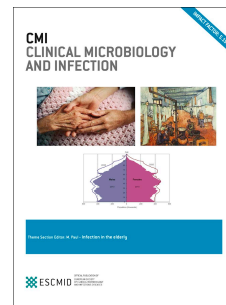


# Journal Pre-proof

## Treatment and Follow-up of Vascular Graft and Endograft Infection: Delphi Consensus Document

Ilse J.E. Kouijzer, Marta Hernández-Meneses, Erik H.J.G. Aarntzen, Jonas Ahl, Larry M. Baddour, Daniel C. DeSimone, Emanuele Durante Mangoni, Nuria Fernández-Hidalgo, Guillaume S.C. Geuzebroek, Efthymia Giannitsioti, Andor W.J.M. Glaudemans, Lars Husmann, Marco Merli, Carlos A. Mestres, Flaminia Olearo, Matthaios Papadimitriou-Olivgeris, Nis Pedersen Jørgensen, Andrés Perissinotti, Annibale Raglio, Zoran Rancic, Akshatha Ravindra, Benedikt Reutersberg, Leonardo Francesco Rezzonico, Marco Ripa, Petar Risteski, Alessandro Russo, Ben Saleem, Karl Sörelus, Dolores Sousa, Pierre Tattevin, Marjan Wouthuyzen-Bakker, Thomas R. Wyss, Xavier Yugueros, Alexander Zimmermann, Barbara Hasse



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1 **Treatment and Follow-up of Vascular Graft and Endograft Infection: Delphi Consensus Document**

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**1 ABSTRACT**

2

**3 Scope**

4 Vascular graft or endograft infection (VGEI) is a severe complication requiring a multidisciplinary approach  
5 combining surgery and antimicrobial therapy. This study aimed to develop expert consensus on the  
6 management and follow-up of VGEI, with a focus on antimicrobial strategies.

7

**8 Methods**

9 A modified Delphi method was conducted to reach consensus on key aspects of VGEI care, including  
10 antimicrobial treatment, surgical management, and follow-up. An expert panel representing infectious  
11 diseases, vascular and cardiothoracic surgery, microbiology, and nuclear medicine participated in four  
12 rounds of surveys. Ten general and 35 specific statements were rated using a five-point Likert scale.  
13 Statements with  $\geq 75\%$  agreement (agree/strongly agree) were considered to have achieved consensus.  
14 Internal consistency across rounds was assessed using Cronbach's alpha ( $>0.80$ ).

15

**16 Questions addressed by the Delphi method and Recommendations**

17 The panel agreed that empirical antimicrobial therapy should be initiated only in patients with complications  
18 (e.g., sepsis, bleeding) or when diagnostic intervention is delayed. Empirical therapy must be individualized  
19 based on graft location and risk factors. For abdominal VGEI without aorto-enteric fistula and unknown  
20 pathogens, initial coverage should target Gram-positive cocci, Gram-negative bacilli, and anaerobes, with  
21 consideration for MRSA/MRSE based on risk. For thoracic VGEI without fistula, Gram-positive coverage is  
22 prioritized, with optional MRSA coverage. Postoperative treatment duration should be individualized. In  
23 cases of complete graft removal and replacement with autologous veins, a 6-week antibiotic course is  
24 recommended, with early oral switch if bioavailable options are available. If prosthetic material remains, at  
25 least 4–6 weeks of intravenous therapy followed by oral treatment for a total of 12 weeks is advised.  
26 Prolonged therapy should be considered in cases with virulent pathogens, incomplete source control, or  
27 persistent inflammatory markers. The study provides practical, expert-based antimicrobial guidance for VGEI  
28 management and emphasizes the importance of individualized, microbiologically informed therapy within a  
29 multidisciplinary care framework.

30

**1 SCOPE**

2

3 This position paper provides consensus-based recommendations for the treatment and follow-up of patients  
4 with vascular graft and endograft infections (VGEI). VGEI represents a rare but life-threatening complication  
5 following open or endovascular procedures. The focus of this work is the selection, duration, and mode of  
6 administration of antimicrobial therapy, a domain where current evidence is limited and guidance in existing  
7 guidelines is often lacking.

8

9 This manuscript is intended for use by clinicians directly involved in the management of VGEI,  
10 including vascular and cardiothoracic surgeons, infectious disease specialists, microbiologists, radiologists,  
11 and nuclear medicine physicians. It is relevant across various care settings, particularly tertiary referral  
12 centers with expertise in multidisciplinary care for complex vascular infections. The recommendations apply  
13 to intra- and extracavitary VGEI, including scenarios with complications such as fistulas or bleeding, and  
14 cover empirical, targeted, suppressive, and curative antimicrobial strategies.

