**Abstract**

**Background:** *Lactococcus garvieae* is an unusual cause of infective endocarditis (IE). No current diagnostic and therapeutic guidelines are available to treat IE caused by these organisms. Based on a case report, we provide a review of the literature of IE caused by *L. garvieae* and highlight diagnostic and treatment challenges of these infections and implications for management.

**Case presentation:** A 50-year-old Asian male with mitral prosthetic valve presented to the hospital with intracranial haemorrhage, which was successfully treated. Three weeks later, he complained of generalized malaise. Further work up revealed blood cultures positive for Gram-positive cocci identified as *L. garvieae* by MALDI-TOF. An echocardiogram confirmed the diagnosis of IE. Susceptibility testing showed resistance only to clindamycin. Vancomycin plus gentamicin were started as empirical therapy and, subsequently, the combination of ceftriaxone plus gentamicin was used after susceptibility studies were available. After two weeks of combination therapy, ceftriaxone was continued as monotherapy for six additional weeks with good outcome.

**Conclusions:** Twenty-five cases of IE by *Lactococcus garvieae* have been reported in the literature. Compared to other Gram-positive cocci, *L. garvieae* affects more frequently patients with prosthetic valves. IE presents in a subacute manner and the case fatality rate can be as high as 16%, comparable to that of streptococcal IE (15.7%). Reliable methods for identification of *L. garvieae* include MALDI-TOF, 16S RNA PCR, API 32 strep kit and BD Automated Phoenix System. Recommended antimicrobials for *L. garvieae* IE are ampicillin, amoxicillin, ceftriaxone or vancomycin in monotherapy or in combination with gentamicin.

**Keywords:** Lactococcus, Case report, Gram positive cocci, Infective endocarditis, Diagnosis, Treatment, Risk factors

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**Background**

*Lactococcus garvieae* are Gram-positive cocci previously considered part of the genus *Streptococcus*. In 1985, these organisms were classified within the genus lactococci due to DNA-DNA hybridization studies and fatty acid profiles [1–3]. Currently, the genus *Lactococcus* contains 11 species [4]. *L. garvieae* is associated with fish infections in warm water causing outbreaks of haemorrhagic sepsis in rainbow trout [2, 5]. These organisms have also been isolated from raw cow milk, goat cheese, fish, beef meat, poultry and pork meat [6]. Human infections caused by *L. garvieae* have been reported in different countries and have been associated to ingestion of raw seafood. Indeed, a study by Wang et al. found that among four patients with invasive *L. garvieae* infection, three had ingested seafood contaminated by these organisms [7]. Infective endocarditis (IE) is a known disease caused by *L. garvieae*, however, the true incidence of disease is difficult to assess since misidentification with other Gram-positive cocci like *Enterococcus* spp. and streptococci (employing different automatized diagnostic tools) has commonly been reported [8, 9]. Here, we report a case of *L. garvieae* IE and describe the risk factors associated with this disease, the diagnostic challenges to identify these organisms and therapeutic approaches used to treat these infections. We
seek to provide clinicians with relevant and updated information on the diagnosis and management of IE caused by the genus *L. garvieae*.

We searched MEDLINE, EMBASE and LILACS using the following MeSH, major and free terms: “endocarditis”, “endocarditis, bacterial”, “endocarditis, subacute bacterial”, “endocarditis bacteriana”, “endocarditis bacteriana subacute” and “lactococo”, “lactococcus”, “lactococcus lactis”, “lactococcus garvieae”, “lactococcus garvieae endocarditis”. We selected all the articles in Spanish, English and French published before March 2018 that included case reports of endocarditis and *Lactococcus* in the titles.

