70TH ESCVS CONGRESS & 7TH IMAD MEETING

Validation of the management of aortic graft infection collaboration (MAGIC) criteria for the diagnosis of vascular graft/endograft infection

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Disclosure

- Nothing to disclose

Importance of vascular graft/endograft infection (VGEI)

- Low frequent disease with incidence 0.6-5%
- High morbidity
- High mortality 25 - 88%
  - < 30% within first year after surgery
  - < 70% within first year after conservative treatment
- Timely + accurate assessment/ diagnosis (VGEI) crucial for a favorable outcome

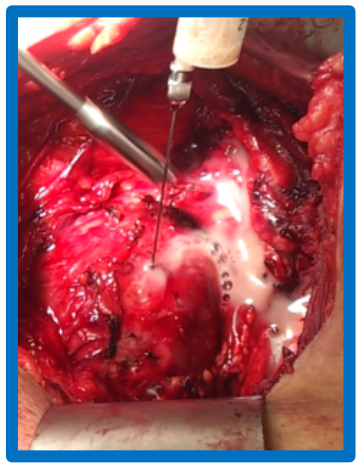
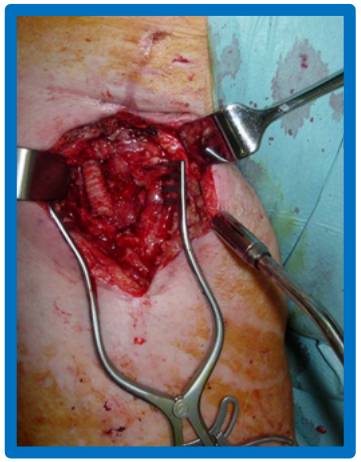
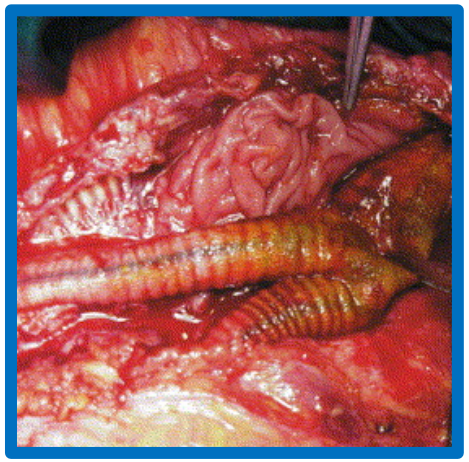
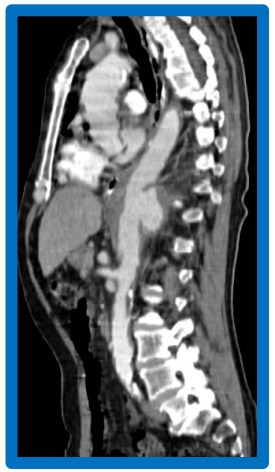
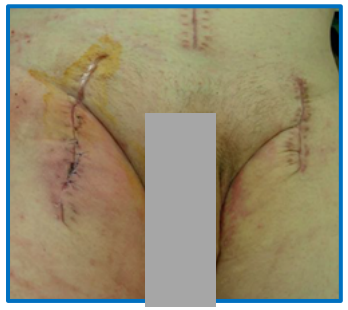
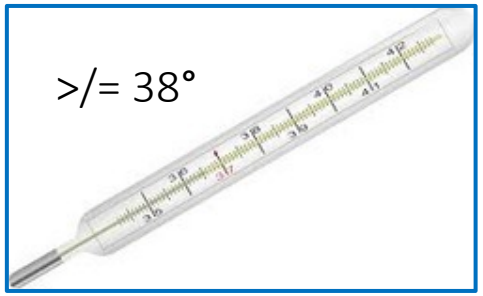
Eur J Vasc Endovasc Surg 2015; 49:581-585
J Vasc Surg 2006;44:38-45
Am J Surg 2010; 200: 47-52

VGEI diagnosis is challenging and no one gold standard

- Non specific FitzGerald criteria
  - Abdominal and Peripheral VGEI
- Modified Duke criteria to thoracic VGEIs with composite grafts
  - Thoracic aorta
- MAGIC CRITERIA
  - Aorta
- ESVS Guidelines “suggest” use of MAGIC criteria for VGEI
  - Abdominal and Thoracic Aorta, and peripheral

FitzGerald et al. Journal of Antimicrobial Chemotherapy 2005; 56, 996–999
Li et al. Clin Infect Dis. 2000; 30: 633-638
Lyons et al. Eur J Vasc Endovasc Surg 2016;52(6):758-763
Chakfe et al. Eur J Vasc Endovasc Surg 2020;59:339-84.