14

**15 CONTEXT**

16 Vascular graft or endograft infection (VGEI) is a serious complication following open or endovascular surgery.  
17 The incidence of VGEI is estimated at approximately 1–6%, and is expected to rise as vascular graft  
18 implantation becomes more common due to the increasing prevalence of atherosclerosis due to the aging of  
19 the population. Although the incidence is relatively low, the impact on patients is substantial, with morbidity  
20 and mortality rates exceeding 30%. Even after treatment, patients often experience long-term consequences  
21 (1,2). Effective management of VGEI requires a multidisciplinary team, including vascular and cardiothoracic  
22 surgeons, infectious diseases specialists, microbiologists, radiologists, and nuclear medicine physicians (3,4).  
23 The complexity and heterogeneity of VGEI—caused by differences in anatomical location, pathogen  
24 spectrum, and clinical presentation—pose significant challenges for standardizing therapy. Moreover, the  
25 lack of randomized controlled trials means most treatment decisions are based on retrospective series and  
26 expert opinion (5–13).

27

28 Previous guidelines have addressed the diagnosis and surgical management of VGEI but did not  
29 provide detailed, standardized recommendations for antimicrobial therapy (1,2). Moreover, available expert  
30 reviews are frequently single center in nature (9,14,15). This Delphi consensus survey was to develop  
31 international expert recommendations on antimicrobial treatment and follow-up in cases of VGEI.

31

**32 QUESTIONS ADDRESSED BY THE DELPHI PROCESS**

33 A core group of members from the European Society of Clinical Microbiology and Infectious Diseases Implant  
34 group (ESGIAI) developed 45 questions, primarily aimed at supporting clinical decision-making on the

1 treatment and follow-up strategies for patients with confirmed or suspected VGEI. The questions developed  
2 covered a range of scenarios relevant to antimicrobial decision-making, surgical treatment and follow-up.  
3 The target population includes adult patients with intra- or extra-cavitary VGEI, with or without  
4 complications such as fistulas or sepsis. The resulting recommendations aim to harmonize care, especially in  
5 complex cases lacking high-level evidence.

## 6 7 **METHODS**

### 8 **Study design**

9 A thorough review of the VGEI literature in PubMed was conducted. We included observational studies  
10 (both retrospective and prospective) and case series examining antimicrobial treatment, surgical strategies  
11 and follow-up of abdominal, peripheral and thoracic VGEI. Evidence from the literature was limited,  
12 particularly regarding comparisons of different antibiotic regimens, treatment durations, and surgical  
13 strategies. Hence, to reach consensus on optimal antimicrobial therapy, surgical management, and follow-up  
14 strategies for VGEI, a modified Delphi method (16,17) was developed following the DelphiStar  
15 recommendations (18). This structured approach was chosen since it systematically captures expert opinions  
16 across disciplines and effectively identifies areas of agreement and disagreement, making it well suited to  
17 address our research question.

### 18 19 **Panel**

20 The expert panel included specialists in cardiothoracic surgery, vascular surgery, infectious diseases,  
21 microbiology, as well as dual board-certified physicians in radiology and nuclear medicine. Members of the  
22 ESGIAI core group nominated candidates with clinical and/or research experience in VGEI from various  
23 countries. VGEI experts were defined as clinicians actively managing VGEI cases and/or researchers with at  
24 least five years of experience and at least one PubMed-indexed publication in the field. Efforts were made to  
25 ensure broad international representation and a diverse range of expertise. Gender was not used as a  
26 selection criterion. Experts were informed about the survey and invited via email individually to guarantee  
27 anonymity. Those who did not participate after receiving a reminder email were excluded from the Delphi  
28 study.

### 29 30 **Delphi survey**

31 The core group developed the initial questionnaire through iterative expert discussions informed by the  
32 literature review. The Delphi survey was conducted via an online platform ([www.surveymonkey.com](http://www.surveymonkey.com)) from  
33 June to December 2024. Panelists rated each statement using a five-point Likert scale (1 = strongly agree, 2 =  
34 agree, 3 = neutral, 4 = disagree, 5 = strongly disagree), with an additional option to select 6 = abstain. A

1 comment field was provided to suggest modifications. Four iterative rounds were planned a priori. In each  
2 round, both the invited panelists and the core group rated all statements and could provide anonymous  
3 feedback. Each round concluded either when all panelists had responded or after three weeks. Aggregated  
4 feedback was summarized across expert groups, including Cronbach's alpha values for overall agreement  
5 and by domain. Consensus was defined as  $\geq 75\%$  of panelists rating a statement as "strongly agree" or  
6 "agree." Final consensus strength was further supported by a Cronbach's alpha  $> 0.80$ .

