Endocardites infectieuses
Des recommandations à la pratique

Quelles explorations en 2017 ?

Pr Xavier Duval
Conflict of interest to declare

None
Case History

62-year old man

- Bentall intervention in 2005 for severe AR on a bicuspid aortic valve + aortic aneurysm
- Hospitalized
  - persisting fever for 3 weeks
  - amoxicillin treatment for one week
  - normal clinical examination
  - INR = 2
- WBC 13 500 leuco / ml, CRP 185 mg/l
- Negative blood cultures
TTE / TEE

- no evidence of abscess
- no regurgitation
- mobile mass 8 mm (thrombus ?, vegetation ?)
- no prosthesis dysfunction
Cerebral MRI
Summary

- **Major Duke criteria**: vegetation?
- **Minor Duke criteria**
  - Valve prosthesis
  - Fever
  - + 2 small asymptomatic strokes

- **After cerebral MRI**
  possible IE $\rightarrow$ definite IE?
Radionuclide Labelled Leucocytes
Imagings in IE patients

To establish IE diagnosis
• Cardiac involvement
• Peripheral localizations

EI workup / indications for cardiac surgery
• Cardiac (abscess)
• Extra cardiac localizations

Prognostic assessment
Follow-up
2015 ESC Guidelines for the management of infective endocarditis

The Task Force for the Management of Infective Endocarditis of the European Society of Cardiology (ESC)

Endorsed by: European Association for Cardio-Thoracic Surgery (EACTS), the European Association of Nuclear Medicine (EANM)

Authors/Task Force Members: Gilbert Habib* (Chairperson) (France), Patrizio Lancellotti* (co-Chairperson) (Belgium), Manuel J. Antunes (Portugal), Maria Grazia Bongiorni (Italy), Jean-Paul Casalta (France), Francesco Del Zotti (Italy), Raluca Dulgheru (Belgium), Gebrine El Khoury (Belgium), Paola Anna Erbaa (Italy), Bernard Iung (France), Jose M. Mirob (Spain), Barbara J. Mulder (The Netherlands), Edyta Plonska-Gosciniak (Poland), Susanna Price (UK), Jolien Roos-Hesselink (The Netherlands), Ulrika Snygg-Martin (Sweden), Franck Thuny (France), Pilar Tornos Mas (Spain), Isidre Vilacosta (Spain), and Jose Luis Zamorano (Spain)
To establish IE diagnosis

Cardiac involvement

• Cardiac echo
Endocardial Involvement

- **Major Duke criteria**
  - New regurgitation murmur

- **Echocardiography**
  - Vegetation (presence, size, mobility)
  - Abscess (frequency PVE>>NVE; Aortic position >> Mitral)
  - New dehiscence on a prosthetic valve

- **Improved sensitivity of TEE vs. TTE**
  - Native valve 70% → >90%
  - Prosthetic valve 50% → >90%

- The diagnostic value of TEE should be interpreted according to patient characteristics and the probability of endocarditis
### Anatomic and echo definitions

<table>
<thead>
<tr>
<th></th>
<th>Surgery / Necropsy</th>
<th>Echocardiography</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vegetation</strong></td>
<td>Infected mass attached to an endocardial structure or an implanted intracardiac material</td>
<td>Oscillating or non oscillating intracardiac mass or other endocardial structures or non implanted intracardiac material</td>
</tr>
<tr>
<td><strong>Abscess</strong></td>
<td>Perivalvular cavity with necrosis and purulent material not communicating with the cardiovascular lumen</td>
<td>Thickened non-homogeneous perivalvular area with echodense or echoluent appearance</td>
</tr>
<tr>
<td><strong>Pseudoaneurysm</strong></td>
<td>Perivalvular cavity communicating with the cardiovascular lumen</td>
<td>Pulsatile perivalvular echo-free space with colour-Doppler flow detected</td>
</tr>
<tr>
<td><strong>Perforation</strong></td>
<td>Interruption of endocardial tissue continuity</td>
<td>Interruption of endocardial tissue continuity traversed by colour Doppler flow</td>
</tr>
<tr>
<td><strong>Fistula</strong></td>
<td>Communication between 2 neighbouring cavities through a perforation</td>
<td>Colour-Doppler communication between 2 neighbouring cavities through a perforation</td>
</tr>
<tr>
<td><strong>Valve aneurysm</strong></td>
<td>Saccular outpouching of valvular tissue</td>
<td>Saccular bulging of valvular tissue</td>
</tr>
<tr>
<td><strong>Dehiscence of a prosthetic valve</strong></td>
<td>Dehiscence of the prosthesis</td>
<td>Paravalvular regurgitation identified by TTE/TTE with or without rocking motion of the prosthesis</td>
</tr>
</tbody>
</table>

