



OPEN ACCESS

Probable zoonotic pulmonary prosthetic valve infective endocarditis and acalculous cholecystitis caused by *Streptococcus equi* subspecies *zooepidemicus*

Matthew Eustace ,^{1,2} Gabriela Strey ,³ Timothy J Kidd,¹ John F McNamara⁴

¹Pathology Queensland—Central Microbiology Laboratory, Queensland Health, Brisbane, Queensland, Australia

²Royal Brisbane Clinical Unit, University of Queensland School of Medicine, Herston, Queensland, Australia

³General Medicine, Queensland Health, Hervey Bay, Queensland, Australia

⁴Infectious Diseases Unit, The Prince Charles Hospital, Cherside, Queensland, Australia

Correspondence to

Dr Matthew Eustace;
matthew.eustace@health.qld.gov.au

ME and GS are joint first authors.

Accepted 19 September 2024

SUMMARY

Prosthetic pulmonary valve endocarditis is a rare but serious infective complication following correction of tetralogy of Fallot (ToF). We describe a probable zoonotic case of *Streptococcus equi* subspecies *zooepidemicus* prosthetic pulmonary valve infective endocarditis in a young woman with corrected ToF with regular exposure to horses. The case was further complicated by acalculous cholecystitis, which was the initial presenting syndrome, requiring laparoscopic cholecystectomy. Microbiological analysis of blood cultures yielded growth of *S. equi* with whole genome sequencing confirming the subspecies identification of *zooepidemicus*. The patient underwent successful combined medical and surgical management incorporating a 6-week course of intravenous antibiotics and a re-do homograft pulmonary valve replacement followed by prolonged oral antibiotic therapy. Clinicians should be mindful of the increased risk of endocarditis in adult congenital heart disease and relevant bacteraemia detection should prompt thorough valvular assessment.

BACKGROUND

Right-sided valvular intervention of the tricuspid and/or pulmonary valve occurs most commonly for repair of valve degeneration due to injecting drug use or central venous access device-associated right-sided infective endocarditis.¹ The evidence base for understanding the epidemiology, aetiology, diagnosis, management and outcomes of right-sided endocarditis is heavily based on the study of these populations. However, pulmonary valve replacement is also observed in correction of congenital heart diseases such as tetralogy of Fallot (ToF).² Postcorrection, these patients remain at lifelong increased risk of prosthetic valve infective endocarditis (PVE), a severe and life-threatening infection with significant morbidity and mortality.^{2–4} Furthermore, episodes of PVE require prolonged intravenous antimicrobial therapy, hospitalisation and may require additional surgical intervention to achieve adequate source control and/or valvular function. Pulmonary PVE has an estimated incidence rate of 22.4 per 10 000 person years in patients with ToF.² *Streptococcus equi* subspecies *zooepidemicus* (SEZ) is a commensal organism of the upper respiratory and urogenital tract of horses. SEZ has been described as a zoonotic pathogen in humans implicated in reported cases of respiratory, skin and soft tissue, osteoarticular and endovascular infections.⁵

Here, we describe a case of probable zoonotic pulmonary PVE and its sequelae in a patient with surgically corrected ToF caused by SEZ.

CASE PRESENTATION

A woman in her 30s presented to a regional hospital with a 2-day history of fever, nausea, vomiting, diarrhoea and dizziness. She reported anorexia but denied any chills, sweats, significant abdominal pain, bloody stools or weight loss. In relation to exposure history, she had no history of any relevant travel although lived on a large rural property with regular exposure to livestock including daily interaction with horses. In terms of sick contacts, she recalled her husband having a febrile illness 1 week before the onset of her own symptoms which fully resolved without intervention. Her medical history was significant for ToF which was surgically corrected over three operations, the most recent being a bioprosthetic pulmonary valve replacement 20 years before this presentation.