7 Panelists were not restricted to selecting a single antibiotic regimen per clinical scenario; rather,  
8 they could indicate multiple appropriate options via open-text responses. The initial list of therapeutic  
9 regimens was generated by the core study group based on expert opinion. Following each Delphi round, this  
10 list was revised based on panel feedback, including free-text suggestions, to ensure that the final consensus  
11 reflected the collective expertise and judgment of the full panel.

### 12 13 **Definitions**

14 Diagnosing VGEI is challenging and requires an expert multidisciplinary approach. We employed the  
15 Management of Aortic Graft Infection Collaboration (MAGIC) criteria (19), which use a syndromic approach,  
16 categorizing clinical, radiological, and laboratory findings as 'Major' or 'Minor' to define suspected or  
17 confirmed VGEI. Intracavitary VGEI relates to graft infection in the aortic arch, abdominal and thoracic aortic  
18 interposition, aorto-iliac, aortofemoral, and iliofemoral. To evaluate the extent of infection in extracavitary  
19 VGEI, we also employed the Samson criteria (20). Samson Stage I was defined as a superficial infection at the  
20 vascular graft site. Stage II referred to a deep infection at the graft site. Stage III was defined as VGEI  
21 involving the graft body, while Stage IV indicated infection affecting both the graft body and its anastomosis.  
22 Stage V represented the most severe form, involving both the graft body and anastomosis, accompanied by  
23 bleeding or bacteremia. Suppressive antimicrobial therapy (SAT) was defined as the administration of  
24 antimicrobial therapy for a long period of time or potentially life-long without a fixed duration.

### 25 26 **Statistics**

27 Data analysis involved summarizing and evaluating the data using descriptive statistics. After each round, the  
28 internal consistency of the assessment tool was measured using Cronbach's alpha coefficient, which reflects  
29 the level of correlation among a set of items, ranging from 0 (no consistency) to 1 (perfect consistency). In  
30 round four, consensus was defined as a Cronbach's alpha value greater than 0.80. Item-rest correlations  
31 were calculated using Pearson correlation coefficients between the score of each item and the mean score  
32 of the remaining items within its domain using Stata's alpha command. If negative correlations were  
33 observed, these items were flagged for closer review and discussion during subsequent rounds, and their  
34 interpretation was carefully re-evaluated by the expert panel. No items were excluded solely based on item-

1 rest correlation values. Categorical variables were reported as proportions (%). We conducted data analyses  
2 using Stata 18.0 SE (StataCorp, College Station, TX, USA).

## 4 RESULTS

### 6 Delphi survey results

7 A summary of the Delphi process is illustrated in a flowchart (**Figure 1**). A total of 46 experts from Europe  
8 and North America were invited to participate in the Delphi survey, with 35 ultimately accepting the  
9 invitation. A total of 35 experts participated in all four Delphi rounds, with no dropouts throughout the  
10 process. In the first round, the survey included 10 general statements or recommendations and 35 Delphi  
11 survey statements. For round 2, revisions were made based on feedback from the previous round, resulting  
12 in 10 general statements or recommendations and 34 Delphi survey statements. Rounds 3 and 4 each  
13 consisted of 10 general statements or recommendations and 35 Delphi survey statements, which included  
14 the following main topics: antimicrobial therapy (n=22), surgical management (n=8) and follow-up in VGEI  
15 (n=5). The internal consistency of responses increased over time, as reflected by Cronbach's alpha values:  
16 0.8405 in Round 1, 0.9173 in Round 2, 0.9381 in Round 3, and 0.9204 in Round 4, indicating a growing and  
17 ultimately strong consensus within the panel.

18 Overall, the Delphi process facilitated increased consensus in most domains, with agreement  
19 improving notably between Round 1 and Round 4, particularly in surgical management and targeted  
20 antimicrobial therapy. In Round 4, surgical management ( $\alpha = 0.86$ ) and targeted therapy ( $\alpha = 0.83$ ) domains  
21 showed high reliability, while the empirical therapy domain ( $\alpha = 0.56$ ) demonstrated lower internal  
22 consistency, highlighting the need for further discussion or additional evidence-based guidance.

### 24 General statements on VGEI

25 The final general statements are summarized in **Table 1**. Management of VGEI should be done in referral  
26 centers equipped with multidisciplinary expertise (8,9). Moreover, the experts suggested specific measures  
27 for diagnostic aspects, including blood cultures, intraoperative tissue cultures, and molecular diagnostic  
28 techniques. If surgery is not performed, consider direct puncture of the aneurysm sac or perigraft tissue for  
29 sampling (21).

