Risk-benefit assessment of systematic thoracoabdominopelvic CT scan in infective endocarditis

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Summary:

The thoraco-abdomino-pelvic CT-scan frequently leads to the finding of embolic event or metastatic foci. However, when they are asymptomatic, they rarely change the diagnosis or therapeutic management. Moreover, the risk of acute kidney injury after the CT-Scan is significant.

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Abstract:

Background: In the management of Infective Endocarditis (IE), the presence of extracardiac complications has an influence on both diagnosis and treatment. Current guidelines suggest that systematic thoraco-abdomino-pelvic CT scan (TAP-CT) may be helpful. Our objective was to describe how systematic TAP-CT affects the diagnosis and the management of IE.

Methods: In this multicenter cohort study, between January 2013 and July 2016 we included consecutive patients who had definite or possible IE according to the Duke-modified criteria, validated by endocarditis teams. We analyzed whether the Duke classification and the therapeutic management were modified regarding the presence or the absence of IE-related lesion on the CT and investigated the tolerance of this exam.

Results: Of the 522 patients included in this study, 217 (41.6%) had one or more IE-related lesion. On the basis of CT results in asymptomatic patients, diagnostic classification was upgraded from possible endocarditis to definite endocarditis for only 4 cases (0.8%). The presence of IE-related lesion on CT did not modify the duration of antibiotic treatment (p=0.55), nor the decision of surgical treatment (p=0.39). Specific treatment of the lesion was necessary in 42 patients (8.0%) but only 9 of these lesions (1.9%) were asymptomatic and diagnosed only on the TAP-CT. Acute kidney injury (AKI) within 5 days of the CT was observed in 78 patients (14.9%).

Conclusions: The TAP-CT findings slightly affected diagnosis and treatment of IE in a very small proportion of asymptomatic patients. Furthermore, contrast media should be used with caution because of the high risk of AKI.

Key-words:

CT scan – Infective endocarditis – Embolic event – Acute kidney injury – Duke's classification.

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INTRODUCTION

Despite recent improvement in diagnostic and therapeutic strategies, infective endocarditis (IE) is still associated with high in-hospital mortality ranging from 17% to 23% [1–4]. Extracardiac complications of IE remain one of the most common and often devastating complications (especially cerebral embolism) of IE. These IE-related lesions can be either embolic events (EE), metastatic foci (spondylodiscitis, abscesses), or mycotic aneurysms. Asymptomatic lesions occur in most patients who have IE, as demonstrated with systematic MRI: silent cerebrovascular complications may occur in 55% to 81% of patients [5,6] whereas symptomatic embolism may occur in 12% to 35% of patients [5–8]. Therefore, their frequency depends on investigations performed.

Extracardiac IE complications may influence diagnosis, therapeutic plans and prognosis. First, their presence can facilitate and accelerate the diagnosis of IE by adding minor criteria of the Duke classification. Second, they can affect medical or surgical treatment. Hence, according to the current guidelines, a diagnosis of embolism in a patient with persistent vegetation (>10 mm) despite appropriate antibiotic therapy may lead to urgent valvular surgery to prevent further embolisms [9].

In clinical practice, TAP-CT is mostly used for screening TAP asymptomatic complications in IE. Numerous teams have included a systematic TAP-CT for the extension work-up of the disease. Randomized clinical trials are particularly difficult to perform in IE because of the rarity, highly polymorphic presentation, and large number of prognostic variables of the disease. Therefore, there have been no large prospective studies to date that assess the impact of TAP-CT in the management of IE. Subsequently, no general agreement emerges from currently available guidelines [9,10].

In the present study, we used a large multicenter database registry of IE prospectively enrolled and report the results of a systematic search for extracardiac complications using TAP-CT. The objective of the current study was to further evaluate how the finding of asymptomatic events on TAP-CT had influenced the diagnosis of IE and the management of patients.