**Eur Heart J 2015**
An isolated periprosthetic regurgitation has a low positive predictive value for the diagnosis of IE
Prosthetic Endocarditis

Limitations of Echocardiography

• Shadowing: attenuation of ultrasound by prosthetic material
  → false -

• Image artifacts
  → false -, false +

• Aortic prostheses
  – Posterior part poorly visualised in TTE
  – Anterior part poorly visualised in TEE

• Other artifacts (sutures ..)

➢ Importance of high resolution (TEE)
Indications for echocardiography

Clinical suspicion of IE

Transthoracic echocardiography

- Prosthetic valve or Intracardiac device
- Poor quality TTE
- Positive
- Negative

Clinical suspicion of IE

High
- TEE

Low
- TEE

Stop

If initial TEE is negative but persistent suspicion of IE: repeat TEE within 7-10 days

Eur Heart J 2015
To establish IE diagnosis

Cardiac involvement

- Cardiac echo
- Cardiac multislice computed tomography (MSCT)
Cardiac multislice computed tomography (MSCT)

- Mainly used to analyze perivalvular lesions
  - abscesses, fistulae and pseudoaneurysms
- May complete TEE to assess
  - the topography and extension of abscesses, fistulae and pseudoaneurysms.
- Sensitivity and specificity of MSCT:
  > 95% as compared with surgical findings
Cardiac multislice computed tomography (MSCT)

• **Aortic prosthetic tubes:**
  – Superior to TTE and TEE to diagnose abscesses and/or pseudoaneurysms around.

• **Coronary MSCT**
  – To assess coronary anatomy
  – Mainly considered in pts at low risk of coronary artery disease, due to its high negative predictive value.
Multislice Computed Tomography in Infective Endocarditis

Comparison With Transesophageal Echocardiography and Intraoperative Findings
To establish IE diagnosis

Cardiac involvement

- Cardiac echo
- Cardiac multislice computed tomography (MSCT)
- Nuclear Imaging [18F]FDG PET/CT
Nuclear Imaging [18F]FDG PET/CT

- **18F-FDG PET/CT:**
  - Reveal glucose consuming cells: tumoral, inflammation..
  - widely used in oncology for staging and evaluation of treatment response
- Introduced more recently for imaging of infection
- Gram positive bacteremia: cost-effective method for detection of metastatic infection
- High physiological cardiac and cerebral 18F-FDG uptake: unsuitable for detecting cardiac and cerebral infectious lesions?
Nuclear Imaging [18F]FDG PET/CT

• **Suppression of Cardiac** $^{18}$F-FDG uptake
  – Carbohydrate-restricted diet
  – Patient fasts for at least 12 hours

• **Improvement of images using correction for attenuation**

• **Semi-quantitative analysis of the intensity of FDG uptake**
  – maximal standardized uptake value ($SUV_{max}$)
  – valve-to-background ratio: valve $SUV_{max}$ / atrial blood $SUV_{max}$
Nuclear Imaging \([18F]FDG\) PET/CT

1. High sensitivity
2. Absolute quantification

18 F-deoxyglucose (FDG)

Nguyen et al., Am J Physiol 1990

Nguyen et al., Am J Physiol 1990

18th JNI, Saint-Malo, du 21 au 23 juin 2017
[18F]FDG PET/CT “True” whole-body acquisition

