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Abiotrophia defectiva endocarditis implicated in antineutrophil cytoplasmic antibody-negative glomerulonephritis

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SUMMARY

We report a rare case of antineutrophil cytoplasmic antibody (ANCA)-negative pauci-immune necrotising glomerulonephritis (PING) in *Abiotrophia defectiva* (*A. defectiva*) endocarditis. A woman in her 50s presented to the hospital with acute kidney injury (AKI), pancytopenia, microscopic haematuria, proteinuria and maculopapular rash. She had *A. defectiva* sepsis and endocarditis. Serologies were positive for antinuclear antibody and low complement components 3 and 4 but negative for ANCA. A kidney biopsy revealed PING with minimal focal crescents, fibrinoid necrosis and tubulointerstitial fibrosis. She was managed with antibiotics and mitral valve replacement alone. Haemodialysis (HD) was initiated briefly until renal recovery. She remained in complete remission after 2 years. This case illustrates the complex immune response to bacterial endocarditis resulting in ANCA-negative PING. The appropriate use of antibiotics and surgical intervention without immunosuppression in *A. defectiva* endocarditis led to the resolution of AKI and maculopapular rash.

BACKGROUND

Pauci-immune necrotising glomerulonephritis (PING) is one of the subcategories of small-vessel vasculitis that can lead to rapidly progressive glomerulonephritis and acute kidney injury (AKI). Renal injury results in focal glomerular necrosis and extracapillary proliferation with minimal or lack of immune complex deposits. Most PING cases are associated with antineutrophil cytoplasmic antibody (ANCA) targeting antigens either myeloperoxidase (MPO) or proteinase 3 antibodies (PR3) as detected by indirect immunofluorescence assay (IIF).[1] However, cases of ANCA-negative PING associated with infection, specifically infective endocarditis (IE), have been reported.[2 3] Majority of IE-associated PING cases involve *Staphylococcus aureus* and *Streptococcus*. *A. defectiva* is a rare *Streptococcus* variant, first described in 1961[4], which is implicated in the minority of IE and rarely with PING.

The first case of *A. defectiva* IE-associated HLH without PING highlighted the aggressive and unpredictable nature of the bacteria.[5] Another unique case reported was that of *A. defectiva* aortic valve (AV) and mitral valve (MV) IE leading to the development of ANCA-positive PING without HLH.[6] The histological extent of the activity and chronicity of PING in the previous case is unknown. In both cases, antibiotics, immunosuppression and valve replacement led to the improvement of the disease state.

Here, we present a rare case of AKI in a patient who contracted *A. defectiva* sepsis leading to the development of IE and ANCA-negative PING. To our knowledge, this is the first case of ANCA-negative PING triggered by *A. defectiva* endocarditis managed with medical and surgical interventions without immunosuppression.

CASE PRESENTATION

A woman in her 50s with a history of depression and hypertension presented to our hospital with AKI and pancytopenia. She reported a 3-month history of unintentional 13.6 kg weight loss and generalised weakness along with a 1-month history of rash on both arms and legs. She denied recent dental work, travel or illicit drug abuse. She was taking sertraline 50 mg daily and stopped lisinopril several months prior to the presentation due to hypotension. Her physical examination was notable for holosystolic murmur and maculopapular rash (figure 1A). She had a fever of 38.8°C 1 day after admission.

INVESTIGATIONS

The initial laboratory test revealed a white cell count of 2.6×10^9/L, haemoglobin of 87 g/L, platelet count of 78×10^9/L, creatinine level of 236 mmol/L, urinalysis red blood cell count of >100/hpf and urine protein-to-creatinine ratio of 1409 mg/g (table 1). Her creatinine level was 59.2 mmol/L 3 months prior to admission.

Abdominal ultrasound (US) demonstrated splenomegaly measuring 20.4 cm but no hydronephrosis. On hospital day 4, bone marrow biopsy was performed, and the pathological examination revealed normocellular marrow showing trilineage haematopoiesis with an adequate number of megakaryocytes. A skin biopsy was not performed.