Management of Aortic Graft Infection Collaboration (MAGIC) Clinical/Surgical criteria

	CLINICAL / SURGICAL
MAJOR CRITERIA	• Pus (confirmed by microscopy) around graft or in aneurysm sac at surgery • Open wound with exposed graft or communicating sinus • Fistula development e.g. aorto-enteric or aorto-bronchial • Graft insertion in an infected site e.g. fistula, mycotic aneurysm or infected pseudoaneurysm
MINOR CRITERIA	• Localized clinical features of AGI e.g. erythema, warmth, swelling, purulent discharge, pain • Fever ≥38°C with AGI as most likely cause

Lyons et al. Eur J Vasc Endovasc Surg 2016;52(6):758-763
Dorigo et al. Eur J Vasc Endovasc Surg 2003, 26(5): 512-518

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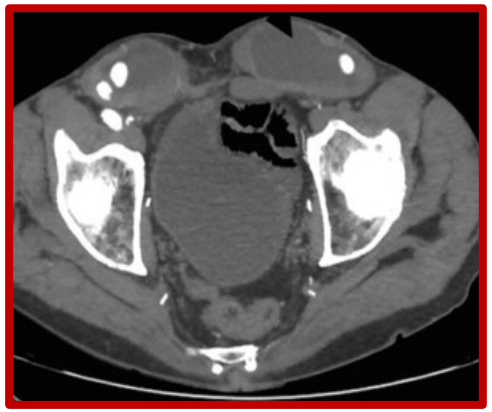
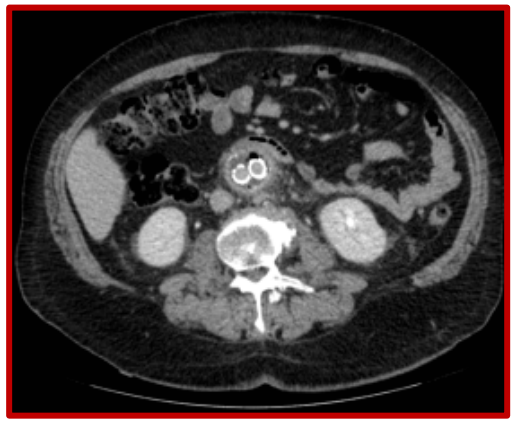
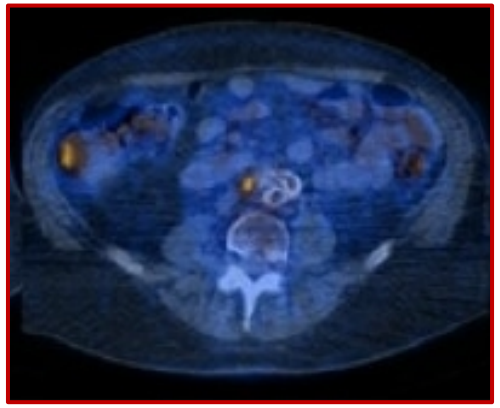
Management of Aortic Graft Infection Collaboration (MAGIC) Radiology criteria