**Case presentation**

A 50-year-old Asian man with history of rheumatic heart disease (without hypertension) and mechanical prothetic mitral valve replacement 5 years before admission, dyslipidaemia and reflux esophagitis presented to the emergency room with severe bilateral occipital headache. He was diagnosed with an intracranial haemorrhage confirmed by CT brain. At the time of admission, his INR was within therapeutic range (2.35). After initial work up, the patient was hospitalized for 10 days and discharged without any residual neurologic sequelae. Atorvastatin was prescribed. No fever or elevation of the C reactive protein (CRP) or erythrocyte sedimentation rate (ESR) were identified during the admission. He worked as an accountant and had been living in the US for the past 30 years with no recent travel outside the US. Three weeks later, he complained of flu-like symptoms and oseltamivir was prescribed. A week later, the patient returned to the hospital with epistaxis, haematuria, and malaise without fever. Physical examination was unremarkable with normal neurologic exam, except for a pansystolic heart murmur. Blood tests showed elevated white blood count (14.5 × 10⁹/L) and serum creatinine of 1.54 mg/dl (Normal value: 0.8–1.2 mg/dl). CRP and ESR were also elevated (34.5 mg/dl and 75 mm/h, respectively). A Chest X ray was found without acute abnormalities and the urine analysis showed no abnormalities. Three days after admission, blood cultures were positive for Gram-positive cocci in chains in 4 out of 4 bottles. Transthoracic echocardiography was inconclusive, but a transoesophageal echocardiography (TEE) revealed a 0.8 cm vegetation on the ventricular side of the native aortic valve without valve dysfunction, confirming the diagnosis of IE. Empirical intravenous antibiotic therapy was started with vancomycin 30 mg/kg/day in divided doses and gentamicin 3 mg/kg/day. The organism was recovered on blood agar and was identified by MALDI-TOF as *Lactococcus garvieae*. Susceptibility testing showed resistance to clindamycin, whereas it was susceptible to penicillin (MIC 0.25 μg/ml), ceftriaxone (MIC 0.25 μg/ml), vancomycin (MIC 1.5 μg/ml) and levofloxacin (MIC 2 μg/ml). With these results, vancomycin was switched to ceftriaxone 2 g IV twice daily plus gentamicin as combination therapy for the first 2 weeks. This regimen was chosen based on previous cases since no specific guidelines exist on how to treat these organisms. Gentamicin was stopped after two weeks and ceftriaxone was continued for 4 additional weeks pending a surgical decision. In the setting of intracranial bleed and IE, rupture of a mycotic aneurysm was highly suspected and the patient was considered a possible surgical candidate for aortic valve replacement. CT angiography of the brain (5 weeks after the initial episode of intracranial bleed) showed encephalomalacia in the left parietal and occipital lobes with subacute to chronic haemorrhage, with no mycotic aneurysms. After several discussions, the stroke team agreed on resuming anticoagulation with heparin IV drip (considering that the patient had a “chronic” bleed without active haemorrhage and that the risk of embolism was high due to the presence of a mechanical heart valve and IE). It was also suggested postponing aortic valve replacement for at least 4 weeks after effective antimicrobial therapy. After 4 weeks of therapy, decrease of inflammatory markers (CRP to 8.5 mg/dl and ESR to 40 mm/h) was observed and repeat blood cultures were negative.

Upon further questioning, the patient admitted that his diet was rich in grilled fish. Additionally, he reported a long history of chronic epigastric pain for 5 years, for which he had been taking over the counter medicines. An esophagogastroduodenoscopy showed severe gastritis and reflux esophagitis. After 6 weeks of treatment for IE, the patient had clinical improvement with no recurrence of infection but repeat TEE revealed severe aortic valve insufficiency. He underwent mechanical aortic valve replacement without complications and cultures from the excised valve were sterile.

**Discussion and conclusion**

Different clinical presentations of subacute IE make it challenging to make an early diagnosis of infection and can cause delays in appropriate treatment. In our case, treatment of IE was delayed due to low suspicion of the disease at presentation and the occurrence of the intracranial haemorrhage. Importantly, collection of blood cultures as soon as infection was suspected, led to isolation of *L. garvieae* and identification using MALDI-TOF.