Her renal function continued to worsen, and a thorough workup was performed (table 2). Serologies were remarkable for positive antinuclear antibody (ANA) and low complement components (C3, 49 mg/dL; C4, 17 mg/dL), whereas anti-double-stranded DNA, anti-Smith antibody and ANCA were negative (table 2). A renal biopsy was performed, and on hospital day 7, renal pathology findings resulted. Light microscopy revealed cellular crescents and fibrinoid necrosis in 2 out of 16 glomeruli and 5%–10% tubulointerstitial fibrosis without immune complex deposits, segmental glomerulosclerosis, endocapillary proliferation or

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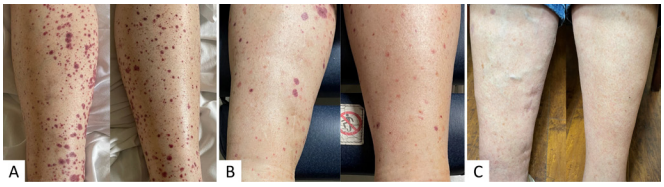

Figure 1 Maculopapular rash of the lower extremities. (A) Right and left lower extremities on admission. (B) Right and left lower extremities on postoperative day 3 of mitral valve replacement (hospital day 21). (C) Right and left lower extremities on 3 months after hospital discharge.

acute tubular necrosis. There were scattered red blood cell casts. The arterioles were unremarkable. The interlobular arteries and large-sized arteries showed mild intimal fibrosis (figure 2). Immunofluorescence showed trace irregular mesangial staining for C3 but no staining for IgA, IgG, IgM, C4, C1q, fibrinogen, albumin, kappa or lambda. No subepithelial, subendothelial or mesangial immune complex deposits were found on electron microscopy.

Coronavirus SARS-CoV-2 PCR, hepatitis A antibody, hepatitis B surface antigen, hepatitis C antibody and HIV were negative (table 2). Blood cultures initially grew Gram-positive cocci. Transesophageal echocardiogram (TEE) confirmed a 0.8 × 0.6 cm mobile vegetation and severe MV regurgitation. CT scan of the head did not reveal septic emboli, whereas CT scan of the abdomen and pelvis without contrast was negative for hepatic or splenic abscess.

DIFFERENTIAL DIAGNOSIS

The presence of maculopapular rash signifies a serious medical condition. The initial differential diagnoses can be categorised into drug-induced, haematological, infectious and rheumatological. The timing of the maculopapular rash did not coincide with the duration of her medication. Thrombotic microangiopathy in the setting of anaemia and AKI was considered initially, but coagulation studies, lactate dehydrogenase and haptoglobin were unremarkable. Blood smear did not reveal any schistocytes either. Since there was a high suspicion of a rheumatological aetiology, ANCA-associated vasculitis, systemic lupus erythematosus and mixed cryoglobulinaemia were in the differential diagnosis. Most of her serologies, however, were negative, except for positive ANA and low C3 and C4. Several infectious causes of rash were also unremarkable including COVID-19, hepatitis A, B and C and HIV. After the initial blood cultures grew Gram-positive cocci, streptococcal infection or bacterial endocarditis were the final differential diagnosis of her rash. Renal biopsy was pursued to determine an accurate diagnosis of her AKI. Once there was evidence of an MV vegetation on TEE and the final blood cultures detected *A. defectiva*, the rash and AKI were the most likely consequences of IE.

TREATMENT

Vancomycin 750 mg daily and ceftriaxone 2 g daily were initiated after her initial blood cultures grew Gram-positive cocci. The antibiotics were changed to vancomycin 750 mg daily alone on day 8 of hospitalisation after the final blood culture grew *A. defectiva*. The vancomycin trough levels were closely monitored to avoid further AKI. She did not receive immunosuppressants. HD was started when her creatinine level reached 331.6 mmol/L (table 1).

On day 18, she had MV replacement. The pathological evaluation of the MV leaflet identified benign vascular tissue with patchy acute inflammation and fibrin deposit. The rash and renal function started improving after MV replacement (figure 1B, table 1). A repeat TEE, 6 days postoperatively, confirmed a well-seated bioprosthetic valve without regurgitation. HD was discontinued on day 28 due renal recovery. On discharge day, her creatinine was 145 mmol/L (table 1). Vancomycin 750 mg daily was continued for an additional 2 weeks postdischarge.

OUTCOME AND FOLLOW-UP

Her condition improved clinically after addressing the IE with antibiotics and MV replacement (table 1). The rash completely resolved 3 months postdischarge (figure 1C). There were no pancytopenia, microscopic haematuria or proteinuria after hospitalisation while her renal function remained stable at 21 months (table 3). While her splenomegaly was still evident on a follow-up abdominal US prior to her discharge, it fully recovered in 2 years based on abdominal US.