Oncology-derived field of acquisition: skull base to upper thighs
[18F]FDG PET/CT Diagnostic of valvular involvement
### Diagnostic of valvular involvement

#### Patients with **definite IE**

<table>
<thead>
<tr>
<th>Clinical situations</th>
<th>Total Nb pts</th>
<th>Definite EI / total</th>
<th>sensitivity</th>
<th>specificity</th>
<th>PPV False +</th>
<th>NPV False -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Riet 2010 *</td>
<td>Definite IE</td>
<td>25 pts 10/0/15</td>
<td>all</td>
<td>12% (3/25)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Kestler M 2014</td>
<td>Definite IE</td>
<td>47 pts 15/11/24</td>
<td>all</td>
<td>9.5% (4/47)</td>
<td>4/15 PVE (27%)</td>
<td>NA</td>
</tr>
</tbody>
</table>

* NO carbohydrate-restricted diet

0/24 (0%) native valve
### Diagnostic of valvular involvement

#### Patients with suspected IE

<table>
<thead>
<tr>
<th>Clinical situations</th>
<th>Total Nb pts</th>
<th>Definite EI / total</th>
<th>sensitivity</th>
<th>specificity</th>
<th>PPV False +</th>
<th>NPV False -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kouijzer 2013 *</td>
<td>Gram + bacteremia</td>
<td>72 pts 6/561</td>
<td>18/72 7/18</td>
<td>39% 93%</td>
<td>64% 36%</td>
<td>82% 18%</td>
</tr>
<tr>
<td>Saby 2013</td>
<td>Prosthetic valve AND Fever or crp &gt; 10 mg, or bacteremia or + serology or echo pos</td>
<td>72pts 72/0/0</td>
<td>30/72 22/30</td>
<td>73% 80%</td>
<td>85% 15%</td>
<td>67% 33%</td>
</tr>
</tbody>
</table>

* NO carbohydrate-restricted diet

---

18th JNI, Saint-Malo, du 21 au 23 juin 2017
SUVmax value to improve PET diagnosis performance?

Results of the Prosthetic Valve SUV\textsubscript{max} and Prosthetic Valve-to-Background SUV\textsubscript{max} Ratio According to the Final Diagnosis

The SUV\textsubscript{max} was significantly higher in patients with definite PVE in comparison with the 2 other groups (A), whereas the prosthetic valve-to-background SUV\textsubscript{max} ratio was not significantly higher (B). *p < 0.05. Abbreviations as in Figures 1 and 2.
False positive results in patients with valvular prosthesis

Subject of concern?
Absence of uptake on the PV

Myocardial uptake / Absence of uptake on the PV

Intense / Homogeneous uptake on the PV

Non infected prosthesis
Perivalvular uptake in pts with valvular prosthesis

51 patients with 54 non infected prosthetic valves
Uptake: (AC) $n=50/54$ (93%)
Absence of uptake on the PV

Myocardial uptake / Absence of uptake on the PV

Intense / Homogeneous uptake on the PV

Non infected prosthesis
Absence of uptake on the PV

Myocardial uptake / Absence of uptake on the PV

Intense / Homogeneous uptake on the PV

Intense / Heterogeneous uptake on the PV in IE pts

Non infected prosthesis

Heterogeneity rather than intensity of the uptake to distinguish infected from non-infected prosthesis

Infected prosthesis
CIED infection diagnosis

- 42 pts suspected of CIED infection

<table>
<thead>
<tr>
<th></th>
<th>Group A Suspected CIED infection N=42</th>
<th>Group B Controls 6 W post implantation N=12</th>
<th>Group C Controls &gt; 6 Mths post implantation N=12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmed infection</td>
<td>35 (83%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18F-FDG PET/CT uptake</td>
<td>32/42 1 false pos 3 false neg</td>
<td>No or mild uptake</td>
<td>0</td>
</tr>
<tr>
<td>SUVmax</td>
<td>4.4 ± 1.6</td>
<td>1.2 ± 1.4</td>
<td>0</td>
</tr>
<tr>
<td>ETOveg&lt;sup&gt;tion&lt;/sup&gt;</td>
<td>12/42</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