A total of 25 cases of IE caused by *L. garvieae* were identified in the literature review [8–30]. Among the 25 cases of IE caused by *L. garvieae* (Table 1), 58% were reported in men and the median age of presentation was 68 years. Median duration of symptoms before consulting was 14 days (IQR = 6.2–21). The most common reported symptoms were fever (68%) and chills (28%).
| Reference          | Country   | Age | Sex | Associated factors for IE by *L. garvieae* and comorbidities | Symptoms and duration (days) | Physical examination | Laboratories and Echocardiography (Vegetation size) | Identification | Susceptibility | Therapy and days of treatment | Complications and Outcome |
|--------------------|-----------|-----|-----|-------------------------------------------------------------|-------------------------------|-----------------------|----------------------------------------------------------------|---------------|---------------|-------------------------------|--------------------------|
| Clavero et al. 2017| Chile     | 72  | F   | AV fistulas, Diverticulosis, CKD, DM 2 and HTN, colonic polyps | Chills, fever (1)             | Fever, systolic murmur, pulmonary crackles | TEE: mitral vegetation (4 mm) Labs: Leucocytosis elevated CRP Colonooscopy: Colonic polyps | LG, Vitek 2 
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and 16S rRNA PCR. | MIC: VAN 2 µg/ml, CTX 0.25 µg/ml PEN 0.5 µg/ml | Empiric: CLO + AMK 
Directed: VAN + GEN µg (NI) | Shock, respiratory failure (Died) |
| Lim and Jenkins 2017 | UK        | 57  | M   | Cooked fish, gallstones, renal stones, Colonic polyps | Fever weight loss (60)        | Panystolic murmur       | TEE: mitral valve vegetation (NI) and regurgitation. Colonooscopy: Duodenal polyps | LG, MS | PEN MIC: 1 mg/L Etest BioMérieux, S: GEN 200 µg Oxoid by diffusion disc testing. | AMX + GEN (42d) Valve replacement | No complications, (Alive) |
| Landeloos et al. 2017 | Belgium   | 82  | F   | Prosthetic mitral valve, previous endocarditis, Cooked fish, colonic polyps, FA, HTN, Osteoporosis. | Fever, hyporexia, dyspnoea (14) | Bradycardia, Basal lung crepitations, reinforce caused S2 | TEE: mitral vegetation (10x5 mm) Labs: Elevated CRP no leucocytosis. Colonooscopy: Colonic polyps. | LG, MS, 16S rRNA PCR. | PEN, MIC 1 mg/L Etest BioMérieux, S: GEN 200 µg Oxoid by diffusion disc testing. | AMX + GEN (42d) Valve replacement | No complications (Alive) |
| Bazemore et al. 2016 | USA       | 45  | M   | Multiple substance abuse. Repair of aortic root aneurysm, Hepatitis C and cirrhosis | Malaise, weakness (60)        | Fever, systolic murmur | No Echo reported. Leucocytosis, Elevated CRP and ESR. | LG, MS | E-test: sensitive to CRO and VAN Cut-off values for *S. bovis* | Empiric: TJP + VAN 
Directed: CRO + GEN (NI) + Valve repair | Aortic valve dehiscence (Alive) |
| Suh et al. 2016    | South Korea | 75  | F   | Mitral valve prosthesis, eats sea fresh food. | Dyspnoea (3) Holosystolic murmur | TTE: mitral vegetation (16 mm) Labs: Leucocytosis, Elevated CRP | LG, Vitek 2 
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and 16S rRNA PCR. | MicroScan MICrOSTREP plus panel: PEN 0.12 µg/ml, AMC 0.5/0.25 µg/ml, CRO 0.25 µg/ml, CTX 0.25 µg/ml, MEM 0.06 µg/ml, VAN 1 µg/ml, LVX 1 µg/ml, CLI > 0.5 mg/ml (only R to CLI), E test (bioMérieux, Marcy l'Etoile, France) PEN 0.75 mg/L, CRO 0.38 mg/L | Empiric: CRO + GEN + RIF 
Directed: TEC 
Changed: CRO monotherapy (40d) | Aortic and mitral replacement | Heart failure (Alive) |
| Reference | Country | Age | Sex | Associated factors for IE by L. garvieae and comorbidities | Symptoms and duration (days) | Physical examination | Laboratories and Echocardiography (Vegetation size) | Identification | Susceptibility | Therapy and days of treatment | Complications and Outcome |
|-----------|---------|-----|-----|------------------------------------------------------------|----------------------------|---------------------|----------------------------------------------------|---------------|--------------|-------------------------------|----------------------------|