DISCUSSION

Our patient presented with AKI in the setting of *A. defectiva* IE-associated ANCA-negative PING. *A. defectiva* is a nutritional

Table 1 Timeline of haematology and chemistry results during hospitalisation

Lab	Admit	Day 1	Day 2	Day 4	Day 6	Day 8	Day 16	Day 18	Day 21	Day 25	Day 28	Day 34
WBC	2.6	2.1	2.0	2.9	5	2.5	2	4.9	2.5	22.7	3.4	4.1
Hb	87	71	78	73	76	78	84	84	79	91	90	91
Plt	78	78	88	108	151	107	26.2	89	96	143	170	298
ANC	1.6	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	21.3	2.7	3.3
ALC	0.6	0.4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.6	0.4	0.6
BUN	13.2	11.8	12.1	11.4	12.7	6.78	6.07	5.36	4.29	6.43	9.64	5.36
Cr	236	218.4	225.5	267	331.6	258.2	337.8	334.2	220.2	207.8	221.1	145
Alb	26	26	23	23	24	21	22	23	27	25	28	31
Event	Labs	Fever GPC Abx	Echo MV IE	BM BX	First HD Kidney BX	A. defectiva Vanco	Start G-CSF Neg BC	MV Surg	Rash better	G-CSF stopped	HD stopped	d/c Home

Laboratory units and range: WBC, 4.5–11×10^9/L; Hb, 117–155 g/L; Plt, 150–450×10^9/L; ANC, 1.8–7.7× 10^3/mcl; ALC, 1.0–4.8× 10^3/mcl; BUN, 2.5–8.92 mmol/L; Cr, 53–106 mmol/L; Alb, 35–57 g/L.

Abx, antibiotics; Alb, albumin; ALC, absolute lymphocyte count; ANC, absolute neutrophil count; BMBX, bone marrow biopsy; BUN, blood urea nitrogen; BX, biopsy; Cr, creatinine; d/c, discharge; G-CSF, granulocyte-colony stimulating factor; GPC, Gram-positive cocci; Hb, haemoglobin; HD, hemodialysis; IE, infective endocarditis; MV, mitral valve; n/a, not available; Neg BC, negative blood culture; Plt, platelet; Surg, surgery; Vanco, vancomycin; WBC, white blood cell.

Table 2 Additional haematology, chemistry, serology and infectious disease workup

Haematology and chemistry	
Albumin (35–57 g/L)	26
C reactive protein (≤ 9.9 g/L)	19.4
Fibrinogen (5.5–13.1 µmol/L)	5.6
Ferritin (11–306.8 µg/mL)	837.8
Haptoglobin (0–25.3 µmol/L)	7.44
Lactate dehydrogenase (2.33–4.52 µkat/L)	4.65
Reticulocyte relative (0.5%–1.5%)	1.73
International normalised ratio (0.8–1.1)	1.14
Prothrombin time (11–13 s)	12.2
Partial thromboplastin time (25–33 s)	31.7
Autoimmune serologies	
Antinuclear antibody (ANA)	Positive
ANA immunofluorescence antibody	Negative
Anticardiolipin antibody immunoglobulin G (<15 GPL)	<15
Anticardiolipin antibody immunoglobulin M (<13 MPL)	23
Antineutrophil cytoplasmic antibody (ANCA)	
Atypical ANCA (<1:20)	<1:20
Cytoplasmic ANCA (<1:20)	<1:20
Anti-proteinase three antibodies (0.0–0.9)	<0.2
Perinuclear ANCA (<1:20)	<1:20
Anti-myeloperoxidase antibodies (0.0–0.9)	<0.2
Anti-double-stranded DNA antibody (0–9 IU/mL)	<1
Anti-Smith antibody (0–9 AI)	<0.2
Beta-2 glycoprotein one antibody, IgM (0–32 GPI IgM units)	20
C3 complement (87–200 mg/dL)	49
C4 complement (19–52 mg/dL)	17
Cryoglobulin, Q1, reflex	Negative
Rheumatoid factor	Negative
Serum protein electrophoresis with immunofixation	No monoclonal gammopathy
Sjogren's anti-SSA (0.0–0.9 AI)	<0.2
Infectious disease workup	
Blood culture	*Abiotrophia defectiva*
Coccidioides immitis antibodies	
Immunoglobulin G	Positive
Immunoglobulin M	Negative
Coccidioides antibodies by complement fixation (<1:2)	Negative
Coronavirus SARS-CoV-2 PCR	Negative
Hepatitis A immunoglobulin M	Non-reactive
Hepatitis B surface antibody	Reactive
Hepatitis B surface antigen	Non-reactive
Hepatitis C antibody	Non-reactive
HIV p24 antigen direct	Non-reactive
HIV 1/2 antibody direct	Non-reactive
Urine culture	Mixed flora