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METHODS

Design and patients:

From January 2013 to July 2016, a prospective observational cohort study of IE was designed in two French referent centers: Bordeaux University Hospital and Nantes University Hospital. All consecutive patients admitted with possible or definite diagnosis of IE according to Duke University criteria and confirmed by the local endocarditis teams were eligible for study entry. Echocardiography, assessment of embolic complications and treatment were in accordance with current clinical practice: the study did not prescribe any standard diagnostic nor therapeutic approach. The only exclusion criterion was the absence of a TAP-CT during the management of a given patient.

The study was approved by the local ethics committee. Patients were informed of the study but did not have to provide individual consent, in accordance with French legal standards.

Clinical data:

The following clinical parameters were prospectively collected at diagnosis and during hospitalization: age, sex, fever, physical examination reports, predisposing conditions, previous heart disease, intravenous drug abuse, history of cancer, diabetes, Charlson co-morbidity index, moderate or severe congestive heart failure, surgical history (native or prosthetic valve), history and grade of renal failure. Peripheral IE-related lesions were reported with details of anatomic site. All patients were followed during hospitalization, at 3 months, 6 months and 1 year.

Biological data:

The following microbiological data were collected: causative pathogens, results of blood cultures, serology testings, valve culture, or polymerase chain reaction testings from valve samples, according to international guidelines. We specially assessed the renal function according to the KDIGO recommendation about the contrast-induced acute kidney injury (CI-AKI) [11]. Acute kidney

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injury (AKI) was defined as an increase in serum creatinine (SCr) by ≥0.3 mg/dl (≥26.5 μmol/l) within 48 hours or an increase in SCr by ≥1.5 times baseline.

Echocardiography data:

We collected the echocardiographic data from transthoracic echocardiography (TTE) and transoesophageal echocardiography (TOE), including anatomic site of disease, the presence of the vegetation, and complications [12].

TAP-CT scan:

All the enrolled patients underwent TAP-CT during the hospitalization. The diagnosis of IE-related lesion on TAP-CT included the following findings: septic infarction or metastatic abscess to spleen, kidneys, liver, lungs, muscles and spondylodiscitis and vascular aneurysms. Number, size, and location of lesions were assessed. Additional imaging modalities (e.g. chest X-ray, ultrasound, MRI, bone scintigraphy) were performed if indicated and at the discretion of the treating physician. IE-related lesions were considered symptomatic when patients presented with clinical signs (pain, neurological deficit, pulmonary symptoms…).

Assessment of impact of TAP-CT:

Diagnosis:

A final Duke classification was established at discharge considering the occurrence of new events and the results of valvular surgery (microbiology, histology). We established the Duke

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classification without and with TAP-CT results. Whenever we found differences related to a CT lesion, the symptomatic or non-symptomatic nature of the lesion was assessed.

Therapeutic management:

On the basis of the TAP-CT result, patients were divided into 2 groups according to the presence or the absence of IE-related lesion, which were compared for antibiotic duration and cardiac surgical procedures.

For patients who had any IE-related lesion, we assessed whether they had a specific treatment for that lesion and whether the lesion was symptomatic. Specific treatments were radiological or surgical drainage of an abscess, immobilization in case of spondylodiscitis, addition of an antibiotic, embolization of an aneurysm.

Statistical analysis:

Quantitative variables are reported as means ± standard deviations and qualitative variables as numbers and percentages.

For the analyses concerning the therapeutic management, bivariate analyses were performed followed by multivariate analyses in order to consider possible confounding factors. The bivariate analyses were performed using statistical tests according to the nature of the variables and the numbers: Student T-test to test the association between a quantitative variable and a binary variable and Chi2 or Fisher's test, if small numbers, to test the association between binary variables.

To estimate the effect of the presence of IE-related lesions on surgical management, a logistic regression model was constructed taking into account known factors associated with therapeutic management and variables which were statistically significant in the bivariable analyses (α=.05): age, sex, micro-organism, type of IE, presence of IE related lesions from other locations than TAP, location of valve lesion if present, type of valvular damage ~~(vegetation, abscess, leakage or perforation)~~.

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To test the effect of the presence of IE-related lesions on the duration of antibiotic treatment, a linear regression model was used with the following adjustment variables: age, sex, type of germ, type of IE, lesions other than TAP, surgical treatment and localization of endocarditis. A P value of less than 0.05 was considered significant. Statistical analysis was done with R software (version 3.2.2).