| Heras Cañas et al. 2015 | Spain | 68 | M | Prosthetic aortic valve, HTN, dyslipidaemia, Hodgkin lymphoma in remission, AV block | Fever, Dyspnoea (10) | NI | TTE: mitral vegetation (NI) | LG: MS and 16S rRNA PCR | Streptococci breakpoints: S: CTX: 0.38 µg/ml, ERY: 0.25 mgidl, VAN 1 µg/ml, LVX 1.5 µg/ml, VAM, AMP, CTX, OXA, I: PENH:MIC 0.75 µg/ml, R: CLI 1 µg/ml | Empiric: DAP + AMP + CRO | Aortic valve dehiscence | (Alive) |
| Ignesti et al. 2015 | USA | 83 | M | Prosthetic aortic valve, Recent dental intervention, CHF, CLL, Prostate cancer, Coarctation of aorta, CABG | Malaise, fever, vomit, headache, cough, myalgia, diaphoresis (7) | NI | TTE: Could not exclude vegetations, Labs: Leucocytosis, Elevated CRP | NI | NI | Empiric: AMP + GEN | No complication, (Alive) |
| Ortiz et al. 2014 | Spain | 70 | F | No risk factors or comorbidities | Dyspnoea (NI) | Holosystolic murmur, fever | TTE: mitral vegetation (NI) Labs: Leucocytosis and elevated CRP | NI | S: CTX, CIP, ERY, DAP, VAN | Empiric: AMC + GEN | No valve surgery | No complications | (Alive) |
| Spain | 77 | F | Colorectal cancer, HTN, CLL | Back pain, fever (2) | Purpuric lesions in extremities, fever | TEE: mitral and aortic vegetation (NI) Labs: NI | NI | S: PEN, AMC, CIP, VAN | AMP + GEN (NI) No valve surgery | AKI, Heart failure | (Died) |
| Tsur et al. 2014 | Israel | 76 | M | Raw fish, Prosthetic aortic valve, CHF, AF, DM 2, HTN, Oesophageal carcinoma. | Constipation, fever (NI) | Fever, Tachycardia, Systolic murmur. | TEE: Vegetation biologic prosthetic valve (NI) Labs: Leucocytosis | S: CRO and GEN | Vitek 2 ¥, 16S rRNA PCR | Empiric: CRO | No valve replacement | No complications | (Alive) |
| Rasmussen et al. 2014 | Sweden | 81 | M | Prosthetic aortic valve, rectal diverticulosis, CAD, CABG, AF | Malaise, headache, dysphasia (NI) | Fever, systolic murmur. | TEE: vegetations mitral valve and prosthetic valve (NI) Labs: Elevated CRP | LG: Vitek 2 ¥, 16S rRNA PCR | PEN 0.5 mg/L, TOB: 2 mg/L | PEN + TOB (28d) No valve replacement | Subdural hematoma | (Alive) |
| Navas et al. 2013 | USA | 64 | M | Previous mitral valve repair, Dental intervention, CAD, Cardiac | Fatigue, weight loss, hypoxemia, weakness, fever (NI) | NI | Echo not specified: Aortic vegetations | LG: Vitek 2 ¥, 16S rRNA PCR and MS Wrong ID. Microscan | Streptococcus breakpoints: I: PEN and AMP | VAN monotherapy (42d) Aortic valve replacement. Removal of pacemaker | Intracardiac device infection (Alive) |
| Reference          | Country | Age | Sex | Associated factors for IE by *L. garvieae* and comorbidities | Symptoms and duration (days) | Physical examination | Laboratories and Echocardiography (Vegetation size) | Identification | Susceptibility | Therapy and days of treatment | Complications and Outcome |
|--------------------|---------|-----|-----|------------------------------------------------------------|-----------------------------|-----------------------|-------------------------------------------------|---------------|---------------|-----------------------------|---------------------------|
| Fleming et al. 2012| USA     | 68  | M   | Prosthetic aortic valve, NHL in remission. Colonic polyps | Migratory arthralgias, dyspnoea, hypoxia, fatigue, weight loss, fever (21) | Systolic ejection murmur. Splinter haemorrhage in nails of left hand | Echo not specified: Vegetation mitral valve. (NI) | LG: Vitek 2®, 16S rRNA PCR | Breakpoints for VGS: S: VAN, SAM, CRO, T2P R: AMP, GEN, CLI | Empiric: AMP + GEN Directed: VAN monotherapy (42d) | No information of complications (Died) |
| Russo et al. 2012  | Italy   | 63  | M   | Ascending aorta and aortic valve replacement previous endocarditis, HTN. | Fever, chills, Pharyngitis, weakness (7) | Systolic murmur, hepatomegaly | TEE: mitral vegetation (NI) Labs: Elevated CRP | LG: API 32®, Vitek 2®, 16S rRNA PCR | EUCAST Streptococci breakpoint: S: ERY/S: 0.125 μg/ml, CTX 0.5 μg/ml LVX: 0.5 μg/ml AMP: 0.25 μg/ml AMC: 0.5 μg/ml CIP: 0.75 μg/ml DAP: 0.125 μg/ml GEN: 2 μg/ml VAN: 2 μg/ml TEC: 0.5 μg/ml PEN: 2 μg/ml R: CLI: > 64 μg/ml RIF > 64 μg/ml | Empiric: VAN + GEN Directed: AMP monotherapy (14d) | No valve replacement |
| Watanabe et al. 2011| Japan   | 55  | F   | No risk factors or comorbidities | Malaise, myalgia, fever (60) | Systolic murmur, painful black induration in finger. | TEE: Mitral vegetation (10 mm) Labs: No leucocytosis Elevated CRP | LG: Rapid ID32 Strep. 7, 16S rRNA | E test: (AB Biodisk, Dalvagen, Solna, Sweden): ERY 0.25 mg/L, CLI: > 256, VAN: 0.38 mg/L, LZD: 2 mg/L PEN 0.5 mg/L, CRO 0.38 1mg/L, GEN: 1.5 mg/L, STR: 64 mg/L | Empiric: PEN + GEN. Directed: CRO + GEN (63d) No valve surgery | Septic embolism, stroke, aspirative pneumonia (Alive) |