variant of *Streptococcus* that resides in oropharyngeal, gastrointestinal and genitourinary tracts.[7] It is implicated in 5% of all IE cases. *A. defectiva* has high predilection for endovascular tissue, and the AV and MV are equally affected.[7 8] Besides heart failure and valvular structural damage caused by IE, it can cause embolic renal infarction and glomerulonephritis leading to AKI.[6 9] The mortality of *A. defectiva* IE is similar to viridans group streptococci (9.2% vs 9.6%, respectively).[10]

ANCA is detected by IIF targeting MPO and PR3 expressed in neutrophils and monocytes.[1] The central theme in the

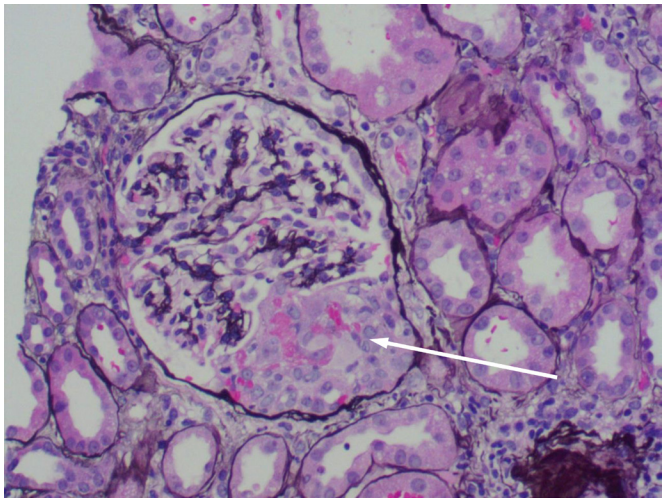

Figure 2 Kidney biopsy. Light microscopy shows a glomerulus with cellular crescents and fibrinoid necrosis (white arrow). There are no immune complex deposits, segmental glomerulosclerosis, endocapillary proliferation or acute tubular necrosis. There is no vasculitis in the arteriole. Periodic acid-Schiff, Jones and trichome stains were used.

pathogenesis of ANCA PING is the priming and activation of neutrophils causing degranulation thereby triggering a proinflammatory response causing additional recruitment of monocytes inducing tissue damage.[1] The alternative complement system can further prime and activate neutrophils, and hypocomplementaemia (low C3) is observed in the majority of IE-associated glomerulonephritis.[1 11] Bacterial infection can lead to the development of IE-associated glomerulonephritis, and molecular mimicry can play a role.[11 12] We postulated that IE triggered an autoimmune response through molecular mimicry. This mechanism occurs when a foreign source, in this case an infection, triggered an immune response against self-antigens by possessing antigenic similarity to self-antigens in susceptible individuals, inducing autoimmunity.[13] Most of the reviewed literature describing the clinical and histological observations of IE are associated with ANCA-positive PING.[14] In 10% of cases, ANCA is negative despite having similar histological features with ANCA-positive PING.[15] In spite of IIF high sensitivity and

Table 3 Timeline of haematology and chemistry results after hospitalisation

Lab	4 months postdischarge	9 months postdischarge	21 months postdischarge
WBC	5	5.3	5.5
Hb	126	140	153
Plt	160	171	164
BUN	9.28	7.14	6.78
Cr	90.2	78.7	76
Alb	44	46	44
UPCR	95	72	n/a
UACR	n/a	n/a	< 4
Urinalysis RBC	none	none	none

Laboratory units and range: WBC, 4.5–11 x 10^9/L; Hb, 117–155 g/L; Plt, 150–450 x 10^9/L; BUN, 2.5–8.92 mmol/L; Cr, 53–106 mmol/L; Alb, 35–57 g/L; UPCR, <200 mg/g; UACR, <30 mcg/g Cr.
Alb, albumin; BUN, blood uread nitrogen; Cr, creatinine; Hb, haemoglobin; n/a, not available; Plt, platelet; RBC, red blood cell; UPCR, urine protein/creatinine ratio; WBC, white blood cell count.

low false negativity in detecting ANCA, other unknown autoantibodies targeting different antigens are not detected.[3 16]