At presentation, she was noted to be febrile to 38.2°C, borderline tachycardic with a regular heart rate of 100 beats per minute and hypotensive with a systolic blood pressure of 75 mm Hg. On cardiovascular examination, there were neither peripheral stigmata of infective endocarditis nor any palpable heaves or thrills. Auscultation of the chest revealed a grade 3 systolic murmur loudest over the left parasternal area with no radiation, breath sounds in all lung fields were vesicular with no adventitious sounds. A 12-lead ECG showed normal sinus rhythm, an established incomplete right bundle branch block and low voltage amplitudes. Abdominal examination was significant for right upper quadrant tenderness with positive Murphy's sign.

In the setting of septic shock with localising abdominal signs suggestive of a biliary source, the patient was commenced on empiric broad-spectrum antimicrobial therapy with intravenous piperacillin/tazobactam. A CT of the abdomen and pelvis was undertaken demonstrating gall-bladder wall thickening. Targeted ultrasonography the next day confirmed the diagnosis of acalculous cholecystitis. The patient was admitted under the general surgical team with a collaborative referral to general medicine in view of her complex cardiac history. On day 2 of admission, blood cultures flagged positive for an organism identified as *S. equi*, specialist infectious diseases



© BMJ Publishing Group Limited 2024. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Eustace M, Strey G, Kidd TJ, et al. *BMJ Case Rep* 2024;**17**:e262383. doi:10.1136/bcr-2024-262383



Figure 1 Ultrasound image of long axis of gallbladder demonstrating mural wall thickening with no visualised cholelithiasis.

advice was sought and antimicrobial therapy was narrowed to intravenous amoxicillin/clavulanate. The patient proceeded to an uncomplicated laparoscopic cholecystectomy on day 4 of admission under the general surgical team to manage the acalculous cholecystitis.

Postoperatively, the patient's care was transferred to the general medical team. Repeat blood cultures after initial presentation were negative and the patient remained afebrile and clinically well. The growth of *Streptococcal* species in blood culture in a patient with a prosthetic pulmonary valve raised suspicion for PVE. After an inconclusive transthoracic echocardiogram (TTE), the general medical team advocated strongly for transfer of the patient to a tertiary centre for further valvular assessment with transoesophageal echocardiogram (TOE). On day 11 of admission, the patient was transferred to the state referral cardiothoracic surgical centre where TOE confirmed the presence of a large, mobile vegetation on the prosthetic pulmonary valve.

INVESTIGATIONS

Medical imaging

Abdomen

CT abdomen and pelvis (day 1): transmural thickening of the gallbladder.

USS abdomen (day 2): hepatomegaly with associated steatosis and a thick-walled gallbladder with increased vascularity and with pericholecystic fluid, but no calculi. A small pocket of fluid adjacent to the gallbladder measured $21 \times 13 \times 10$ mm and was overall suggestive of acalculous cholecystitis ([figure 1](#)).

Cardiac

TTE (day 3): pulmonary valve replacement was not well visualised but appeared well seated without regurgitation.

TOE (day 14): a large vegetation attached to the 24 mm pulmonary homograft (possible left pulmonary leaflet). The mass consisted of a thickened and irregular segment attached to the leaflet measuring 19 mm and a more thin, highly mobile segment measuring 23 mm extending distally. Leaflet motion appeared normal; no significant pulmonary regurgitation was noted (online supplemental video 1).

Blood tests

Full blood count (day 1)—(reference range)

- ▶ Haemoglobin: 117 g/L (115–160)
- ▶ White cell count: 7.0×10^9 /L (4.0–11.0)
 - Neutrophils: 6.73×10^9 /L (2.00–8.00)
 - Lymphocytes: 0.22×10^9 /L (1.00–4.00)
- ▶ Platelets: 186×10^9 /L (140–400)

Biochemistry (day 1)—(reference range)

- ▶ Sodium: 136 mmol/L (135–145)
- ▶ Potassium: 3.4 mmol/L (3.5–5.2)
- ▶ Creatinine: 75 μ mol/L (45–90)
- ▶ eGFR > 90 mL/min/ 1.73m^2 (> 90)
- ▶ Total bilirubin: 19 μ mol/L (< 20)
- ▶ Conjugated bilirubin: 11 μ mol/L (< 4)
- ▶ Alkaline phosphatase: 32 U/L (30–110)
- ▶ Gamma-GT: 42 U/L (< 38)
- ▶ Alanine transaminase: 32 U/L (< 34)
- ▶ Aspartate transaminase: 22 U/L (< 31)