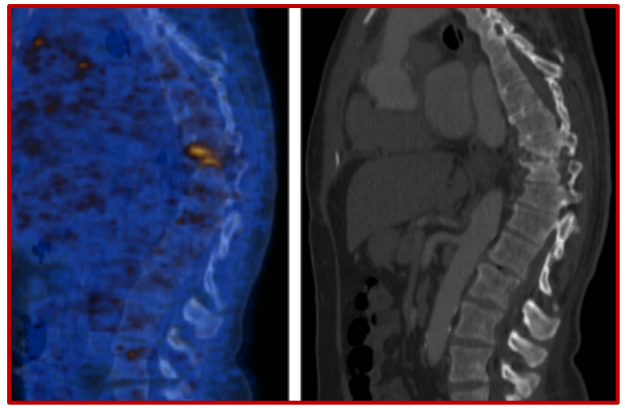




>/= 3 months

>/= 7 weeks



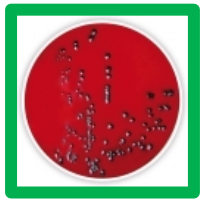


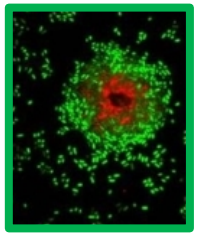
	RADIOLOGY
MAJOR CRITERIA	• Peri-graft fluid on CT scan ≥ 3 months after insertion • Peri-graft gas on CT scan ≥ 7 weeks after insertion • Increase in peri-graft gas volume demonstrated on serial imaging
MINOR CRITERIA	• Other e.g. suspicious peri-graft gas/fluid/soft tissue inflammation; aneurysm expansion; pseudoaneurysm formation; focal bowel wall thickening; discitis/ osteomyelitis; suspicious metabolic activity on FDG PET/ CT; radiolabelled leukocyte uptake

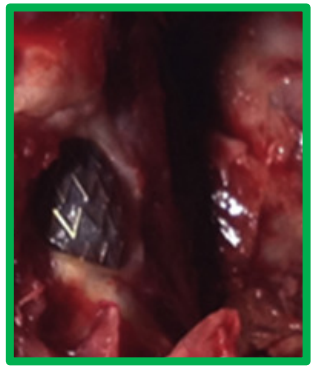
Lyons et al. Eur J Vasc Endovasc Surg 2016;52(6):758-763
Davila et al. J Vasc Surg 2015;62:877-83.
Vicareti, M. 2020, Vascular Graft Infections; https://doi.org/10.1007/978-3-030-43683-4_29

Management of Aortic Graft Infection Collaboration (MAGIC) Laboratory criteria

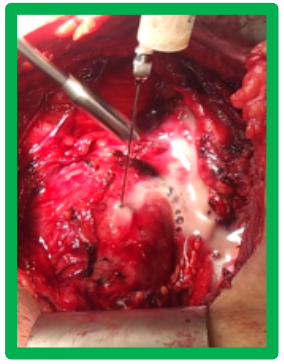
Organisms recovered from



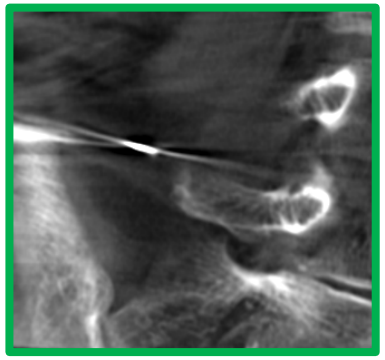




Explanted graft



Intra OP



Guided aspiration

	CLINICAL / SURGICAL	RADIOLOGY	LABORATORY
MAJOR CRITERIA			• Organisms recovered from an explanted graft • Organisms recovered from an intra-operative specimen • Organisms recovered from a percutaneous, radiologically-guided aspirate of peri-graft fluid
MINOR CRITERIA			• Blood culture(s) positive and no apparent source except AGI • Abnormally elevated inflammatory markers with AGI as most likely cause e.g. ESR, CRP, white cell count

Lyons et al. Eur J Vasc Endovasc Surg 2016;52(6):758-763
Spyros et al. Eur J Vasc Endovasc Surg 2019;57(1):149

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Management of Aortic Graft Infection Collaboration (MAGIC) criteria

	CLINICAL / SURGICAL	RADIOLOGY	LABORATORY
MAJOR CRITERIA	• Pus (confirmed by microscopy) around graft or in aneurysm sac at surgery • Open wound with exposed graft or communicating sinus • Fistula development e.g. aorto-enteric or aorto-bronchial • Graft insertion in an infected site e.g. fistula, mycotic aneurysm or infected pseudoaneurysm	• Peri-graft fluid on CT scan ≥ 3 months after insertion • Peri-graft gas on CT scan ≥ 7 weeks after insertion • Increase in peri-graft gas volume demonstrated on serial imaging	• Organisms recovered from an explanted graft • Organisms recovered from an intra-operative specimen • Organisms recovered from a percutaneous, radiologically-guided aspirate of peri-graft fluid
MINOR CRITERIA	• Localized clinical features of AGI e.g. erythema, warmth, swelling, purulent discharge, pain • Fever ≥38°C with AGI as most likely cause	• Other e.g. suspicious peri-graft gas/fluid/soft tissue inflammation; aneurysm expansion; pseudoaneurysm formation; focal bowel wall thickening; discitis/ osteomyelitis; suspicious metabolic activity on FDG PET/ CT; radiolabelled leukocyte uptake	• Blood culture(s) positive and no apparent source except AGI • Abnormally elevated inflammatory markers with AGI as most likely cause e.g. ESR, CRP, white cell count

- AGI is **diagnosed** if there is
  - one *major*

  AND
  - any criterion (*major* or *minor*) from another category.