| Zuily et al. 2011  | France  | 64  | F   | Mitral valve prosthesis, fresh seafood, Pacemaker, Hepatitis C cirrhosis | Fever (NI) | Fever, Murmur. | TEE: Mitral vegetation (NI) Labs: Elevated CRP and ESR Leucocytosis | LG: PCR | NI | AMX + GEN (42d) | No complications (Alive) |
| Wilbring et al. 2011| Germany | 55  | M   | Fish farmer, mechanical tricuspid valve prosthesis, periodontitis | Chills, fever, dyspnoea (14) | Murmur | TEE: Mechanical prosthetic valve vegetation (7x9mm) Labs: Leucocytosis and elevated CRP | NI | | Inpatient: GEN + VAN + RIF ambulatory: LVX + AMC (56d) No valve replacement | No complications (Alive) |
| Hirakawa Brazil 2011| Brazil  | 58  | F   | Mitral prosthesis | Fever, chills, Fever, Osler | TEE: No vegetations Labs: | LG: Not specified | S: PEN, GEN, VAN. | | VAN monotherapy (28d) | No |
| Reference | Country | Age | Sex | Associated factors for IE by L. garvieae and comorbidities | Symptoms and duration (days) | Physical examination | Laboratories and Echocardiography (Vegetation size) | Identification | Susceptibility | Therapy and days of treatment | Complications and Outcome |
|-----------|---------|-----|-----|----------------------------------------------------------|-----------------------------|-----------------------|---------------------------------------------------|---------------|--------------|--------------------------------|--------------------------|
| et al. 2011 | Taiwan | 41 | M   | No risk factors or comorbidities                         | Slurred speech (1)          | Right hemiparesis of right body sensation, right positive Babinski sign, murmur, fever | TEE: Mitral vegetation and rupture of chordae tendineae (NI) Labs: Leucocytosis and elevated CRP | LG: Vitek 2®, Automated Phoenix®, 16S rRNA PCR | NI            | PEN: 0.75 µg/ml. PEN + GEN (30d) | No complications Complications (Alive) |
| Li et al. 2008 | China | 67 | M   | Heart rheumatic disease, previous endocarditis, eats fresh fish, AF | Chills, fever (21) | Fever, mitral regurgitation murmur | TEE: Mitral vegetation (10x1mm) Labs: Elevated ESR Neurophilia | NI            | NI            | AMP monotherapy (42d) Valve replacement | Partial rupture of mitral valve (Alive) |
| Yiu et al. 2007 | Taiwan | 72 | M   | Kidney stones, mitral valve prolapse, raw fish consumption, gastric ulcer | Fever, purpuric leg lesions (14) | Systolic murmur. | Echo not specified: Severe mitral regurgitation, prolapse of posterior mitral valve, echogenic mass on the posterior mitral valve Labs: No leucocytosis. Endoscopy: Gastric ulcer | LG: ID32 STREP; BioMérieux, Hazelwood, MO, USA, 16S rRNA PCR | NI            | PEN + GEN (42d) | No complications (Alive) |
| Wang et al. 2006 | Canada | 80 | M   | DM2, Hypertension, CAD, CHF | Dyspnoea, epigastric discomfort. (NI) | Midsystolic murmur | TEE: Aortic vegetation (24 mm) Labs: Nil | Wrong ID: API 20® (L. lactis), Vitek Z® (Enterococcus), 16S rRNA PCR | CLSI Enterococcus spp. breakpoints: S: PEN, CIP, OFX, LVX, TET, VAN, CLSI Streptococcus spp. breakpoints: S: AMP, VAN, GEN | Empiric inpatient: Amp Ambulatory: PEN and then switched to AMP again. Monotherapy (56d) Valve replacement | No complications (Alive) |
| Fihman et al. 2005 | France | 86 | M   | Prosthetic aortic valve, Cholecystectomy. | Fever, right hip pain (21) | Fever, respiratory distress | TEE: Aortic vegetation (10 mm) Labs: Leucocytosis and elevated CRP. | LG: API 32®, 16S rRNA PCR | E test: MIC: PEN: 0.75 µg/ml, AMX: 0.5 µg/ml CTX: 0.38 µg/ml, VAN: 1.5 µg/ml, TEC: 0.38 µg/ml, CLI > 8 µg/ml | Inpatient: AMX + GEN Ambulatory: AMX monotherapy (49d) Valve repair | No complications (Alive) |
| James et al. 2000 | UK | 56 | F   | Aortic valve prosthesis | Low back pain, chills, | Low back tenderness, | TTE: No vegetation Labs: Elevated ESR and CRP. No | LG: API Step 1 | With streptococci reference laboratory | Empiric: VAN Directed: TEC monotherapy (56d) Osteomyelitis (Alive) | No complications (Alive) |
Table 1  Clinical, microbiological and management characteristics of IE by L. garvieae (Continued)