There are similarities and differences in the clinical presentation and histological findings for both ANCA-positive and ANCA-negative PING. While the initial serum Cr level on presentation is similar in both ANCA-associated PING, the Cr level is higher in infection-associated ANCA-negative PING compared with primary, malignancy and drug-related ANCA-negative PING.[3 17] Patients with infection-related ANCA-negative PING are older men presenting with nephrotic proteinuria and *S. aureus* bacteraemia.[3] More cellular crescents, severe interstitial fibrosis and lower percentage of normal glomeruli are observed in ANCA-negative glumerulonephritis.[17] Infection is the most common cause of death, leading to high mortality in infection-related ANCA-negative PING.[3]

A. defectiva IE often leads to a higher rate of valve replacement.[10] Only one case report described *A. defectiva* IE of both the AV and MV resulting in positive ANCA-PR3 PING requiring immunosuppressants to stabilise renal function prior to valvular replacements.[6] What is unique about our case compared with the previous case is the reporting of a favourable renal histology and her clinical response to antibiotics and surgical intervention alone without immunosuppression.

A. defectiva is difficult to eradicate and must be treated aggressively with antibiotics and early surgical intervention of IE based on clinical guidelines.[18] While the susceptibility testing of *A. defectiva* is difficult to perform in clinical microbiology laboratories due to its fastidious growth requirements, there are also susceptibility differences across antimicrobial and geographical regions of the USA.[19] Additionally, our local microbiology laboratory was unable to perform susceptibility testing of *A. defectiva*. The Infectious Disease Society of America recommends treating *A. defectiva* IE with penicillin (MIC >0.5 µg/mL) with the combination of ampicillin and gentamicin or vancomycin alone (class IIa; level of evidence C).[20] Since *A. defectiva* was least susceptible to penicillin in a large nationwide cohort, it was decided to treat IE with vancomycin alone for 6 weeks.[19] Vancomycin trough levels were drawn regularly to ensure the effective dose is delivered while limiting the risk of developing nephrotoxicity.

Currently, there are no previous case reports of *A. defectiva* IE-associated ANCA-negative PING to guide our management, hence the importance of using renal biopsy to guide treatment. Her age, sex and lower Cr level on presentation portends better survival.[3] Her renal prognosis was good based on the histological findings of higher normal glomeruli, absence of IgG deposits, minimal C3 deposits, minimal focal crescents, minimal necrosis and tubulointerstitial fibrosis, and lack of evidence of vasculitis on arterioles and interlobular arteries—these findings reflect minimal chronic renal damage from active autoimmune activity.[1 15 17] We also based our therapy on her favourable clinical presentation. Immunosuppression was not administered since it could have increased her risk for mortality from infection.[3] Her clinical course improved over time, and she remained disease-free after 2 years.

In summary, *A. defectiva*-associated ANCA-negative PING is a rare clinical disorder. We believe that it triggered a vasculitis response through the activation of a complex immune process reaching a minimum threshold to develop PING without ANCA detection. The decision to start immunosuppression can be challenging in infection-associated PING and should be determined on an individualised case presentation. In our case, treating the main infectious culprit resulted in full clinical recovery. As more cases are published in the future, we hope that there will be clinical guidelines on the management of infection-related ANCA-negative PING.

Patient's perspective

It started with weight loss, nausea, inability to eat, shortness of breath, fatigue, resting heart rate over 100, low blood pressure even after I quit taking lisinopril for hypertension. I also experienced hair loss, anaemia, overall weakness and a rash on extremities. After being sick for months, enduring many tests and specialist visits, I was not getting any answers. When I was admitted to the hospital with kidney failure, this led to more tests and consultation with specialists, and finally a diagnosis. After a 5 week in-patient stay, open heart surgery for mitral valve replacement, medications and dialysis, I was released with a healthy, grateful heart and two functioning kidneys.

Learning points

- *Abiotrophia defectiva* is implicated in 5% of all infective endocarditis cases.
- In 10% of cases, antineutrophil cytoplasmic antibody (ANCA) is negative despite having similar histological features with ANCA-positive pauci-immune necrotising glomerulonephritis (PING).
- Infection is the most common cause of death, leading to high mortality risk in infection-related ANCA-negative PING.
- A favourable renal histology of ANCA-negative PING can respond to antibiotics alone.
- Initiating immunosuppressive medications in infection-associated ANCA-negative PING should be based on individual clinical data.