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RESULTS (753 words)

Study population:

A total of 630 consecutive patients were hospitalized for IE between March 2013 and July 2016. Figure 1 details the reasons for exclusion. In 102 patients, no TAP-CT was performed; in 3 other patients, the diagnosis of IE was ruled out; 3 patients were excluded due to insufficient data. Therefore, 522 patients who met the study criteria were included in the final analysis. Patients included for the renal function analysis are detailed in Figure 1. At the discharge, IE was classified as definite in 457 patients (87.6%) and possible in 65 (12.4%).

Epidemiological and clinical characteristics, outcomes:

Table 1 summarizes the main epidemiological, clinical and echocardiographic findings. The median age was 69.0 years (interquartile rage [IQR], 58.0-77.0). The majority of patients were males (76.2%). The median score on the Charlson index was 2 points (IQR, 1-4 points). Vegetation was identified by echocardiography in 367 patients (71.7%). The two most common bacteria were staphylococci (36.0%) and streptococci (38.5%). An extracardiac complication occurred in 320 patients (61.3%), with more than one lesion in 157 episodes (30.1%), and a cumulative number of 504 IE-related lesions. Details are reported in supplementary data (Table S1). *Staphylococcus aureus* and *Streptococcus gallolyticus* were more frequently identified among IE patients with IE-related lesions respectively 32.5 vs 18.8% (p<.001) and 15.8 vs 8.9% (p=.02). Eighty-two patients (15.8%) died during their hospital stay and overall mortality after one year was 19.6%. In multivariate analysis, the presence of IE-related lesions was independently associated with excess mortality with an odd ratio of 2.71 (95% CI (1.51 - 5.09), P=.001) for hospital mortality and 2.18 (95% CI (1.26 - 3.86), p=.006) for one-year mortality (supplementary data, table S2).

TAP-CT results

TAP-CT revealed at least one IE-related lesion in 217 patients (41.6%). Of the 522 patients, 131 had splenic lesions (25.1%), 63 had kidney lesions (12.1%), 60 had vertebral osteomyelitis

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(11.5%), 39 had lung lesions (7.5%) and 12 had liver lesions (2.3%). More than one IE-related lesion on the TAP-CT was identified in 61 patients (11.7%). Eleven patients had vascular lesions: arterial aneurysm for 8 patients; emboli for 3 patients. Of the total cohort, 95 patients (18.2%) had IE-related lesions only on the TAP-CT. The median time between hospital admission and abdominal CT was 3 days (IQR 1-7) in the group with IE-Related lesion and 4 days (IQR 2-8) in the group without IE-related lesion.

Changes in Diagnostic Classification

The results are shown in the Figure 2. Two hundred seventeen patients had an IE-related lesion on the TAP-CT, of whom 180 had already 2 major criteria, and 14 had, without the results of the vascular criterion of the Duke classification, 1 major criterion and one or three minor criteria: therefore, the scan could not modify the diagnostic classification for them. Of the remaining 23 patients, the vascular minor criteria could be fulfilled by another lesion than those found by TAP-CT. Finally, diagnosis classification of 10 possible endocarditis was upgraded to definite endocarditis solely on the basis of TAP-CT results. Last, six of the 10 patients for whom the diagnostic classification was upgraded were symptomatic. Therefore, the systematic scan modified the Duke classification for only 4 out of 522 patients (0.8%).

Changes in Clinical Decisions

In multivariate analysis, the difference in median treatment duration according to the presence of thoraco-abdomino-pelvic IE-related lesions was not significant (-0.62 days [-7.93; 6.69], p=.87) (supplementary data, table S3).