- AGI is **suspected** if there is presence
  - a single *major* criterion

  OR
  - two or more *minor* criteria from different categories.

Lyons et al. Eur J Vasc Endovasc Surg 2016;52(6):758-763

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Management of Aortic Graft Infection Collaboration (MAGIC) criteria. Potential use as

Eur J Vasc Endovasc Surg (2016) 52, 758–763

Diagnosis of Aortic Graft Infection: A Case Definition by the Management of Aortic Graft Infection Collaboration (MAGIC)

O.T.A. Lyons [a,b], M. Baguneid [c,d], T.D. Barwick [e,f], R.E. Bell [a], N. Foster [g], S. Homer-Vanniasinkam [h,i], S. Hopkins [j], A. Hussain [k,l], K. Katsanos [m,n], B. Modarai [a,b], J.A.T. Sandoe [g,o], S. Thomas [p], N.M. Price [q,*]

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[e] Department of Radiology & Nuclear Medicine, Imperial College Healthcare NHS, London, UK
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[k] Public Health Laboratory Birmingham, National Infection Service, Public Health England, Birmingham, UK
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[q] Department of Infectious Diseases, Guy's & St Thomas' NHS Foundation Trust, London, UK

WHAT THIS PAPER ADDS

There is no universally accepted aortic graft infection case definition and clinical approaches to this complex condition differ widely with variable outcomes. Here, the Management of Aortic Graft Infection Collaboration (MAGIC), involving clinicians from several English hospital National Health Service Trusts with large vascular services, propose a formal case definition, derived by a process of multidisciplinary, expert consensus. The definition is readily applied in routine practice and aids early recognition. Importantly and towards development of evidence-based clinical guidelines that are presently lacking, it provides a consistent diagnostic standard, essential for clinical trial design and meaningful comparison between diagnostic and therapeutic strategies.

1. Practical diagnostic standard,
2. Essentials for comparing clinical management strategies,
3. Essentials for trial design,
4. Tool to develop evidence-based guidelines.

BUT, still requires validation

- that is planned in a multicenter, clinical service database supported by the Vascular Society of Great Britain & Ireland

Lyons et al. Eur J Vasc Endovasc Surg 2016;52(6):758-763

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Management of Aortic Graft Infection Collaboration (MAGIC) criteria. Validation for VGEI in the VASGRA study

Vascular Infection

Eur J Vasc Endovasc Surg (2021) 62, 251–257

EJVES Open Access

Editor's Choice – Validation of the Management of Aortic Graft Infection Collaboration (MAGIC) Criteria for the Diagnosis of Vascular Graft/Endograft Infection: Results from the Prospective Vascular Graft Cohort Study

Alexia Anagnostopoulos [a,,‡], Fabienne Mayer [a,‡], Bruno Ledergerber [a], Judith Bergadà-Pijuan [a], Lars Husmann [b], Carlos A. Mestres [c], Zoran Rancic [d], Barbara Hasse [a,*], the VASGRA Cohort Study**

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[b] Clinic for Nuclear Medicine, University Hospital Zurich, University of Zurich, Zurich, Switzerland
[c] Clinic for Cardiac Surgery, University Hospital Zurich, University of Zurich, Zurich, Switzerland
[d] Clinic for Vascular Surgery, University Hospital Zurich, University of Zurich, Zurich, Switzerland

WHAT THIS PAPER ADDS

The Management of Aortic Graft Infection Collaboration (MAGIC) criteria have been proposed as a novel diagnostic test for vascular graft/endograft infection (VGEI). The criteria were validated retrospectively in a prospective cohort of patients with definite and suspected vascular graft infections. For a definite VGEI diagnosis, the criteria had a good sensitivity but reduced specificity, owing to suspected VGEI. To improve the accuracy, further modifications of the criteria should be evaluated.