| Reference | Country | Age | Sex | Associated factors for IE by L. garvieae and comorbidities | Symptoms and duration (days) | Physical examination | Laboratories and Echocardiography (Vegetation size) | Identification | Susceptibility | Therapy and days of treatment | Complications and Outcome |
|-----------|---------|-----|-----|-----------------------------------------------------------|-----------------------------|----------------------|---------------------------------------------------|----------------|--------------|----------------------------|--------------------------|
| Fefer et al. 1998 | USA 84 F | Pacemaker for heart block, Aortic valve prosthesis, omeprazole, hypertrophic cardiomyopathy, ITP, hypothyroidism. | Hyporexia, weakness, dyspnoea (NI) | Holosystolic murmur, bilateral pulmonary rales | TEE: Ruptured chordae tendineae. Labs: Leucocytosis. Negative colonoscopy. | LG: Biochemical tests. | NCCLS Staphylococcus spp. breakpoints: S: VAN, AMP, CRO Empiric: AMP + GEN Directed: CRO monotherapy (NI) | Intracranial haemorrhage, Rupture of chordae tendineae (Died) |

NI No information, AMK amikacin, AMX amoxicillin, AMC amoxicillin-clavulanic acid, AMP ampicillin, CFZ cefazolin, CDN cefditoren, CTX cefotaxime, CRO ceftriaxone, CEF cephalothin, CHL chloramphenicol, CIP ciprofloxacin, CLR clarithromycin, CLI clindamycin, DAP daptomycin, ERY erythromycin, GEN gentamicin, LVX levofloxacin, LZD linezolid, MEM meropenem, MXF moxifloxacin, OFX ofloxacin, PEN penicillin, TZP piperacillin-tazobactam, RIF rifampin, STR streptomycin, TEC teicoplanin, TET tetracycline, TOB tobramycin, SXT trimethoprim-sulfamethoxazole, VAN vancomycin, MIC Minimal inhibitory concentration, S Sensitive, I Intermediate, R resistant, VGS Viridans Group Streptococci, CKD Chronic kidney disease, AKI Acute kidney injury, DM2 Diabetes mellitus type 2, AF Atrial fibrillation, CHF Cardiac heart failure, NHL Non-Hodgkin Lymphoma, COPD Chronic obstructive pulmonary disease, CLL Chronic lymphocytic leukaemia, CAD Coronary artery disease, CABG Coronary artery bypass graft, LG Lactococcus garvieae a Manual API 32 step kit, automated Vitek 2 kit with GP identification card (BioMérieux Marcy l’étoile, france), b Microscan walk away system (dade behring, inc., Sacramento, CA), c Automated Phoenix system (Becton Dickinson Diagnostic systems, Franklin Lakes, NJ), d: API 20strep kit (BioMérieux), e: 500 16S ribosomal RNA bacterial sequencing kit (PE applied Biosystems, Foster city, CA, USA) ABI PRISM 310 Genetic Analyzer (PE applied biosystems), f: API 2010 Strep (BioMérieux, Basngstoke, Hants, UK)
Presence of heart murmurs was the most common finding in the physical examination (72%). Laboratory tests usually showed leucocytosis, elevated CRP and ESR. Echocardiogram was reported in 24 out of 25 cases and vegetations were identified in 83.3%. The mitral valve was the most frequently involved valve. Colonoscopy was performed in 5 cases, all of which reported colonic polyps. The median duration of antimicrobial therapy was 42 days (IQR 41–45.5).