Of the 217 patients with an IE-related lesion on the TAP-CT, 42 patients (19.3%) received a specific treatment. Ten patients underwent drainage of a deep abscess, 23 patients with spondylodiscitis had an immobilization or a second antibiotic for better bone diffusion, 6 patients with pulmonary lesion had anticoagulation or a second antibiotic, and 3 patients underwent endovascular treatment of a mycotic aneurysm. However, all the drained abscesses, 17 of the 23

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spondylodiscitis, 4 of the 6 pulmonary lesions and 1 of the 3 aneurisms were symptomatic and suspected or diagnosed before realization of the CT scan. Overall, the TAP-CT modified the treatment for only 9 asymptomatic patients (Table 2).

In multivariate analysis, we did not find any association between the presence of an IE-related lesion on the TAP-CT and surgical treatment (OR 1.2 (0.79-1.81), p=.387), (supplementary data, table S4).

Safety outcomes:

AKI was observed in 17% of patients within 5 days after the CT-scan: 69% of AKI were grade I, 8% Grade II and 23% grade III. In univariate analysis, factors associated with AKI were age (p=.01) and renal function prior to scanning inferior to 60 mL/min/m^2 (p<.001). AKI was associated with increased mortality (OR 4.47 95%IC (2.59; 7.70) p<.001). Renal embolism was not associated with an increased risk of AKI (p=.82).

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DISCUSSION (985 words)

While some studies have suggested that brain imaging is dispensable in patients with endocarditis [5,13,14], there is no evidence regarding usefulness of systematic TAP-CT. The current investigation is the largest study to assess this issue. TAP-CT frequently shows extracardiac complications. However, when asymptomatic, these lesions rarely modify the course of diagnosis or therapeutic management. Furthermore, the risk of renal failure is a real issue largely underestimated in this population.

The frequency of IE-related lesions in our study is similar to that observed in recent large studies with systematic TAP-CT [15]. Emboli or metastatic foci are common in endocarditis and often asymptomatic: more than 90% of patients have brain lesions when an autopsy is performed [16]. Studies that used systematic imaging have shown the high frequency of asymptomatic lesions [17–19]. Therefore, the real question is the impact of the finding of asymptomatic lesions.

According to our results, TAP-CT shows limited potential for improving the diagnosis of IE. First, in our study as in the literature, the two major criteria are most often used to make the diagnosis: 89% of the 1456 patients in the study by Rizzi *et al* had 2 major criteria [20]. The results of the study by Lung *et al* are consistent with our results: 58 patients with endocarditis underwent systematic cerebral and abdominal MRI within 7 days following admission [21]: changes in medical or surgical therapy were never solely based on abdominal MRI results. Although comparison between series should be made with caution, the performance to upgrade the diagnostic classification by brain MRI was considerably better in the study by Duval than the performance of the TAP-CT in our study [5]. In this study, diagnostic classification of 17 of 53 cases (32%) of nondefinite endocarditis was modified. The main reason to explain this difference between TAP-CT and Brain MRI is the better sensitivity of MRI in the detection of small parenchymal or meningeal complications and a high performance in the diagnosis of aneurysms. Therefore, brain MRI seems to have a better risk-benefit assessment than TAP-CT. One particular case should however be highlighted: in case of right

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endocarditis, the thoracic CT could be very efficient: 76.9% of patients with right endocarditis with IE-related lesion had a pulmonary localization versus only 5.9% of those with left endocarditis ($p<0.01$).

Concerning the therapeutic management, few patients benefited from thoraco-abdominopelvic abscess drainage procedures in our study. When necessary, the abscess was always large and symptomatic. The recommended duration of endocarditis treatment is 4 to 6 weeks depending on the type of valve and the results of valve culture in case of surgery [9,10]. It is therefore logical that the presence of IE related-lesion does not modify the duration of treatment, especially since the duration of treatment of a spondylodiscitis has been reduced to 6 weeks [22]. As in our study, Rizzi *et al* observed no significant difference in the rate of cardiac surgical procedures when comparing IE episodes complicated by embolism with uncomplicated IE episodes [20]. In addition, a recent study of 157 patients did not find any impact of the presence of lesions in the spleen, kidneys, or liver on the duration of treatment or the need of surgery [15]. Interestingly, although history of embolism is integrated into the recommendations for surgery [9], the literature is very poor on the benefit of surgery in this indication: only one study has shown that having one EE is a risk factor for a further one [23].