### 31 Antimicrobial therapy (Table 2, Q1-22)

32 Statements on antimicrobial therapy (**Table 2**) reached consensus ( $\geq 79.1\%$  agreement) across all items.

### 34 General principles

1 If diagnostic cultures are required, then ideally antimicrobial therapy should be withheld until blood cultures  
2 and direct samples from the infected area have been obtained (84%). This strategy minimizes the use of  
3 unnecessary broad-spectrum antibiotics—thereby reducing the risk of resistance and adverse drug effects—  
4 while ensuring that treatment is based on reliable microbiological data for targeted therapy (3) (**Table 2**, Q1-  
5 3).

### 6 ***Empirical therapy***

8 Empirical therapy should be guided by the anatomical location of the graft and the presence of fistula (97%)  
9 (**Table 2**, Q4-8). For abdominal VGEI without an aorto-enteric fistula, empirical therapy should cover a broad  
10 spectrum, including Gram-positive cocci, Gram-negative bacilli, and anaerobes, with consideration for MRSA  
11 and MRSE based on local epidemiology and risk factors (82%). In thoracic VGEI, therapy should similarly  
12 target Gram-positive cocci, with MRSA coverage recommended if local prevalence is high (82%). Infections  
13 with aorto-enteric or aorto-esophageal fistulas require more extensive coverage, including Gram-positive  
14 and Gram-negative bacteria, anaerobes, MRSA, and fungi, due to the polymicrobial composition of  
15 gastrointestinal or bronchial flora; though, consensus for this was slightly lower (77%), likely reflecting the  
16 need for individualized risk assessment. For extracavitary VGEI, empirical therapy should cover Gram-  
17 positive cocci and Gram-negative bacilli, with potential MRSA coverage depending on risk factors.  
18 Colonization status (know MRSA carriage) may influence the initial empirical treatment decision. However,  
19 this strategy was not well supported (70%).

### 21 ***Targeted therapy***

22 Despite the overall convergence, several statements remained contentious throughout multiple rounds  
23 and consistently failed to reach agreement and showed negative item-rest correlations in the later rounds,  
24 reflecting persistent divergence in expert opinion (3). Optimal antimicrobial therapy varies among  
25 institutions and epidemiological scenarios. Recommendations for pathogen-specific regimens (**Tables S5–S9**)  
26 only reached consensus for VGEI due to Staphylococci (76%), whereas the results for Enterococci (74%),  
27 Streptococci (74%), Enterobacterales (71%) and *Pseudomonas aeruginosa* (76%) were less clear (4). The  
28 addition of rifampicin in staphylococcal VGEI was only conditionally supported for use (79%), while deemed  
29 unnecessary if an autologous vein graft is used (74%).

### 31 ***Duration of antimicrobial therapy and suppressive therapy***

32 Although there is neither consensus in the literature nor any randomized studies conducted to define the  
33 ideal antimicrobial therapy duration after total graft removal, the expert panel generally supported an initial  
34 treatment period of one to two weeks of intravenous antibiotics, followed by a transition to oral therapy for

1 a total duration of 6 weeks. In more severe cases, a longer (four to six weeks) course of intravenous  
2 antibiotics was recommended. Some pathogens (e.g., non-tuberculous mycobacteria, *Coxiella burnetii*,  
3 *Brucella* spp.) may require prolonged antimicrobial durations independent of surgical management

4 The panelists also recognized that certain high-risk patients, such as those who are non-surgical  
5 candidates, may require prolonged treatment with some cases potentially necessitating lifelong suppressive  
6 therapy. These findings reflect the complexity and variability of VGEI management, where treatment  
7 duration should be individualized based on patient condition, infection severity, response to therapy, and  
8 the extent of surgery which might range from no surgery (22,23) to drainage, partial explantation or  
9 complete explantation.

#### 11 **Recommendations on surgical management (Table 3, Q1-8)**

12 The study concluded that patients diagnosed with VGEI should receive care managed by a multidisciplinary  
13 team in tertiary care referral centers, with the surgical approach tailored to the individual patient. This  
14 approach is in line with current guidelines (1,18,19). Panelists emphasized the importance of early and  
15 thorough debridement, followed by graft removal and in situ reconstruction (24). While consensus on  
16 surgical management was relatively high, perspectives on the extent of surgical intervention remained  
17 diverse. Panelists acknowledged that aggressive surgical strategies may not always be appropriate,  
18 particularly in older, high-risk patients with significant comorbidities (25,26). The role of debridement with  
19 graft preservation or partial graft removal in selected intracavitary (thoracic or abdominal) VGEI cases  
20 without fistulae (85%) suggests cautious optimism about conservative surgical strategies, provided that close  
21 follow-up is ensured.

