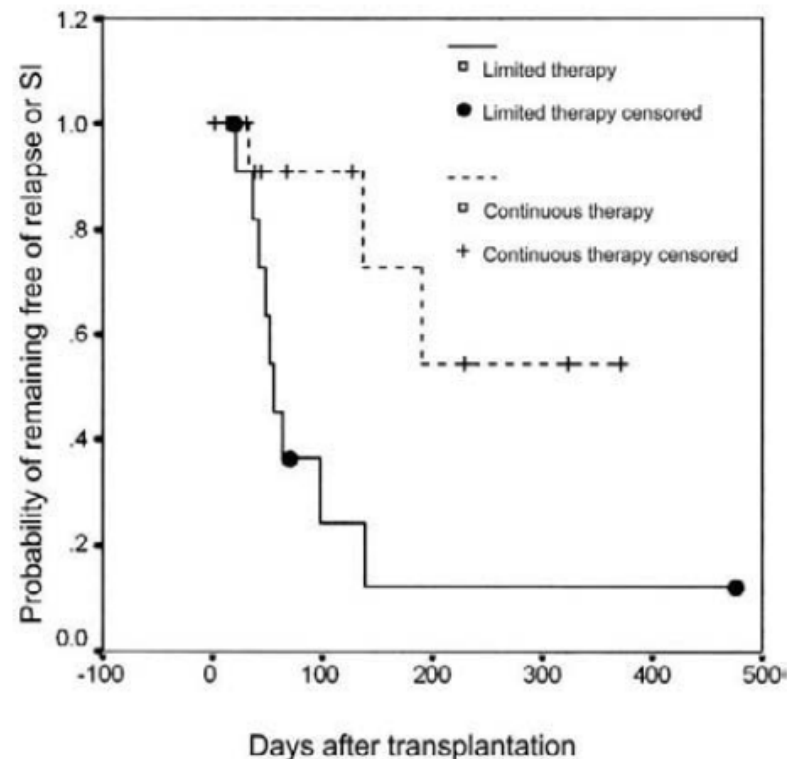
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**Table 5. Data for patients receiving either continuous or limited antibiotic treatment for initial episode of left ventricular assist device (LVAD)-associated infection.**

Variable	Continuous antibiotic therapy (n = 23)	Limited antibiotic therapy (n = 12) <sup>a</sup>	P
Experienced relapse	2	7	.003 <sup>b</sup>
Experienced LVAD-associated superinfection	1	5	.012 <sup>b</sup>
Duration of LVAD support, mean days ± SEM	126 ± 26	289 ± 71	.048 <sup>c</sup>
Total antibiotic therapy, mean days ± SEM	81 ± 23	123 ± 28	NS
Received transplant	21	9	NS
Died from posttransplant infection	6	1	NS
Length of hospital stay after transplantation, mean days ± SEM	28.5 ± 7.1	21.6 ± 4.8	NS
Experienced invasive infection due to VREF after transplantation	4	2	NS



# Alors, comment faire ?

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- Premier épisode d'infection de câble:
  - Eliminer une infection plus profonde voire de pompe:
    - Hémocultures systématiques
    - S'assurer de l'absence de collection
  - Se poser la question de l'intérêt d'une reprise chirurgicale locale
  - Traitement médical « actif » initial:
    - 2 à 4 semaines de traitement
    - Modalités selon la molécule utilisée
  - Soins locaux

# Alors, comment faire ?

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- Traitement suspensif ? Tout dépend du microorganisme en cause
  - Non systématique: streptocoque, enterobactéries, corynebactéries,...
  - Probablement nécessaire: Staphylocoques, *Pseudomonas*
- Modalités du traitement suspensif ?
  - En attente de greffe:
    - Essayer au maximum de diminuer l'inoculum
    - Traitement suspensif plutôt agressif mais sans interaction avec les immunosuppresseurs (et les AVK !)
  - Destination:
    - On privilégie le confort et la simplicité (AVK !)
    - Nécessité fréquente d'alterner

# Conclusions

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- **Infection = complication fréquente**
- **Problématique de l'infection sur matériel**
- **Guérison difficile sans retirer la machine (...)**
- **Traitement suspensif non systématique mais fréquent**
- **Travail en équipe ++++**