Retrospective analysis

- To validate the MAGIC criteria for VGEI diagnosis in VASGRA study
- To evaluate the accuracy of MAGIC criteria for a different VGEI location

Lyons et al. Eur J Vasc Endovasc Surg 2016;52(6):758-763
Anagnostopoulos et al. Eur J Vasc Endovasc Surg 2021; 62:251-257

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VASGRA: Prospective open observational cohort of patients after vascular graft surgery

VASGRA
Vascular Graft Cohort Study

Interdisciplinary approach

Vascular surgery, Infectious Disease Service, Microbiology, Radiology,

Surgical Pathology

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VASGRA: Prospective observational cohort of patients after vascular graft surgery

- >18 years
- vascular graft implantations
- Operated at UHZ
- 4.2013- 9.2019

Follow- up controls

REGULAR

- Image:
  - CECT
- Laboratory tests

VGEI Suspected Re-admission

- Image:
  - FDG PET/CT
  - CECT
  - CEPET/CT

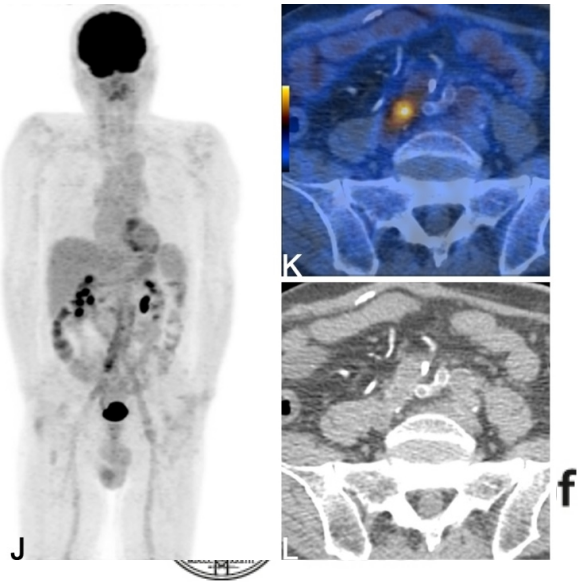
  (In 89% suspected/confirmed VGEI
  In 100% rejected VGEI)
- Laboratory (CRP, SE, WBC)
- Blood/tissue culture
- Serology, <u>if culture negative</u>

VASGRA
Vascular Graft Cohort Study

University of Zurich[UZH]

VASGRA Cohort Study and Definitions

- VEGI is **defined** as presence <u>at the least one of parameter in each category</u>
  - <u>Clinical</u> (*as MAGIC major criteria*) **AND**
  - <u>Imaging</u> CEPET/CECT with focal FDG activity AND at least one CT criterion(Fluid >/= 3months, Gas >/= 7 weeks after OP, fat stranding, and contrast enhancement); No cutoffs defined **AND**
  - <u>Laboratory</u> Positive blood cultures (two for contaminant pathogens; one for "non-contaminant pathogens") in a patient with a vascular graft.
    - PCR (Coxiella burnettii, Bartonella spp.) and Serology
    - Microorganisms shown on stain
    - Histopathological material
    - Elevated inflammatory markers (CRP, WBC)



VASGRA
Vascular Graft Cohort Study

Anagnostopoulos et al. Eur J Vasc Endovasc Surg 2021; 62:251-257
Husmann et al. Eur J Vasc Endovasc Surg 2015;49(4):455-64

VASGRA Cohort Study and Definitions

- VEGI is **suspected** as presence
  - Elevated inflammatory markers **AND**
  - Unexplained fluid collection without focal FDG uptake around the vascular graft (>/= 3 months after insertion)

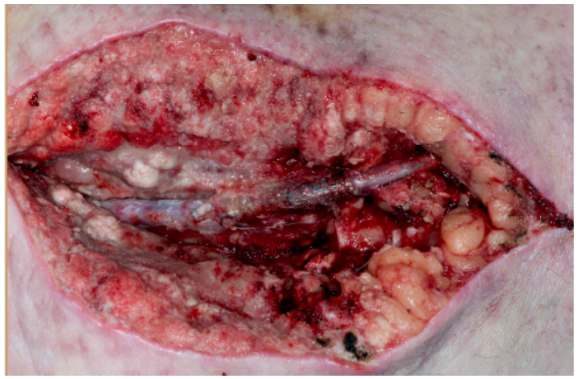
  OR
  - Positive blood cultures (two for contaminant pathogens; one for “non-contaminant pathogens”) in a patient with a vascular graft.