22 Several key surgical considerations achieved moderate to high consensus, indicating substantial but  
23 not absolute agreement. The preference for autologous or biological grafts when revising infected vascular  
24 grafts (85%) highlights a shift towards using non-synthetic materials, which may offer lower reinfection  
25 rates. However, evidence for the use of autologous grafts is mainly based on studies in abdominal VGEI and  
26 less in thoracic VGEI (13,27,28).

27 The use of the Samson criteria (17) for staging extracavitary VGEI further facilitated the classification  
28 of infection severity (2). These stages provide a standardized framework for clinicians to assess the extent of  
29 infection and tailor interventions accordingly. However, while the Samson criteria were well accepted in  
30 extracavitary VGEI by the expert panel (88%) the application of these stages in clinical practice in abdominal  
31 and thoracic VGEI may require further validation through prospective studies.

#### 33 **Recommendations on Imaging and follow up (Table 4, Q1-5)**

34 Almost unanimous agreement was found in considering contrast-enhanced CT (CE-CT) as the preferred

1 imaging modality for monitoring VGEI (29). Accurate imaging interpretation requires surgical details and  
2 multidisciplinary discussion. A baseline post-surgical CE-CT after one week is recommended, followed by  
3 scheduled follow-ups at 3 and 6 months, even in asymptomatic patients. According to the MAGIC case  
4 definition, key CT findings classified as major criteria include the presence of peri-graft fluid persisting  
5 beyond 3 months after graft insertion, peri-graft air observed more than 7 weeks post-procedure, and an  
6 increase in peri-graft gas volume on sequential imaging studies (16).

7 [18F]FDG PET/CT plays a well-established role in the evaluation of VGEI, offering precise anatomical  
8 localization and extension of infection, guidance for diagnostic sampling, and assessment of associated  
9 complications. The use of hybrid imaging should also be considered, especially in the context of low-grade  
10 infections (30). Although not part of our Delphi survey, false-positive results may occur, particularly in the  
11 early postoperative period, due to non-infectious causes such as sterile inflammation, hematomas, or  
12 lymphoceles (31). Furthermore, diffuse FDG uptake can persist for months or even years after surgery,  
13 especially when prosthetic materials are involved, which may complicate interpretation in the absence of  
14 clinical suspicion (31,32,33,34). [18F]FDG PET/CT has an increasingly important role in the diagnosis and  
15 follow up of VGEI after treatment (35). There was unanimous (100%) agreement on the importance of a  
16 structured but flexible follow-up plan to monitor for relapsing infection and potential complications such as  
17 fistula formation. Clinical, laboratory, and imaging assessments should be integrated into a multidisciplinary  
18 approach to guide decisions on discontinuing antimicrobial therapy versus continuing treatment with re-  
19 evaluation if infection persists.

## 21 **Limitations**

22 Despite the valuable insights gained, several limitations must be acknowledged. While the Delphi method is  
23 effective for generating expert consensus, it cannot substitute for randomized controlled trials or large-scale  
24 studies, which remain essential for validating the panel's recommendations. Moreover, the high Cronbach's  
25 alpha values for the last three rounds could be interpreted as a sign of redundancy of statements. As this  
26 study was initiated by infectious disease specialists and its focus was on antimicrobial therapy, the  
27 composition of the panel was not well balanced for all specialties involved and country representation.  
28 Another limitation is the absence of an interventional radiologist on the panel, despite the critical role this  
29 specialty plays in CT-based diagnosis and image-guided biopsy. Furthermore, the lack of patient data  
30 prevents a direct assessment of how these treatment strategies affect clinical outcomes. This Delphi  
31 consensus study did not address the discontinuation of suppressive antimicrobial therapy (SAT), and thus  
32 provides no standardized criteria for when or how SAT might be safely stopped. In clinical practice, decisions  
33 regarding the cessation of SAT remain at the discretion of the treating physician and are based on individual  
34 patient factors. Furthermore, the consensus did not include recommendations regarding the use of follow-

1 up imaging—such as PET/CT scans—or other monitoring strategies during SAT. As such, fixed duration  
2 endpoints or standardized follow-up protocols could not be established. These areas represent important  
3 knowledge gaps and warrant future investigation.

4

#### 5 **Conclusion**

6 This Delphi consensus study offers evidence-informed guidance for managing VGEI, addressing key  
7 knowledge gaps through expert agreement. It emphasizes the heterogeneity of VGEI presentation, the  
8 importance of early diagnosis using multimodal strategies, and individualized antimicrobial therapy based on  
9 microbiology and clinical context. Surgical decisions should balance infection severity and patient risk, with  
10 graft removal considered selectively. Given the lack of robust trial data, these expert-driven  
11 recommendations provide a practical framework to optimize outcomes. The study also underscores the  
12 need for multidisciplinary collaboration and identifies priorities for future research to improve care for this  
13 complex condition.