We observed a particularly high rate of AKI within 5 days of the CT-scan (17% of the cases). The potential causes of this AKI are numerous, and Contrast-Induced AKI (CI-AKI) is only one of the possible causes (others: glomerulonephritis, hemodynamic impairment, antibiotic toxicity, renal infarction). However, our data are consistent with the literature because incidence of CI-AKI is low in a healthy patient population but may be higher in co-morbid conditions such as diabetes, advanced age, pre-existing renal failure, and can reach nearly 25% [11,24]. In addition, AKI is an independent risk factor for mortality in endocarditis [25,26], and CI-AKI, even mild, has been shown to cause excess mortality [27]. Therefore, it appears crucial to properly assess the risk of an AKI before an injected CT-Scan and the potential benefit of this exam [9].

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Our conclusions on the limited potential and on the risks of TAP-CT may increase the interest of PET-CT, which could be an interesting alternative. The role of PET-CT is currently under debate: while its value in diagnosing cardiac involvement of endocarditis in prosthetic valves is well established [9], there is only limited data for the diagnosis of extracardiac foci [28–34]. To date, the studies included small numbers of patients, were monocentric and used different preparation protocols, which complicates the evaluation of PET-CT. A prospective monocentric study showed that PET-CT detected extracardiac lesions in 17 of 40 patients (42.5%) and modified the management in 14 of 40 patients (35%) [28]. However, it is not demonstrated that these modifications improved the prognosis.

We acknowledge several limitations to our study, primarily due to its prospective but non-interventional design. Indeed, there was no evaluation of therapeutic attitude before and after scanning and the decision to perform the CT-Scan as well as its timing were at the discretion of the physician. However, this is a real-life study, and the objective did not aim to influence the management decisions due to TAP-CT findings. Second, Duke's criteria are useful, but they do not replace the clinical judgement of the Endocarditis Team and TAP-CT may help the clinician by other ways. Third we grouped all the lesions (embolic event or metastatic foci) under the same term "IE-related lesion". The distinction between embolic and metastatic lesions is not always easy as pointed out in the AHA recommendations [10] and choosing a single term allowed to avoid this type of classification difficulties. Because we classified all the secondary lesions as Duke's vascular criteria, we placed the scan in the most advantageous position for diagnosis. But even in this situation, the contribution of this exam was very marginal for the diagnosis, supporting the findings of our study.

Last, we did not assess whether changes in diagnostic classifications and therapeutic plans due to TAP-CT findings affected patient prognosis or outcomes. However, since this examination has no impact on the management, we can assume that it does not modify the prognosis either.

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In conclusion, the finding of silent lesions on TAP-CT does not seem to modify the diagnostic classification or the therapeutic decision. Systematic scanning of an asymptomatic patient does not seem necessary. If the CT scan is performed, prevention of renal failure should be a constant concern for the physician, especially in older patients. This could avoid unnecessary exams and reduce health-care costs for these patients.

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Conflict of Interest

All authors: No Potential conflicts of interest. All authors have submitted the ICMJE form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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Tables

Table 1: Clinical characteristics, surgery findings, and outcome for patients with and without IE-related lesions (Embolic events, metastatic foci or vascular aneurism).