- **Control** patients
  - with the **same** graft site location, clinical visit, Labor, Imaging +/- 2 weeks

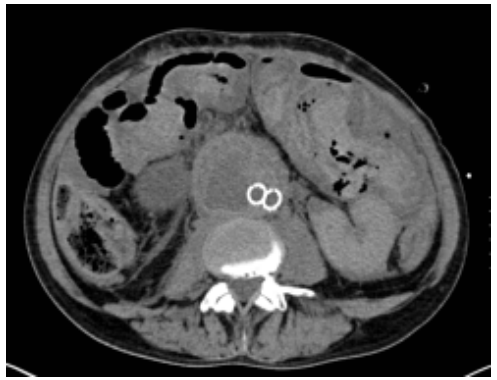
VASGRA Cohort Study: Patients and characteristics (257)

	DISEASED (137 patients)		NOT DISEASED (120 patients)		P value
	DEFINITE VGEI	SUSPECTED VGEI	REJECTED VGEI	Control Patients	
Number	135	2	35	85	
Male	114	2	31	668	
Emergency	33	0	8	4	<.001
Abdominal Aorta	52	2	31	66	<.001
Thoracic Aorta	44	0	2	10	<.001
Peripheral arteries	40	0	2	1	<.001

Samson II



Samson III-IV



Samson V

VASGRA Vascular Graft Cohort Study

Anagnostopoulos et al. Eur J Vasc Endovasc Surg 2021; 62:251-257
Samson RH, et al. JVS 1988; 8:147-53

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Distribution MAGIC criteria within VASGRA definite VGEI (135)

	VASGRA participants (n = 135)
MAGIC major criteria	
Pus (definite by microscopy) around graft or aneurysm sac at surgery	61 (45.2)
Open wound with exposed graft or communicating sinus	33 (24.4)
Fistula development, e.g., aorto-enteric or aortobronchial	30 (22.2)
Graft insertion in an infected site, e.g., fistula, mycotic aneurysm, or infected pseudo-aneurysm	31 (23.0)
Perigraft fluid on CT scan ≥ 3 months after insertion	43 (31.8)
Perigraft gas on CT scan ≥ 7 weeks after insertion	20 (14.8)
Increase in perigraft gas volume demonstrated on serial imaging	12 (8.9)
Microorganism recovered from an explanted graft	27 (20.0)
Microorganism recovered from an intra-operative specimen	92 (68.1)
Microorganism recovered from a percutaneous aspirate of perigraft fluid	12 (8.9)
MAGIC minor criteria	
Localised clinical features of VGEI, e.g., erythema, warmth, swelling, purulent discharge, and pain	69 (51.1)
Fever ≥ 38°C with VGEI as most likely cause	64 (47.4)
Other, e.g., suspicious perigraft gas/fluid/soft tissue inflammation; aneurysm expansion; pseudo-aneurysm formation; focal bowel wall thickening; discitis/osteomyelitis; suspicious metabolic activity on FDG PET/CT; radiolabelled leucocyte uptake	109 (80.7)
Blood culture(s) positive and no apparent source except for VGEI	51 (37.8)
Abnormally elevated inflammatory markers with VGEI as the most likely cause, e.g., ESR, CRP, and white cell count	126 (93.3)

Data are presented as n (%). CT = computed tomography; FDG PET/CT = fluorodeoxyglucose positron emission tomography/co
tomography; ESR = erythrocyte sedimentation rate; CRP = C reactive protein.

102/135 (75.6%) at least 2 major MAGIC criteria
- 27 (26.5%) all 3 MAGIC Categories
- 54.9% Clinical + Laboratory major
- 11.7% Clinical + Radiological major
- 6.9% Radiological + Laboratory major

24/135 (17.8%) 1 major + 1 minor MAGIC criteria
- 14 Clinical major
- 6 Radiological major
- 4 Laboratory major