CIED: cardiovascular intra cardiac electronic device

Sarrazin JF et al. JACC 2012
To establish IE diagnosis

Cardiac involvement

- Cardiac echo
- Cardiac multislice computed tomography (MSCT)
- Nuclear Imaging [18F]FDG PET/CT
- Nuclear Imaging Labelled leukocytes
51 pts with suspected IE (prosthetic IE)
Final Diagnosis of EI
51/131 (39%) patients
Sensitivity : 90%
Specificity : 100%
Labelled leukocytes and infective endocarditis

- **42 pts** with suspected prosthetic IE (valve prosthesis / aortic tube / patch)
- Non-conclusive TTE/TEE in all cases
- **14 (33%)** positive uptake (intense in 9, mild in 5)

(Hyafil et al. Eur Heart J Cardiovasc Imaging 2013;34:1597-606)
FDG PET vs. WBC SPECT

- Single-centre prospective study (Bichat Hospital, Paris)
- 39 patients (males: 22), aged 62±17 years
- Suspected of prosthetic valve endocarditis (PVE)
- Delay between FDG PET and WBC SPECT: 7±7 days
- Diagnosis after ≥3-months follow-up (Duke-Li):
  - Definite, n=14 (36%)
  - Possible, n=3
  - Rejected, n=21

## FDG PET vs. WBC SPECT

<table>
<thead>
<tr>
<th>Final diagnosis after ≥3 mo follow-up</th>
<th>Definite (n=14)</th>
<th>Possible (n=4)</th>
<th>Rejected (n=21)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FDG PET +</strong></td>
<td>13 (93)</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><strong>FDG PET -</strong></td>
<td>1</td>
<td>2</td>
<td>15 (71)</td>
</tr>
<tr>
<td><strong>WBC SPECT +</strong></td>
<td>9 (64)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>WBC SPECT -</strong></td>
<td>5</td>
<td>3</td>
<td>22 (100)</td>
</tr>
</tbody>
</table>

- FDG PET false positive <2 months after valve implantation (n=6)
- WBC SPECT false negative (n=5): Coxiella (n=2), Candida (n=1), no abscess (n=2)

**FDG PET: Higher sensitivity**

**WBC SPECT: Higher specificity**
Clinical suspicion of IE

Modified Duke criteria (Li)

- Blood cultures
- Echocardiography
- Imaging techniques for symptomatic emboli

To perform second line imaging techniques:
- Cerebral CT scan or MRI
- Total body scan
- Cardiac CT scan
  - In prosthetic valve pts:
    - 18 FDG TEP/CT
    - Leucocytes labeled SPECT/CT

To establish valvular involvement
Diagnosis

Imaging techniques

Clinical suspicion of IE

Modified Duke criteria (Li)

Definite IE
Possible/rejected IE but high suspicion
Rejected IE Low suspicion

Native valve
Prosthetic valve

1. Repeat echo (TTE + TOE)/microbiology
2. Imaging for embolic events
3. Cardiac CT
4. Imaging for embolic events

1. Repeat echo (TTE + TOE)/microbiology
2. 18 F-FDG PET/CT or Leucocytes labeled SPECT/CT
3. Cardiac CT
4. Imaging for embolic events

ESC 2015 modified diagnostic criteria

Definite IE
Possible IE
Rejected IE

To apply
### Major criteria

1. **Blood cultures positive for IE**
   a. Typical microorganisms consistent with IE from 2 separate blood cultures:
      - *Viridans streptococci, Streptococcus galollyticus (Streptococcus bovis), HACEK group, Staphylococcus aureus*; or
      - Community-acquired enterococci, in the absence of a primary focus; or
   b. Microorganisms consistent with IE from persistently positive blood cultures:
      - ≥2 positive blood cultures of blood samples drawn >12 h apart; or
      - All of 3 or a majority of ≥4 separate cultures of blood (with first and last samples drawn ≥1 h apart); or
   c. Single positive blood culture for Coxiella burnetii or phase 1 IgG antibody titre >1:800

2. **Imaging positive for IE**
   a. Echocardiogram positive for IE:
      - Vegetation;
      - Abscess, pseudoaneurysm, intracardiac fistula;
      - Valvular perforation or aneurysm;
      - New partial dehiscence of prosthetic valve.
   b. Abnormal activity around the site of prosthetic valve implantation detected by $^{18}$F-FDG PET/CT (only if the prosthesis was implanted for >3 months) or radiolabelled leukocytes SPECT/CT.
   c. Definite paravalvular lesions by cardiac CT.