Microscopy	Culture	Penicillin	Erythromycin	Clindamycin	Vancomycin
Gram-positive cocci resembling <i>Streptococcus/Enterococcus</i>	<i>Streptococcus equi</i> (Group C)	Susceptible	Susceptible	Susceptible	Susceptible

- C-reactive protein: 11 mg/L (<5)

Blood cultures

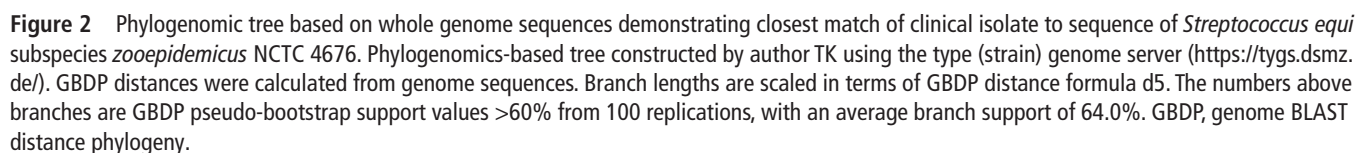
bation from arrival in the microbiology laboratory with *S. equi* grown in four of four bottles (table 1).

BC (days 5, 13, 15, 20): negative.

Pulmonary valve homograft fluid (day 19): no growth after 5 days of incubation.

Gallbladder (day 4): mild muscular hyperplasia, no inflammation and no calculi, consistent with the diagnosis of acalculous cholecystitis.

The patient's initial presentation with gastrointestinal symptoms including fever, nausea, vomiting and diarrhoea combined with abdominal signs including right upper quadrant tenderness and positive Murphy's sign raised the clinical suspicion of biliary sepsis and cholecystitis. Abdominal imaging with CT followed by USS confirmed the diagnosis of acalculous cholecystitis with



subsequent operative management. The patient's history of corrected congenital heart disease with prosthetic pulmonary valve, *S. equi* bacteraemia, combined with her diagnosis of acalculous cholecystitis which is observed in settings of high inflammatory burden such as systemic infection raised suspicion of underlying PVE.

TREATMENT

Surgical management

Acalculous cholecystitis

The patient underwent an uncomplicated laparoscopic cholecystectomy on day 4 of admission. Surgical findings demonstrated a thick-walled gallbladder with surrounding free fluid.

Prosthetic valve infective endocarditis

The patient proceeded to definitive surgical management for PVE with a re-do homograft pulmonary valve replacement on day 20 of admission. Surgical findings demonstrated significant adhesions around the infected pulmonary valve prosthesis and pulmonary arterial trunk, leading to a difficult explantation and the achievement of complete debridement was uncertain.

Antimicrobial therapy

Acalculous cholecystitis

The initial presentation with septic shock from a biliary source led to the initiation of broad-spectrum antimicrobial therapy with intravenous piperacillin/tazobactam 4.5 g 6 hourly in line with local treatment guidelines and antimicrobial resistance surveillance data.⁷ Subsequent identification of SEZ in blood culture prompted consultation with an infectious diseases specialist with therapy narrowed to intravenous amoxicillin/clavulanate 1.2 g 6 hourly on day 3 of admission. This was to provide adequate cover for the isolated SEZ while providing additional enteric Gram-negative and anaerobic cover, acknowledging the polymicrobial

nature of cholecystitis.⁸ Amoxicillin/clavulanate was continued for 7 days after cholecystectomy, through to day 11 of admission.