14

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2

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5

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8

9 **Contribution:** IK and BH conceptualized the study. All authors formulated the general statements and  
10 recommendations for the Delphi survey. IK set up the online questionnaire. IK, BL and BH performed data-  
11 analysis. IK and BH wrote the first draft of the manuscript. All authors critically reviewed the manuscript.

12

13 **Updating**

14 This Delphi survey is part of an initiative to support the development of the planned ESCMID guidelines on  
15 the topic. There are no plans to repeat the survey.

16

17

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1 **Table 1. General statements on VGEI management**

	<b>Statements</b>
<b>1</b>	Management of VGEI should be done in referral centers equipped with multidisciplinary expertise, including vascular and aortic surgeons, infectious disease specialists, microbiologists, radiologists, nuclear medicine specialists, and pharmacists. Other specialties should be consulted depending on the anatomical location of the VGEI (e.g gastrointestinal surgeon or angiologist).
<b>2</b>	Healthcare providers should assess the severity and extent of infection, as these are critical factors in determining appropriate treatment strategies and management plans for patients with VGEI.
<b>3</b>	Identifying source control interventions with curative intent is essential to reduce reliance on long-term suppressive therapy and improve outcomes.
<b>4</b>	Due to the lack of consensus on antimicrobial therapy and its duration in VGEI, international expert agreement is essential to standardize and optimize treatment strategies.
<b>5</b>	Healthcare providers should obtain blood cultures (at least 2-3 sets prior to antimicrobial therapy) in all suspected VGEI cases, regardless of the presence of systemic symptoms including fever.
<b>6</b>	Systematically collecting intraoperative specimens (3-5 deep samples: periprosthetic samples (fluid and tissue) and the graft itself (several fragments, at least from the proximal and distal end)) and ideally one for histopathology is important.
<b>7</b>	If tissue or blood cultures yield negative results within 3-5 days, performing molecular diagnostic techniques (16s PCR or metagenomics sequencing, if available) and serology for culture-negative pathogens is recommended.
<b>8</b>	According to investigations for culture-negative pathogens, it should include at least <i>Coxiella burnetii</i> , <i>T. whipplei</i> , non-tuberculous mycobacteria, <i>Bartonella</i> spp, <i>Brucella</i> spp (according to local epidemiology and exposure risk).
<b>9</b>	If the patient does not undergo surgical intervention, then direct puncture of aneurysm sac or perigraft tissue should be considered.
<b>10</b>	Administer targeted intravenous antimicrobial therapy promptly upon identification of a microbiological pathogen. If possible, prioritize an antimicrobial regimen effective against biofilm.

2

3

1 **Table 2. Final consensus statements after round 4 for antimicrobial therapy in VGEI**

2

No.	Statement	Consensus round 4	Strength of recommendation
<b>Antimicrobial therapy in general</b>			
1	Antimicrobial therapy for VGEI should generally be withheld unless there is a complication (sepsis, bleeding), or if the intervention including tissue cultures cannot be performed within the next few days.	88%	Strong recommendation
2	In case no surgery is planned in VGEI, start antimicrobial therapy after obtaining blood cultures and local samples, always ensuring that every effort has been made to obtain the highest quality samples possible.	84%	Strong recommendation
3	When empirical antimicrobial therapy for VGEI is necessary, such as in cases of sepsis, it should be tailored to patient-specific factors. These factors include the location of the graft (thoracic, abdominal, or peripheral), the presence or suspicion of fistulas, and the local resistance patterns of pathogens.	97%	Strong recommendation
<b>Empirical antimicrobial therapy</b>			
4	In cases of abdominal VGEI <u>without</u> an aorto-enteric fistula and with an unidentified bacterial pathogen, initial antimicrobial therapy should encompass coverage for Gram-positive cocci, Gram-negative bacilli, and obligate anaerobic bacteria. Depending on risk factors and epidemiological factors, empirical coverage for MRSA and MRSE should be considered. Potential options are provided in Table S1, but consultation with infectious diseases specialists is highly recommended.	82%	Strong recommendation
5	In cases of thoracic VGEI <u>without</u> an aorto-esophageal fistula and with an unidentified bacterial pathogen, initial antimicrobial therapy should encompass coverage for Gram-	82%	Strong recommendation