More study is needed to define the utility of $^{18}$F-fluoro-deoxyglucose positron emission tomography/CT in the diagnosis and management of IE.
To establish IE diagnosis

Cardiac involvement

- Echo → False negative
- multislice computed tomography → For Abscess
- [18F]FDG PET/CT → High sensitivity False positive
- Labelled leukocytes → High specificity
Imagings

To establish IE diagnosis

- Cardiac involvement
- Peripheral localizations

EI work up (indications for cardiac surgery)

- Cardiac (abscess)
- Extra cardiac localizations

Prognostic assessment

Follow-up
130 patients admitted to Bichat Claude Bernard Hospital, Paris (June 2005-Sept 2008) with systematic cerebral MRI with MRangiography

Neurological Complications
n=106
82%

Symptomatic lesions 12%

Large Ischemic lesions
n=33 (24 silent) 25%

Small Ischemic lesions
n=60 (45 silent) 46%

Large Intracerebral Hemorrhage
n=10 (8 silent) 8%

Microbleed
n=74 (66 silent) 58%

Sub. Arachnoidal Hemorrhage
n=11 (11 silent) 8%

Aneurysms
n=10 (10 silent) 8%

Abscess
n=8 (7 silent) 6%

Effects of Early Cerebral Magnetic Resonance Imaging on Clinical Decisions in Infective Endocarditis, the IMAGE study

Xavier Duval, Bernard Iung, Isabelle Klein, Eric Brochet, Gabriel Thabut, Florence Arnoult, Laurent Lepage, Jean Pierre Laissy, Michel Wolff and Catherine Leport and the IMAGE study group.
130 patients admitted to Bichat Claude Bernard Hospital, Paris  
(June 2005-Sept 2008)  
with systematic cerebral MRI with MR angiography

Neurological Complications  
\[ n = 106 \]  

- Ischemic lesions  
  \[ n = 33 \]  
  (24 silent)  
  25%  
- Intracerebral Hemorrhage  
  \[ n = 10 \]  
  (8 silent)  
  8%  
- Ischemic lesions  
  \[ n = 60 \]  
  (45 silent)  
  46%  

Symptomatic lesions  
12%

- Aneurysms  
  \[ n = 10 \]  
  (10 silent)  
  8%  
- Microbleed  
  \[ n = 74 \]  
  (66 silent)  
  46%  
- Abscess  
  \[ n = 8 \]  
  (7 silent)  
  6%  
- Sub. Arachnoidal Hemorrhage  
  \[ n = 11 \]  
  (11 silent)  
  8%
81 consecutive definite IE patients;

Systematic Cerebral CT with angiography

Cerebrovascular Complications

n=51 63%

Symptomatic Stroke 
n=34

ICMA 
n=11

Silent emboli 
(21%)

ICMA 
n=15

21% out of 81
36% of 47 asymptomatic pts

N= 26 32%
[18F]FDG PET/CT Brain imaging

Trans Arterial Valve Implantation
[18F]FDG PET/CT Mycotic aneurysms
[18F]FDG PET/CT Portal of entry

- Recurrent chills, fever, and positive blood cultures (E. faecalis)
- Suspicion of aortic prosthetic valve infection
Diagnosis of peripheral complications
Diagnosis of peripheral complications