Prosthetic valve infective endocarditis

The patient was subsequently transitioned to directed therapy for SEZ PVE with 6 weeks of intravenous benzylpenicillin 2.4 g 4 hourly in combination with 2 weeks of synergistic intravenous gentamicin 60 mg 8 hourly. Data are limited on the treatment of zoonotic *Streptococci* infections associated with intravascular prosthesis. Treatment course was adopted as per oral streptococci with PVE according to the European Society of Cardiology guidelines for the management of endocarditis; 'in patients with PVE due to oral *Streptococci* and *S. gallolyticus*, oral penicillin G, amoxicillin or ceftriaxone for 6 weeks combined with gentamicin for 2 weeks is recommended'.⁹ Given the risk of long-term mortality when surgical clearance cannot be achieved, a recommendation was made for long-term suppressive antibiotic therapy with oral amoxicillin 500 mg three times per day for review at 2 years, although the optimum approach is yet to be defined.⁹

OUTCOME AND FOLLOW-UP

Postoperative pulmonary valve replacement assessment demonstrated a well-seated prosthesis with satisfactory haemodynamics. The patient was discharged home on day 35 of admission, linking in with hospital in the home facilitated by her local regional hospital, allowing her to complete her intravenous antimicrobial therapy at home. At 4 weeks postsurgical intervention, the patient remained well with no recurrence of fevers or sweats, and she reported good appetite with weight gain; her C-reactive protein had reduced to near normal levels. At 3 months postsurgery, the patient felt her health status had returned to baseline. She was suffering no adverse medication effects and achieved good adherence with the three times per day oral pill burden.

Table 2 Reported cases of *Streptococcus equi* subspecies *zooepidemicus* endocarditis

Case	Author (year)	Age/gender	Involved valve	Exposure	Reported treatment	Complications	Outcome
1	Lee and Dyer (2004) ¹²	79 M	Native AV	Horse	Benzylpenicillin (6 weeks)	Polyarthrititis, probable meningitis	Recovered
2	Poulin and Bouvin(2009) ¹³	59 F	Native MV	Horse	Ceftriaxone (6 weeks) Rifampicin (6 weeks) Cardiac surgery ► MVR ► Closure of ASD ► CABG × 3	Bilateral endophthalmitis resulting in blindness, meningitis, probable renal septic emboli	Recovered
3	Villamil <i>et al</i> (2015) ¹⁴	73 M	Native MV	Horse	Benzylpenicillin (6 weeks) Gentamicin (2 weeks)	—	Recovered
4	Calvo <i>et al</i> (2016) ¹⁵	77 M	Native AV	Horse	Ampicillin Gentamicin	Aortic aneurysm	Recovered
5	Chang and Webster(2018) ¹⁷	75 M	Native AV	Consumption of unpasteurised milk (horses, goats, cows) and goat cheese	Ceftriaxone Rifampicin	Suppurative pericarditis, cardiac tamponade, meningitis, bilateral endophthalmitis	Died
6	Sleutjens <i>et al</i> (2019) ¹⁸	62 M	Mechanical AV	Horse	Benzylpenicillin (6 weeks) Gentamicin (2 weeks)	—	Recovered
7	Hoyer-Neilsen(2019) ¹⁶	82 M	Native AV	Horse	Benzylpenicillin Gentamicin Cefuroxime Amoxicillin Rifampicin	Septic arthritis, osteomyelitis	Recovered
8	Mahjoub <i>et al</i> (2023) ⁵	70 M	Native AV	Horse	Ampicillin (4 weeks) Gentamicin (2 weeks)	Left middle cerebral artery embolic stroke	Recovered

ASD, atrial septal defect; AV, aortic valve; CABG, coronary artery bypass graft; MV, mitral valve; MVR, mitral valve replacement.

DISCUSSION

Pulmonary PVE is a serious infective complication that can occur in adults with corrected congenital heart disease and remains a significant source of morbidity and mortality in this population.³ The most commonly reported bacterial cause of PVE is *Staphylococcus aureus*, though many other aetiologies have been described.^{1 10 11} Routes of infection acquisition are often through translocation of commensal organisms from the gastrointestinal tract, dissemination of local infection, for example, skin and soft tissue infections, or iatrogenically (eg, in the setting of vascular access devices).¹¹ This case demonstrates a probable zoonotic source of SEZ leading to destructive pulmonary PVE requiring surgical revision and prolonged antimicrobial therapy. Our experience in managing this case highlighted four key elements; SEZ as a zoonotic pathogen and cause of PVE, the utility of whole genome sequencing (WGS) to confirm the microbiological diagnosis, acalculous cholecystitis as a rare association with infective endocarditis and the importance of multidisciplinary management of complex cases of PVE.