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REFERENCES

1 Geetha D, Jefferson JA. ANCA-Associated Vasculitis: Core Curriculum 2020. *Am J Kidney Dis* 2020;75:124–37.

2 Ying C-M, Yao D-T, Ding H-H, *et al*. Infective endocarditis with antineutrophil cytoplasmic antibody: report of 13 cases and literature review. *PLoS ONE* 2014;9:e89777.
3 Ronsin C, Georges M, Chapelet-Debout A, *et al*. ANCA-Negative Pauci-immune Necrotizing Glomerulonephritis: A Case Series and a New Clinical Classification. *Am J Kidney Dis* 2022;79:56–68.
4 Frenkel A, Hirsch W. Spontaneous Development of L Forms of Streptococci requiring Secretions of Other Bacteria or Sulphydryl Compounds for Normal Growth. *Nature New Biol* 1961;191:728–30.
5 Kiernan TJ, O'Flaherty N, Gilmore R, *et al*. Abiotrophia defectiva endocarditis and associated hemophagocytic syndrome--a first case report and review of the literature. *Int J Infect Dis* 2008;12:478–82.
6 Elashery AR, Stratidis J, Patel AD. Double-Valve Heart Disease and Glomerulonephritis Consequent to Abiotrophia defectiva Endocarditis. *Tex Heart Inst J* 2020;47:35–7.
7 Carleo MA, Del Giudice A, Viglietti R, *et al*. Aortic Valve Endocarditis Caused by Abiotrophia defectiva: Case Report and Literature Overview. *In Vivo* 2015;29:515–8.
8 Okada Y, Kitada K, Takagaki M, *et al*. Endocardiac infectivity and binding to extracellular matrix proteins of oral Abiotrophia species. *FEMS Immunol Med Microbiol* 2000;27:257–61.
9 Li J, Zhou L, Gong X, *et al*. *Abiotrophia Defectiva* as a Rare Cause of Mitral Valve Infective Endocarditis With Mesenteric Arterial Branch Pseudoaneurysm, Splenic Infarction, and Renal Infarction: A Case Report. *Front Med (Lausanne)* 2022;9:780828.
10 Lancaster I, Patel D, Tamboli C, *et al*. *Abiotrophia defectiva* Infective Endocarditis: A Rare and Dangerous Cause of Endocarditis. *Case Rep Infect Dis* 2022;2022:7050257.
11 Boils CL, Nasr SH, Walker PD, *et al*. Update on endocarditis-associated glomerulonephritis. *Kidney Int* 2015;87:1241–9.
12 Kain R, Exner M, Brandes R, *et al*. Molecular mimicry in pauci-immune focal necrotizing glomerulonephritis. *Nat Med* 2008;14:1088–96.
13 Rojas M, Restrepo-Jiménez P, Monsalve DM, *et al*. Molecular mimicry and autoimmunity. *J Autoimmun* 2018;95:100–23.
14 Van Gool IC, Kers J, Bakker JA, *et al*. Antineutrophil cytoplasmic antibodies in infective endocarditis: a case report and systematic review of the literature. *Clin Rheumatol* 2022;41:2949–60.
15 Eisenberger U, Fakhouri F, Vanhille P, *et al*. ANCA-negative pauci-immune renal vasculitis: histology and outcome. *Nephrol Dial Transplant* 2005;20:1392–9.
16 Csernok E, Ahlquist D, Ullrich S, *et al*. A critical evaluation of commercial immunoassays for antineutrophil cytoplasmic antibodies directed against proteinase 3 and myeloperoxidase in Wegener's granulomatosis and microscopic polyangiitis. *Rheumatology (Oxford)* 2002;41:1313–7.
17 Chen M, Yu F, Wang SX, *et al*. Antineutrophil cytoplasmic autoantibody-negative Pauci-immune crescentic glomerulonephritis. *J Am Soc Nephrol* 2007;18:599–605.
18 Otto CM, Nishimura RA, Bonow RO, *et al*. 2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation* 2021;143:e35–71.
19 Prasidthrathsint K, Fisher MA. Antimicrobial Susceptibility Patterns among a Large, Nationwide Cohort of Abiotrophia and Granulicatella Clinical Isolates. *J Clin Microbiol* 2017;55:1025–31.
20 Baddour LM, Wilson WR, Bayer AS, *et al*. Infective Endocarditis in Adults: Diagnosis, Antimicrobial Therapy, and Management of Complications: A Scientific Statement for Healthcare Professionals From the American Heart Association. *Circulation* 2015;132:1435–86.