### Patients with definite IE

<table>
<thead>
<tr>
<th>Clinical situations</th>
<th>Total Nb pts</th>
<th>Definite EI / total</th>
<th>Peripheral localisations</th>
<th>sensitivity</th>
<th>specificity</th>
<th>PPV False +</th>
<th>NPV False -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Riet 2010 **</td>
<td>Definite IE</td>
<td>25 pts 10/0/15</td>
<td>25/25</td>
<td>100%</td>
<td>91%</td>
<td>91%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11/25 (44%) 58% silent</td>
<td>100%</td>
<td>91%</td>
<td>91%</td>
<td>9%</td>
</tr>
<tr>
<td>Kestler M 2014</td>
<td>Definite IE</td>
<td>47pts 15/11/24</td>
<td>47/47</td>
<td>100%</td>
<td>80%</td>
<td>90%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>31/47 (66%)</td>
<td>100%</td>
<td>80%</td>
<td>90%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Cf Article Asmar 2014
Pizi Circulation 2015 detection of 14 cases (15%) of peripheral emboli, 10 of which asymptomatic

Kestler M: Cases/controls study; peripheral localisations detected in **57.4%** of cases (TEP) vs **18%** in control (without TEP) \( p=0.0001 \)
## Diagnosis of peripheral complications

### Patients with suspected IE

<table>
<thead>
<tr>
<th>Clinical situations</th>
<th>Total Nb pts</th>
<th>Definite EI / total</th>
<th>Peripheral localisations</th>
<th>sensitivity</th>
<th>specificity</th>
<th>PPV False +</th>
<th>NPV False -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vos 2010 **</td>
<td>Gram pos bacteremia *</td>
<td>115 pts</td>
<td>21/115</td>
<td>11/21 (50%) 50% silent</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Saby 2013</td>
<td>Prosthetic valve AND Fever or crp &gt; 10 mg, or bacteremia or positive serology or echo pos</td>
<td>72 pts</td>
<td>30/72</td>
<td>8/30 (25%)</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonfiglioli 2013</td>
<td>Clinical suspicion</td>
<td>71 pts</td>
<td>29/71</td>
<td>17/29 (?) 74%</td>
<td></td>
<td></td>
<td>94%</td>
</tr>
</tbody>
</table>

*Pts with at least one risk factor for complicated bacteremia (community acquisition, signs of infection more than 48 h before initiation of appropriate treatment, fever more than 72 h after initiation of appropriate treatment, and positive blood cultures more than 48 h after initiation of appropriate treatment*
To look for asymptomatic peripheral IE manifestations

To perform second line imaging techniques:
- Cerebral CT scan or MRI
- Total body scan

Clinical suspicion of IE
Modified Duke criteria (Li)

Definite IE
Possible/rejected IE but high suspicion
Rejected IE Low suspicion

Blood cultures
Echocardiography
Imaging techniques for symptomatic emboli
# ESC modified diagnostic criteria

## Major criteria

1. **Blood cultures positive for IE**
   a. Typical microorganisms consistent with IE from 2 separate blood cultures:
      - *Viridans streptococci, Streptococcus galolyticus* (*Streptococcus bovis*), HACEK group, *Staphylococcus aureus*; or
      - Community-acquired enterococci, in the absence of a primary focus; or
   b. Microorganisms consistent with IE from persistently positive blood cultures:
      - ≥2 positive blood cultures of blood samples drawn >12 h apart; or
      - All of 3 or a majority of ≥4 separate cultures of blood (with first and last samples drawn ≥1 h apart); or
   c. Single positive blood culture for *Coxiella burnetii* or phase I IgG antibody titre >1:800

2. **Imaging positive for IE**
   a. Echocardiogram positive for IE:
      - Vegetation;
      - Abscess, pseudoaneurysm, intracardiac fistula;
      - Valvular perforation or aneurysm;
      - New partial dehiscence of prosthetic valve.
   b. Abnormal activity around the site of prosthetic valve implantation detected by ¹⁸F-FDG PET/CT (only if the prosthesis was implanted for >3 months) or radiolabelled leukocytes SPECT/CT.
   c. Definite paravalvular lesions by cardiac CT.