Variable	All Patients (n=522)	With IE-RL (n=320)	Without IE-RL (n=202)	OR (95% CI)	P value
Center					
Bordeaux	292 (55.9)	179 (55.9)	113 (55.9)		
Nantes	230 (44.1)	141 (44.1)	89 (44.1)		
Demographics					
Age, median years (25-th-75th percentile)	69 (58-77)	67 (57-76)	70 (61-79)	0.99 (0.98 – 1.01)	.99
Male sex	398 (76.2)	247 (77.2)	151 (74.8)	1.14 (0.76 – 1.72)	.53
Comorbidities					
Charlson index	2 [1-3][b]	2 [1-4][b]	1 [0-3][b]	1.09 (1.00 – 1.19)	.05
Injection drug user	31 (6.0)	22 (6.9)	9 (4.5)	1.58 (0.71 – 3.51)	.25
Diabetes mellitus	116 (22.2)	71 (22.2)	45 (22.3)	0.99 (0.65 – 1.52)	.98
HIV infection	10 (1.9)	5 (1.6)	5 (2.5)	0.63 (0.18 – 2.19)	.46
Liver cirrhosis	25 (4.8)	16 (5.0)	9 (4.5)	1.13 (0.49 – 2.60)	.78
Renal disease	61 (11.7)	43 (13.4)	18 (11.2)	1.59 (0.89 – 2.84)	.12
History of cancer	100 (19.2)	59 (18.4)	41 (20.3)	0.89 (0.57 – 1.38)	.60
History of heart failure	96 (18.4)	57 (17.8)	39 (19.3)	0.91 (0.58 – 1.42)	.67
Valve type					
Native	329 (63.0)	208 (65.0)	121 (59.9)	1.24 (0.86 – 1.79)	.24
Prosthetic	193 (37.0)	112 (35.0)	81 (40.1)	0.80 (0.56 – 1.16)	.24
Valve localization					

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Aortic	254 (48.6)	155 (48.4)	99 (49.0)	0.98 (0.69 – 1.39)	.90
Mitral	116 (22.2)	71 (22.1)	45 (22.3)	0.99 (0.65 – 1.52)	.98
Right-sided IE[c]	45 (8.6)	26 (8.1)	19 (9.4)	0.85 (0.46 – 1.58)	.61
Multivalvular[d]	63 (12.1)	43 (13.4)	20 (9.9)	1.41 (0.80 – 2.48)	.23
Microorganism					
Staphylococci					
MSSA	128 (24.5)	95 (29.7)	33 (16.3)	2.16 (1.39 – 3.37)	<.001
MRSA	14 (2.7)	9 (2.8)	5 (2.5)	1.14 (0.38 – 3.45)	.82
CNS	46 (8.8)	18 (5.6)	28 (13.9)	0.37 (0.20 – 0.69)	.001
Streptococci					
Oral streptococci	95 (18.2)	52 (16.2)	43 (21.3)	0.72 (0.46 – 1.12)	.15
S. gallolyticus	69 (13.2)	51 (15.8)	18 (8.9)	1.94 (1.10 – 3.42)	.02
Other streptococci	37 (7.1)	26 (8.1)	11 (5.4)	1.54 (0.74 – 3.18)	.25
Enterococci	68 (13.0)	38 (11.9)	30 (14.9)	0.77 (0.46 – 1.29)	.33
Other[e]	32 (6.1)	17 (5.3)	15 (7.4)	0.70 (0.34 – 1.43)	.33
Microbiology negative	33 (6.3)	14 (4.4)	19 (9.4)	0.44 (0.22 – 0.90)	.02
Echocardiographie					
Vegetation	373 (71.4)	242 (75.6)	131 (64.9)	1.68 (1.14 – 2.47)	.008
Abscess	100 (19.2)	61 (19.1)	39 (19.3)	0.98 (0.63 – 1.54)	.94
Regurgitation	247 (47.3)	147 (45.9)	100 (49.5)	0.87 (0.61 – 1.23)	.43
Timing of TAP-CT[f]	4 [1-7][b]	3 [1-7][b]	4 [2-8][b]	0.99 (0.96-1.01)	0.21
Outcome[g]					
In-hospital Mortality	82/518 (15.8)	65/316 (20.6)	17/202 (8.4)	2.82 (1.60 – 4.97)	<.001
One-Year Mortality	97/501 (19.4)	72/309 (23.3)	25/192 (13.0)	2.03 (1.24 – 3.33)	.005

Note. Data reported as number (% patients) unless otherwise indicated.

[a]Comparison between group with IE-RL and group without IE-RL. Bold values are significant.

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[b]median [Interquartile range 1; Interquartile range 3]

[c]Only right-sided localization.

[d]At least 2 locations.

[e]Other microorganisms or more than one microorganism.

[f]Timing between the first positive blood culture and the TAP-CT.

[g]Data are No. of patients with findings/No. of patients with data (%).