8/135 (5.9%) 2 minor criteria from different categories

VASGRA Vascular Graft Cohort Study

Anagnostopoulos et al. Eur J Vasc Endovasc Surg 2021; 62:251-257

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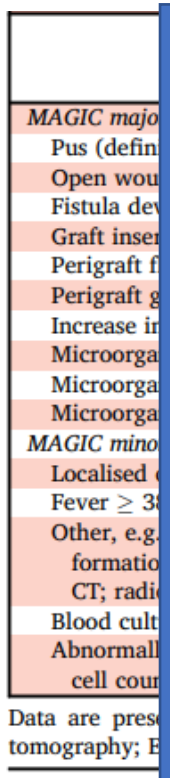
MAGIC criteria distribution within VASGRA definite VGEI (135)



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- 14 Clinical major
- 6 Radiological major
- 4 Laboratory major

8/135 (5.9%) 2 minor criteria from different category

1/135 (0.7%) "0" MAGIC criteria

→ **Confirmed** VGEI according to MAGIC

VASGRA Vascular Graft Cohort Study

Anagnostopoulos et al. Eur J Vasc Endovasc Surg 2021; 62:251-257

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MAGIC criteria distribution within VASGRA definite VGEI (135)

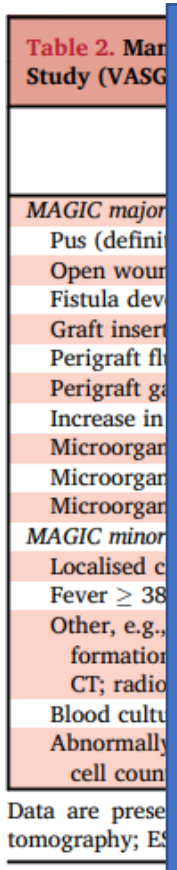
Table 2. Mar
Study (VASG

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Data are prese
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→ **Confirmed** VGEI according to MAGIC

→ **Suspected** VGEI according to MAGIC

→ **Rejected** VGEI according to MAGIC

VASGRA Vascular Graft Cohort Study

Anagnostopoulos et al. Eur J Vasc Endovasc Surg 2021; 62:251-257

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Comparison MAGIC and VASGRA status for definite VGEI

MAGIC adjudication	VASGRA adjudication				Total
	Confirmed VGEI	Suspected VGEI	Rejected VGEI	Control patients	
Confirmed VGEI	126 (93.3)	1 (50)	5 (14)	3 (3)	135 (52.5)
Suspected VGEI	8 (5.9)	1 (50)	25 (71)	14 (16)	48 (18.7)
Excluded VGEI	1 (0.7)	0 (0)	5 (14)	0 (0)	6 (2.3)
Control patients	0 (0)	0 (0)	0 (0)	68 (80)	68 (26.4)
Total					257 (100)

MAGIC and VASGRA definite VGEI (135)

126 (93.3%) in line and confirmed VGEI
5 (3.7%) was in VASGRA rejected
3 (2.2%) was in VASGRA control

1 (0.8%) was also suspected

VASGRA Vascular Graft Cohort Study

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Comparison MAGIC and VASGRA status for suspected VGEI (48)

MAGIC adjudication	VASGRA adjudication				Total
	Confirmed VGEI	Suspected VGEI	Rejected VGEI	Control patients	
Confirmed VGEI	126 (93.3)	1 (50)	5 (14)	3 (3)	135 (52.5)
Suspected VGEI	8 (5.9)	1 (50)	25 (71)	14 (16)	48 (18.7)
Excluded VGEI	1 (0.7)	0 (0)	5 (14)	0 (0)	6 (2.3)
				68 (80)	68 (26.4)
			100)	85 (100)	257 (100)

MAGIC and VASGRA suspected VGEI (48)

25/48 (52.1%) rejected by VASGRA

8/48 (16.6%) confirmed by VASGRA

14/48 (29.2%) control by VASGRA

1/48 (2.1%) was also suspected

Overtreatment: surgery and/or AB Tx, patients discomfort

Delay in surgery

Using the MAGIC criteria: 1.overestimation of suspected VGEI,
2. higher "diseased" patients 71.2%

VASGRA Vascular Graft Cohort Study

Anagnostopoulos et al. Eur J Vasc Endovasc Surg 2021; 62:251-257

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Comparison MAGIC and VASGRA status for rejected VGEI