## Minor criteria

1. Predisposition such as predisposing heart condition, or injection drug use.
2. Fever defined as temperature >38°C.
3. **Vascular phenomena** (including those detected by imaging only):
   - Major arterial emboli, septic pulmonary infarcts, infectious (mycotic) aneurysm, intracranial haemorrhage, conjunctival haemorrhages, and Janeway’s lesions.
4. **Microbiological phenomena**
   - Osler’s node, Bouchet’s spots, and rheumatoid factor.
5. Microbiological evidence: positive blood culture but does not meet a major criterion as noted above or serological evidence of active infection with organism consistent with IE.
**Impact of cerebral lesion detection on IE diagnosis**

- Modified-Duke classification upgraded in **32%**

**Effects of Early Cerebral Magnetic Resonance Imaging on Clinical Decisions in Infective Endocarditis, the IMAGE study**

---

**Figure 1. Study flow diagram.**

- Patients with IE admitted to Bichat-Claude Bernard Hospital ($n = 274$)
  - Excluded ($n = 124$)
    - Urgent surgery: 47
    - Pacemaker: 23
    - Previous MRI: 18
    - Claustrophobia: 13
    - Informed consent unobtainable: 12
    - Declined participation: 10
    - Aged <18 y: 1
  - Included ($n = 150$)
    - No MRI performed ($n = 9$)
      - Claustrophobia: 2
      - Urgent surgery: 2
      - Other: 5
    - Received MRI ($n = 141$)

- IE diagnosis rejected ($n = 11$)
  - Discharge diagnosis:
    - Fever and mitral ruptured chordae tendineae: 4
    - Fever related to extracardiac infectious diseases in patients with known previous valvular insufficiency: 3
    - Stroke with fever: 1
    - Traumatic aortic regurgitation: 1
    - Pulmonary embolism after dental extraction: 1
    - Isolated *S. sanguinis* blood culture: 1

- Duke classification established ($n = 130$)
  - Before MRI
    - Definite IE: 77
    - Possible IE: 50
    - Excluded IE: 3
  - After MRI
    - Definite IE: 91 (101)
    - Possible IE: 39 (29)
    - Excluded IE: 0

- At discharge, regardless of MRI results
  - Definite IE: 105
  - Possible IE: 25
  - Excluded IE: 0
Duke classification upgraded due to
- cardiac uptake in  7/8
- peripheric uptake in  1/8

Table 5

<table>
<thead>
<tr>
<th>Final Diagnosis</th>
<th>Definite PVE</th>
<th>Possible PVE</th>
<th>Rejected PVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duke</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definite PVE</td>
<td>21 (70)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Possible PVE</td>
<td>8 (27)</td>
<td>22 (100)</td>
<td>10 (50)</td>
</tr>
<tr>
<td>Rejected PVE</td>
<td>1 (3)</td>
<td>0 (0)</td>
<td>10 (50)</td>
</tr>
<tr>
<td>Duke-PET/CT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definite PVE</td>
<td>29 (97)</td>
<td>10 (45)</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Possible PVE</td>
<td>1 (3)</td>
<td>12 (55)</td>
<td>10 (50)</td>
</tr>
<tr>
<td>Rejected PVE</td>
<td>0</td>
<td>0</td>
<td>8 (40)</td>
</tr>
</tbody>
</table>

Values are n (% of each final diagnosis). Abbreviations as in Tables 1 and 2.

30 definite IE
Imagings

To establish IE diagnosis

- Cardiac involvement
- Peripheral localizations

IE workup (indications for cardiac surgery)

- Cardiac (abscess)
- Extra cardiac localizations

Prognostic assessment

Follow-up
### Table 22  Indications and timing of surgery in left-sided valve infective endocarditis (native valve endocarditis and prosthetic valve endocarditis)