When compared to other Gram-positive microorganisms, L. garvieae seems to affect more frequently patients with prosthetic valves. In our review, 52% (n = 13) patients with L. garvieae IE had prosthetic valves, while large cohorts of endocarditis caused by Enterococcus spp., Streptococcus spp., Coagulase negative Staphylococci (CoNS) and S. aureus, report prosthetic valve involvement in 15.3–35%, 16.3–17.2%, 28–32.2% and 15.3–16% of cases, respectively [31–33]. Complications of IE such as valve dehiscence or rupture, septic emboli, renal failure, shock, stroke and heart failure were reported in 50% (n = 12) of cases. Surgery for valve repair or replacement was performed in 48% of cases. The case fatality rate of L. garvieae IE was 16% (n: 4), which is low compared to that of other GPC such as S. aureus (44.4%), Enterococcus spp. (23%) and CoNS (33.4%), but comparable to that of streptococci IE (15.7%) [32].

The ingestion of raw sea food or exposure to fish, the presence of colonic polyps and the repeated exposure to dairy products have been postulated to be risk factors for infection by L. garvieae [7]. Less than half of patients with IE caused by L. garvieae reported ingestion of fish (including raw or cooked) [7, 15, 19, 23, 24, 26–28, 30] or were diagnosed with a concomitant GI disorder [10, 13, 19–21, 24, 28–30]. Our patient reported both conditions. The most important predisposing factor in these patients appears to be the presence of previous valvular disease. An association with gastrointestinal disease and consumption of fish has been established. Reliable methods for identification of L. garvieae include MALDI-TOF, 16S RNA PCR, API 32 strep kit (BioMérieux, Marcy l’Etoile, France) and BD Automated Phoenix System. Based on prior case reports and our own patient case, the recommended antimicrobials for L. garvieae are ampicillin (2 g every 4 h), amoxicillin (200 mg/kg/day divided in 4–6 doses), ceftriaxone (2 g every 12–24 h) or vancomycin (30 mg/kg/day divided in 2–3 doses) as monotherapy or in combination with gentamicin (3 mg/kg/day). Doses were defined using the recommendations for the treatment of VGS and enterococcal IE published by the American Heart Association/Infectious Diseases Society of America (AHA-IDSA) and European Society of Cardiology guidelines [34, 35]. It is unclear if combination therapy is needed (in cases where aminoglycoside toxicity is an issue), given that 5 out of 25 patients with L. garvieae IE were treated with vancomycin [9, 15, 17], teicoplanin [17] or ampicillin [8] monotherapy with good outcomes. Further, the majority of patients in the L. garvieae group who died were treated at some point with monotherapy and combination therapy.