	positive cocci. Depending on risk factors and epidemiological considerations, empirical coverage for MRSA should be considered. Potential options are provided in Table S2, but their selection should be made in consultation with infectious diseases specialists.		
6	In cases of abdominal VGEI <u>with</u> an aorto-enteric fistula or thoracic VGEI <u>with</u> an aorto-esophageal fistula and an unidentified bacterial pathogen, initial antimicrobial therapy should encompass coverage for Gram-positive cocci, Gram-negative bacilli, obligate anaerobic bacteria. Depending on risk factors and epidemiological factors, empirical coverage for MRSA and fungi should be considered. Potential options are provided in Table S3, but consultation with infectious diseases specialists is recommended.	77%	Conditional recommendation
7	In cases of extracavitary/peripheral VGEI with an unidentified bacterial pathogen, initial antimicrobial therapy should include coverage for Gram-positive cocci and Gram-negative bacilli. Depending on location of the graft, risk factors and epidemiological considerations, empirical coverage for MRSA should be considered. Potential options are provided in Table S4, but should be chosen in consultation with infectious diseases specialists.	79%	Conditional recommendation
8	In all infections caused by <i>S. aureus</i> , it may be beneficial to note that if antimicrobial therapy is initiated for MRSA coverage, particularly in regions with a high prevalence of MRSA, obtaining nasal/oral/groin swabs for culture/PCR for MRSA is recommended. This allows for de-escalation of therapy in non-colonized patients or confirmation of the necessity for continued therapy.	70%	Conditional recommendation against
<b>Targeted antimicrobial therapy</b>			
9	In cases of staphylococcal VGEI, the addition of rifampicin is considered unnecessary when reconstructing with an autologous venous graft.	74%	Conditional recommendation for either the intervention or the comparison

<b>10</b>	In cases of staphylococcal VGEI, if the addition of rifampicin is considered, it should only occur after achieving source control, confirming the absence of active bacteremia, and ensuring no upcoming surgical procedures are planned. Rifampicin must be administered in combination with another antibiotic effective against staphylococci to prevent resistance. It is also important to consider the potential risk of drug-drug interactions associated with rifampicin use.	79%	Conditional recommendation
<b>11</b>	The pathogen-specific therapy for staphylococcal VGEI is depicted in Table S5.	76%	Conditional recommendation
<b>12</b>	The pathogen-specific therapy for enterococcal VGEI is depicted in Table S6.	74%	Conditional recommendation
<b>13</b>	The pathogen-specific therapy for streptococcal VGEI is depicted in Table S7.	74%	Conditional recommendation
<b>14</b>	The pathogen-specific therapy for VGEI due to Enterobacterales is depicted in Table S8.	71%	Conditional recommendation
<b>15</b>	The pathogen-specific therapy for VGEI due to <i>P. aeruginosa</i> is depicted in Table S9.	76%	Conditional recommendation
<b>16</b>	Consider adding intravenous Fosfomycin (if available in the country) in cases of VGEI due to MDR-GNB. The recommended dose is 12-18g/day divided into 4 doses, this might be increased up to 24g/day in cases of sepsis in consultation with infectious diseases specialists.	53%	Conditional recommendation against
<b>Duration of antimicrobial therapy</b>			
<b>17</b>	The duration of postsurgical antimicrobial therapy in VGEI should be tailored to each individual patient, taking into account the surgical approach, microbiological specimen findings, and response to treatment (clinically, laboratory, and/or imaging).	97%	Strong recommendation
<b>18</b>	When removing and replacing the vascular graft with an autologous vein, a 6-week course of antibiotic therapy is recommended. The need for a minimum duration of IV is not supported by any literature. If highly bioavailable oral drugs are available, therapy may be switched to oral as soon as feasible.	91%	Strong recommendation

<b>19</b>	After conducting an appropriate source control intervention and if a prosthetic graft remains, it is advisable to administer a minimum of 4-6 weeks of intravenous therapy, followed by oral treatment (treatment in total at least 12 weeks). If treatment with antibiotics of high bioavailability and significant efficacy against biofilm is possible, transition to oral administration could occur before 6 weeks of intravenous therapy. In cases where virulent microorganisms are present or in situ reconstruction with extensive infection, or in the basis of an indolent postoperative course and the lack of normalization of the C-reactive protein during follow-up, antimicrobial therapy may be prolonged.	82%	Strong recommendation
<b>20</b>	In the absence of an appropriate source control intervention (see surgical management), it is recommended to administer intravenous therapy for a minimum of 1-2 weeks, followed by long-term suppressive therapy if clinical stability of the patient and control of acute local signs of infection are achieved.	79%	Conditional recommendation
<b>Suppressive antimicrobial therapy</b>			
<b>21</b>	Rifampicin should be discontinued in the context of long-term SAT due to the risk of resistance development and toxicity.	76%	Conditional recommendation
<b>22</b>	After an initial period of IV antimicrobial therapy and in the absence of any surgical intervention, consider long-term suppressive antimicrobial therapy (SAT) with the following antimicrobials (Table S10).	79%	Conditional recommendation