<table>
<thead>
<tr>
<th>Indications for surgery</th>
<th>Timing</th>
<th>Class</th>
<th>Level</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Heart failure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic or mitral NVE or PVE with severe acute regurgitation, obstruction or fistula</td>
<td>Emergency</td>
<td>I</td>
<td>B</td>
<td>111,115, 213,216</td>
</tr>
<tr>
<td>causing refractory pulmonary oedema or cardiogenic shock</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic or mitral NVE or PVE with severe regurgitation or obstruction causing symptoms</td>
<td>Urgent</td>
<td>I</td>
<td>B</td>
<td>37,115, 209,216, 220,221</td>
</tr>
<tr>
<td>of HF or echocardiographic signs of poor haemodynamic tolerance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3. Prevention of embolism</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic or mitral NVE or PVE with persistent vegetations &gt;10 mm after one or more</td>
<td>Urgent</td>
<td>I</td>
<td>B</td>
<td>9,58,72, 113,222</td>
</tr>
<tr>
<td>embolic episode despite appropriate antibiotic therapy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic or mitral NVE with vegetations &gt;10 mm associated with severe valve stenosis</td>
<td>Urgent</td>
<td>IIA</td>
<td>B</td>
<td>9</td>
</tr>
<tr>
<td>or regurgitation, and low operative risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic or mitral NVE or PVE with isolated very large vegetations (&gt;30 mm)</td>
<td>Urgent</td>
<td>IIA</td>
<td>B</td>
<td>113</td>
</tr>
<tr>
<td>Aortic or mitral NVE or PVE with isolated large vegetations (&gt;15 mm) and no other</td>
<td>Urgent</td>
<td>IIb</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>indication for surgery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Quelles explorations en 2017 ?
Quelles explorations en 2017 ?

- Major place of new imaging techniques in doubtful situations
- Modification of Duke classification taking into account asymptomatic lesions
- From the most simple to the most complex imaging
- Choice based on each particular situation
  - To prioritize Sensitivity or Specificity
Quelles explorations en 2017 ?

- Major place of new imaging techniques in doubtful situations
- Modification of Duke classification taking into account asymptomatic lesions
- From the most simple to the most complex
- Choice based on each particular situation
  - To prioritize Sensitivity or Specificity
- Place to systematic whole body imaging in all pts ?
The ‘Endocarditis Team’

When to refer a patient with IE to an ‘Endocarditis Team’ in a reference centre

1. **Patients with complicated IE** (i.e. endocarditis with HF, abscess, or embolic or neurological complication or CHD), should be referred early and managed in a reference centre with immediate surgical facilities.

2. **Patients with non-complicated IE** can be initially managed in a non-reference centre, but with regular communication with the reference centre, consultations with the multidisciplinary ‘Endocarditis Team’, and, when needed, with external visit to the reference centre.
1/ L’imagerie extra cardiaque peut contribuer à affirmer le diagnostic d’endocardite infectieuse.

2/ La fixation de la TEP-18 FDG au niveau valvulaire cardiaque chez un patient présentant une bactériémie persistante à *Staphylococcus aureus* permet d’affirmer l’existence d’une endocardite, même en cas de normalité de l’échocardiographie.

3/ L’imagerie cérébrale systématique est recommandée chez un patient présentant une végétation mitrale de 20 mm de plus grand axe.

4/ Sous traitement antibiotique, la diminution de la taille de la végétation à l’échocardiographie cardiaque est un signe de réponse thérapeutique favorable.

5/ Le TEP FDG est un examen sensible pour faire le diagnostic d’atteinte valvulaire dans l’endocardite infectieuse et la scintigraphie aux leucocytes marqués un examen spécifique.
1/ L'imagerie extra cardiaque peut contribuer à affirmer le diagnostic d'endocardite infectieuse.  
**VRAI**

2/ La fixation de la TEP-18 FDG au niveau valvulaire cardiaque chez un patient présentant une bactériémie persistante à *Staphylococcus aureus* permet d'affirmer l'existence d'une endocardite, même en cas de normalité de l'échocardiographie.  
**FAUX**

3/ L'imagerie cérébrale systématique est recommandée chez un patient présentant une végétation mitrale de 20 mm de plus grand axe.  
**FAUX**

4/ Sous traitement antibiotique, la diminution de la taille de la végétation à l'échocardiographie cardiaque est un signe de réponse thérapeutique favorable.  
**FAUX**

5/ Le TEP FDG est un examen sensible pour faire le diagnostic d'atteinte valvulaire dans l'endocardite infectieuse et la scintigraphie aux leucocytes marqués un examen spécifique.  
**VRAI**