**Abbreviations**

AF: Atrial fibrillation; AKI: Acute kidney injury; AMC: Amoxicillin-clavulanic acid; AMK: Amikacin; AMP: Ampicillin; AMX: Amoxicillin; BD: Becton Dickinson; CABG: Coronary artery bypass graft; CAD: Coronary artery disease; CDN: Cefidetore; CEF: Cefalothin; CFZ: Cefazolin; CHF: Cardiac heart failure; CHL: Chloramphenicol; CIP: Ciprofloxacin; CKD: Chronic kidney disease; CLI: Clindamycin; CL: Chronic lymphocytic leukaemia; CLR: Clarithromycin; CLSI: Clinical and laboratory standards institute; CONS: Coagulase negative staphylococci; COPD: Chronic obstructive pulmonary disease; CRP: C Reactive Protein; CT: Computed Tomography; Ctx: Cefotaxime; DAP: Daptomycin; DM2: Diabetes mellitus type 2; DNA: Deoxyribonucleic acid; ERY: Erythromycin; ESR: Erythrocyte Sedimentation Rate; EUCAST: European Committee on Antimicrobial Susceptibility Testing; GEN: Gentamicin; GI: Gastrointestinal; GP: Gram positive; GPC: Gram positive cocci; I: Intermediate; IE: Infective Endocarditis; INR: International Normalized Ratio; IQR: Interquartile range; IV: Intravenous; LG: Lactococcus garvieae; LVX: Levofloxacin; LZD: Linezolid; MALDI-TOF: Matrix-Assisted Laser Desorption/Ionization Time of Flight; MEM: Meropenem; MIC: Minimum Inhibitory Concentration; MXF: Moxifloxacin; NHL: Non-Hodgkin Lymphoma; NI: No information; OFX: Ofloxacin; PCR: Polymerase Chain Reaction; PEN: Penicillin; R: Resistant; RIF: Rifampin; RNA: Ribonucleic acid; S: Sensitive; STR: Streptomycin; SXT: Trimethoprim-sulfamethoxazole; TEC: Teicoplanin; TET: Tetracyclin; TOB: Tobramycin; TZP: Piperacillin-tazobactam; VAN: Vancomycin

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**Availability of data and materials**
No data or materials are available.

**Authors' contributions**
AM, AD and CAA wrote the manuscript and structured the literature review. CAA, AM, SG and CN took care of the patient and collected clinical data. All authors reviewed and approved the final version of the manuscript.

**Ethics approval and consent to participate**
Does not apply.

**Consent for publication**
Written informed consent was given by the patient to publish the information in this case report.

**Competing interests**
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**Author details**
1. Department of Internal Medicine, Division of Infectious Diseases, UTH - McGovern Medical School, Houston, TX, USA.
2. Grupo de Investigación en Enfermedades Infecciosas, Hospital Universitario San Ignacio, Pontificia Universidad Javeriana, Bogotá, Colombia.
3. Departamento de Microbiología, Universidad de Antioquia, School of Medicine, Medellin, Colombia.
4. Center for Antimicrobial Resistance and Microbial Genomics (CARMIG), UTH - McGovern Medical School, Houston, TX, USA.
5. Molecular Genetics and Antimicrobial Resistance Unit and International Center for Microbial Genomics, Universidad El Bosque, Bogota, Colombia.
6. University of Texas Health Science Center at Houston (UTHealth), 6431 Fannin St. MSB 2.112, Houston, TX 77030, USA.

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