MAGIC adjudication	VASGRA adjudication				Total
	Confirmed VGEI	Suspected VGEI	Rejected VGEI	Control patients	
Confirmed VGEI	126 (93.3)	1 (50)	5 (14)	3 (3)	135 (52.5)
Suspected VGEI	8 (5.9)	1 (50)	25 (71)	14 (16)	48 (18.7)
Excluded VGEI	1 (0.7)	0 (0)	5 (14)	0 (0)	6 (2.3)
Control patients	0 (0)	0 (0)	0 (0)	68 (80)	68 (26.4)
Total	135 (100)	2 (100)	35 (100)	85 (100)	257 (100)

MAGIC and VASGRA rejected VGEI (35)

into the suspected (25)
definite VGEI (5)

Further modifications are suggested

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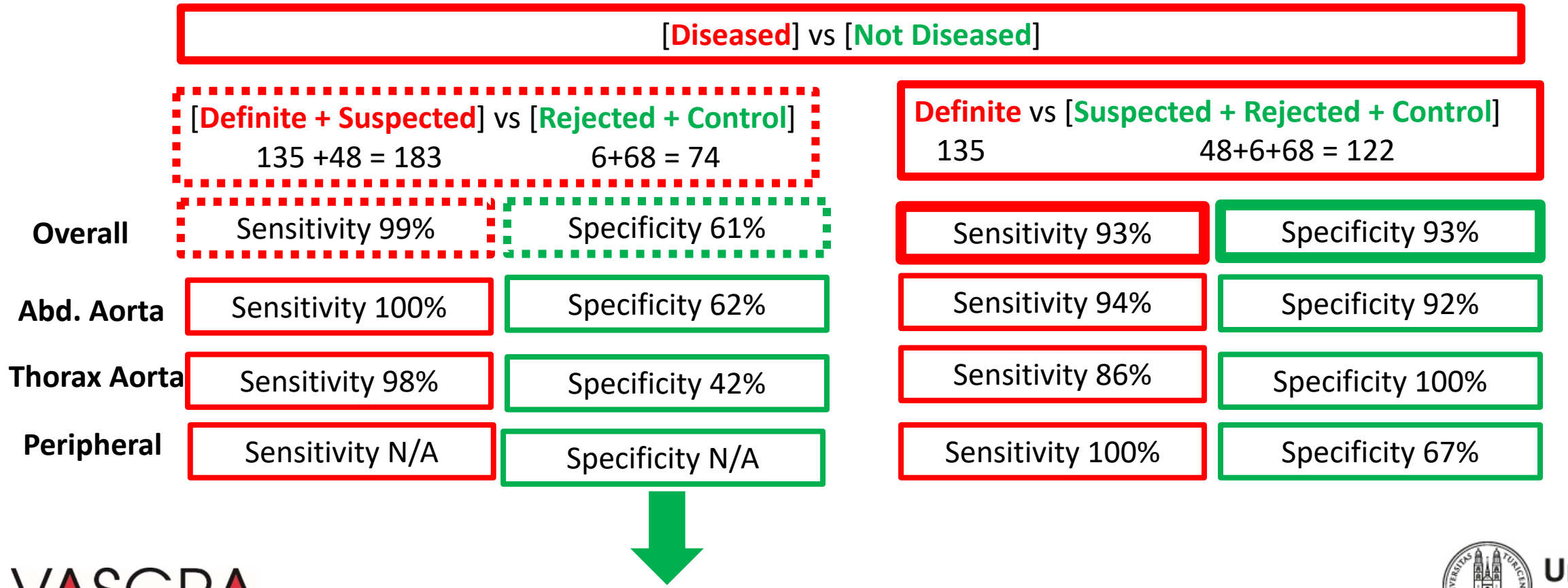
Accuracy of MAGIC criteria by graft location with/without VGEI

257 patients with/without VGEI

Composition of diseased and Not-diseased
If “suspected” is diseased: low specificity

Composition of diseased and Not-diseased
If “suspected” is Not diseased: high specificity



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Conclusion

1. The current MAGIC criteria offer good sensitivity and specificity in the context of true VGEI.

2. The current MAGIC criteria offer reduced specificity for a suspected VGEI.

3. To improve the accuracy, further modifications of the MAGIC criteria should be evaluated.

4. Despite of al criteria, the multidisciplinary management is a necessary for decision making

70TH ESCVS CONGRESS & 7TH IMAD MEETING

Validation of the management of aortic graft infection collaboration (MAGIC) criteria for the diagnosis of vascular graft/endograft infection

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