The microbiological basis of PVE is varied and in order of frequency includes *Staphylococcus* spp., *Streptococcus* spp., *Enterococcus* spp. and other less commonly reported organisms like Gram-negative bacilli and fungi.¹ However, data on the specific epidemiology of pulmonary PVE are limited, as they are often reported as part of larger case series and cohort studies where the majority of included cases of PVE involve the aortic or mitral valves. This case of pulmonary PVE was caused by SEZ, a beta-haemolytic Lancefield group C *Streptococcus* that is often isolated as a coloniser of the upper respiratory tract of horses.¹² SEZ can cause a wide array of infections in animals and has been recognised as an emerging zoonotic pathogen, implicated in human case reports of severe meningitis, endocarditis, osteoarticular infection and complex skin and soft tissue infections.^{5 12–18} To date, there have been eight reported cases of SEZ endocarditis (table 2) with the aortic valve most frequently involved.

Each of these cases had epidemiological exposure to horse products or horses as was seen in our case.^{5 12–18} Only one case of native mitral valve endocarditis required surgical replacement; all other cases were treated successfully with antibiotics alone.¹³ Our case is the first reported case of right-sided endocarditis caused by SEZ. Although it is important to acknowledge that microbiological identification of SEZ to the subspecies level is difficult with standard approaches and may have led to an under-reporting of cases.

Advanced molecular techniques like WGS are increasingly used in diagnostic microbiology to definitively identify isolates, determine genotypic antimicrobial resistance and infer the relatedness of isolates. These techniques can be particularly useful when traditional phenotypic, biochemical and/or proteomic methods are insufficient or inconsistent in the determination of a subspecies-level identification of an isolate as was seen in this case. *S. equi* is comprised of three recognised subspecies, of which two, SEZ and *S. equi* ssp. *ruminatorum*, are very closely related and difficult to discriminate via biochemical and proteomic methods. 16S ribosomal RNA sequencing and WGS allow for higher-level discrimination between closely related organisms offering high-confidence identification. Daubie *et al*¹⁹ illustrated their experience of 16S ribosomal RNA sequencing in reaching a high-confidence identification of *S. equi* subspecies *ruminatorum* where there was discordance between phenotypic methods. Furthermore, WGS offers the opportunity to infer the relatedness of isolates, which can strengthen the clinician's

ability to determine the source of infection and can prove invaluable in outbreak investigation. Although in this case we were unable to obtain clinical samples from the horses to which the patient was exposed, sequencing of SEZ isolates from patient and horse samples by Sleutjens *et al*¹⁸ was able to prove this concept in practice.

Our case of SEZ pulmonary PVE presented with acalculous cholecystitis, a rare but recognised association. Prior reports of the association between infective endocarditis and acalculous cholecystitis have been predominantly in the setting of *Staphylococcus aureus* infection; however, other bacterial aetiologies have been described.^{20 21} The diagnosis of acalculous cholecystitis should lead the clinician to judiciously investigate for an underlying cause and infective endocarditis should be considered.²² Our case demonstrates the importance of multidisciplinary and collaborative care for these patients to obtain the correct underlying diagnosis and to achieve the best possible outcome. This was of particular importance in this case given the additional complexity of corrected congenital heart disease and the presence of a pulmonary valve prosthesis.

Contributors ME, GS, TJK and JFM were responsible for drafting the text, sourcing and editing of clinical images, investigation results, drawing original diagrams and algorithms, and critical revision for important intellectual content. All authors also gave final approval of the article.

Patient's perspective

It started with a rash 10 days before my hospital admission. The rash was followed by body aches and fevers that lasted 2 days, recovered for 4 days and then the fevers, body aches returned. They were then followed by dizziness and vomiting, and I was admitted to hospital. Before the gallbladder surgery, I was very weak (could hardly talk or move and could not get out of the hospital bed without assistance) and had swollen abdomen. I remember hearing my heartbeat ringing in my ears the entire time and my headache was extremely painful. I was given half a dose of gentamicin before my gallbladder surgery, and I remember feeling better after this dose.