Abbreviations: IE-RL: Infective endocarditis related lesions; IV: intraveinous; IE: Infective endocarditis; MSSA: Methicillin Susceptible *Staphylococcus aureus*. MRSA: Methicillin-Resistant *Staphylococcus aureus*; CNS:coagulase negative *Staphylococcus*.

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Table 2: Impact of the discovery of secondary lesions on the TAP-CT according to the type of lesion

Lesion	Lesion on the TAP-CT	Lesion with modification of treatment	Asymptomatic lesion with modification the treatment
Spondylodiscitis	25	23	5
Abcess[a]	254	10	0
Vascular	11	3	2
Pulmonary	39	6	2
Total	325	42	9

[a]*Spleen, kidney, liver or muscle location. Abbreviations: TAP : thoraco-abdomino-pelvic*

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Figure legends

Figure 1: Flowchart.

Abbreviations: TAP: thoraco-abdomino-pelvic; IE: Infective endocarditis; CM: contrast media.

Figure 2. Changes in Diagnostic Classification because of the thoraco-abdomino-pelvic CT Scan.

[1]*Four patients with vertebral osteomyelitis, 1 splenic embolic lesion, 1 pulmonay abcess*

Abbreviations: IE: Infective Endocarditis; IE-RL: Infective endocarditis related lesions; TAP: thoraco-abdomino-pelvic.