1 Consensus: green >80%, orange 75-80%, red <75%

2

1 **Table 3. Final consensus statements after round 4 for surgical management in VGEI**

2

No.	Statement	Consensus round 4	Strength of recommendation
1	The selection of surgical treatment for VGEI should be individualized to each patient, considering factors such as age, comorbidities, clinical condition, and location of the graft. It is important to promptly assess whether the approach will be conservative or serve as a bridge to surgery, as well as to determine the timing of surgery.	97%	Strong recommendation
2	When revising VGEI, it is advisable to use an autologous graft (vein) or biological graft (e.g. surgeon-made bovine pericardial graft, cryopreserved allograft) as the preferred choice, taking into account the location of the VGEI and the specific surgical issues on an individualized basis.	85%	Strong recommendation
3	The staging of extracavitary/peripheral vascular graft infection according to the Samson classification is important for coordinating management, including antimicrobial and surgical treatment. However, the exact staging is not always entirely clear which might be a limitation.	88%	Strong recommendation
4	For extracavitary/peripheral VGEI of Samson stage III, debridement with graft preservation is deemed an appropriate source control measure in selected patients (e.g. patients without sepsis, with patent grafts and intact anastomosis, and with pathogens with a favorable susceptibility pattern).	74%	Conditional recommendation
5	For any type of extracavitary/peripheral VGEI Samson IV-V, graft excision and in situ reconstruction or graft excision and extra-anatomic reconstruction are deemed appropriate source control measures. In previously thrombosed grafts without any clinical significance (asymptomatic) and currently infected, graft excision without any other vascular reconstruction should be considered.	77%	Conditional recommendation
6	In abdominal and peripheral VGEI, whenever possible, graft excision and in situ reconstruction should be preferred over graft excision and extra-anatomic reconstruction in order to reduce long-term complications	79%	Strong recommendation

	(aortic stump rupture, graft stenosis, graft occlusion, leakage, rupture, necessity of repeat surgeries).		
7	In selected cases intracavitary (thoracic or abdominal) VGEI <u>without fistula</u> , debridement with graft preservation could be considered. However, close follow-up is essential, with consideration given to graft excision if there is inadequate progress.	85%	Strong recommendation
8	The absence of any form of surgical intervention (such as debridement with graft preservation, graft excision within situ reconstruction, or extra-anatomic revascularization) should prompt consideration for long-term suppressive treatment for all types of VGEI taking into account patient's preference. However, it might be reasonable to attempt a curative treatment effort with a defined duration from the outset (depending on specific factors like comorbidities, duration of infection, relation of infection to primary surgery, isolated microorganism, antimicrobial susceptibility, and tolerance to antibiotics).	91%	Strong recommendation

1 Consensus: green >80%, orange 75-80%, red <75%

2

1 **Table 4. Final consensus statements after round 4 for follow-up in VGEI**

2

No.	Statement	Consensus round 4	Strength of recommendation
1	The preferred initial imaging method for monitoring VGEI with a replaced graft is contrast-enhanced computed tomography (CE-CT). Consider also the possibility of performing a hybrid [18F]FDG-PET/CE-CT in selected cases when available.	100%	Strong recommendation
2	Consider separate [18F]FDG-PET/CT or combined with CE-CT as an additional imaging modality for the follow-up of VGEI especially in low-grade infection and unclear or discordant CE-CT results with high clinical suspicion of VGEI.	100%	Strong recommendation
3	For accurate interpretation of [18F]FDG uptake in [18F]FDG-PET/CT scans, both in terms of pattern and intensity several months after implantation, it is necessary to provide the radiologist/nuclear medicine specialist with details from the operating room report and information regarding the materials and surgical adhesives used. Multidisciplinary discussion is highly important.	100%	Strong recommendation
4	Following all forms of surgical treatment, it is advisable to undergo contrast-enhanced CT to establish baseline imaging. Recommended intervals for post-discharge imaging at 3 and 6 months, followed by yearly assessments thereafter if the patient remains asymptomatic and exhibits normal laboratory test results (white blood cell count and C-reactive protein).	97%	Strong recommendation
5	Before discontinuing antimicrobial therapy, conduct a clinical examination, white cell blood count, C-reactive protein tests, and contrast-enhanced CT imaging. Follow with a multidisciplinary conference and consider [18F]FDG PET/CT if necessary. If signs of infection persist, continue antimicrobial therapy for at least three more months, then re-evaluate using the above criteria. In cases where surgical intervention was deemed appropriate for source control, consider imaging or clinical examination, along with CRP levels and	97%	Strong recommendation

	white blood cell counts, to determine if treatment cessation is warranted.		
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1 Consensus: green >80%, orange 75-80%, red <75%

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Journal Pre-proof

Figure 1. Process of the Delphi study