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Figure 1

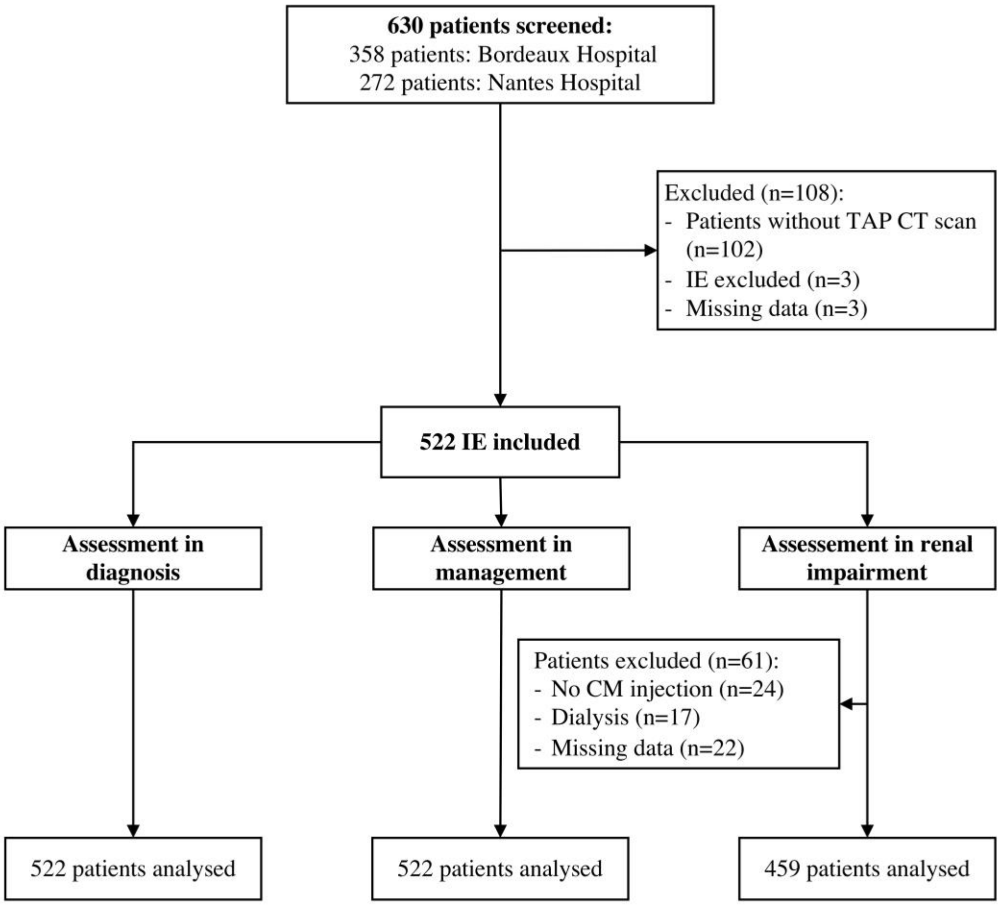

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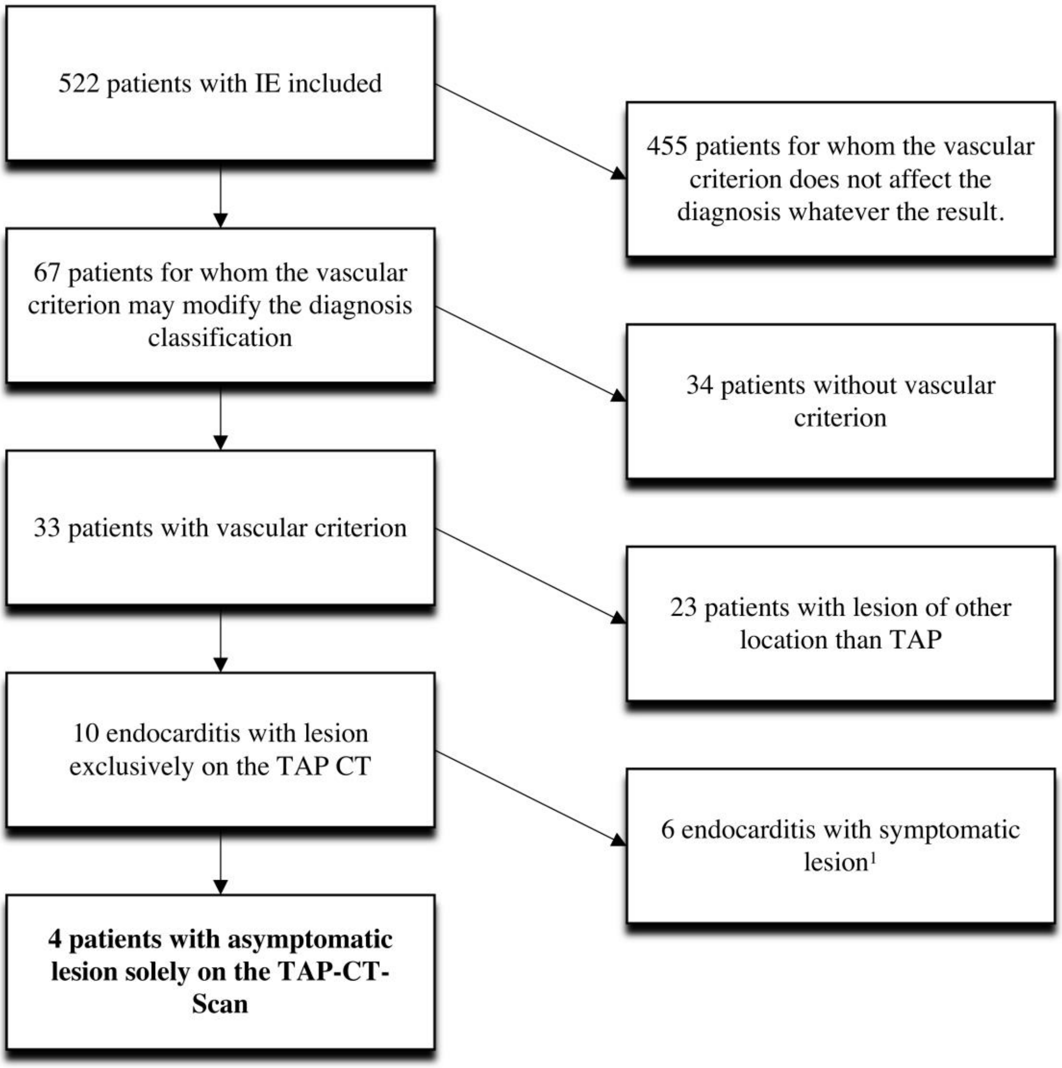
Figure 2



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