After the gallbladder surgery, I started to regain my strength and was relatively independent, but was still experiencing dizziness, mind fog and headaches. I also had lost about 5 kg, and my appetite was very low. I did not have a temperature during this time. 13 days after my hospital admission, I started to experience septic showers where my temperature spiked and my body would be rigorous. I lost control of my temperature and started experiencing hot sweats. My headache was still extremely painful.

It was discovered that the infection had spread to my donor pulmonary valve and surgery was needed to replace the valve. My antibiotics were changed, and the septic showers ceased 2 days before surgery.

After surgery, the hot sweats continued, and I still had a lack of temperature control over my body. However, the headache disappeared after surgery.

I experienced the night sweats for around 2 weeks after surgery. I also experienced sweating under my eyes when I would eat food. This continued to around 8 weeks post-surgery. At times, I still mildly experience this if I am eating food quickly. Presently, 17 weeks post-surgery and 21 weeks post the first signs of the infection, I have regained 90% of my fitness, gained weight and am presently not experiencing any infection symptoms.

Learning points

- ▶ Clinicians should be aware of the association between acalculous cholecystitis and infective endocarditis, prompting the rapid collection of blood cultures.
- ▶ *Streptococcus equi* species *zooepidemicus* is an emerging zoonotic pathogen transmitted from horses to humans and can cause a wide spectrum of infections including infective endocarditis.
- ▶ Microbial whole genome sequencing is a valuable diagnostic tool that can improve taxonomic classification, assist with inferring relatedness of isolates and identify genotypic antimicrobial resistance mutations.
- ▶ Complex cases of endocarditis like prosthetic valve endocarditis in corrected congenital heart disease should be managed by a multidisciplinary team.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Consent obtained directly from patient(s).

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

Case reports provide a valuable learning resource for the scientific community and can indicate areas of interest for future research. They should not be used in isolation to guide treatment choices or public health policy.

ORCID iDs

Matthew Eustace <http://orcid.org/0000-0001-7210-347X>

Gabriela Strej <http://orcid.org/0000-0002-4753-6924>

REFERENCES

- Shmueli H, Thomas F, Flint N, *et al.* Right-Sided Infective Endocarditis 2020: Challenges and Updates in Diagnosis and Treatment. *J Am Heart Assoc* 2020;9:e017293.
- Havers-Borgersen E, Butt JH, Smerup M, *et al.* Incidence of Infective Endocarditis Among Patients With Tetralogy of Fallot. *J Am Heart Assoc* 2021;10:e022445.
- Iyer KS. The infected right ventricular outflow tract in children and adults with congenital heart disease. *Indian J Thorac Cardiovasc Surg* 2024;40:110–4.
- Nahhal SB, Sarkis P, Zakhem AE, *et al.* Streptococcus oralis pulmonic valve endocarditis: a case report and review of the literature. *J Med Case Rep* 2023;17:120.
- Mahjoub Z, Boughattas S, Boughzala S, *et al.* Streptococcus equi subspecies zooepidemicus and endocarditis: first reported case in Tunisia and review of the literature. *Rev Res Med Microbiol* 2023.
- The European Committee on Antimicrobial Susceptibility Testing. Breakpoint tables for interpretation of mics and zone diameters, version 14.0. 2024.
- Australian Commission on Safety and Quality in Health Care. AURA 2021: fourth Australian report on antimicrobial use and resistance in human health. Sydney, 2021.
- Gallaher JR, Charles A. Acute Cholecystitis. *JAMA* 2022;327:965.
- Delgado V, Ajmone Marsan N, Waha S. Correction to: 2023 ESC Guidelines for the management of endocarditis: Developed by the task force on the management of endocarditis of the European Society of Cardiology (ESC) Endorsed by the European Association for Cardio-Thoracic Surgery (EACTS) and the European Association of Nuclear Medicine (EANM). *Eur Heart J* 2023;44:4780.
- Dardari M, Cinteza E, Vasile CM, *et al.* Infective Endocarditis among Pediatric Patients with Prosthetic Valves and Cardiac Devices: A Review and Update of Recent Emerging Diagnostic and Management Strategies. *J Clin Med* 2023;12:4941.
- Fishbein GA, Fishbein MC. Tricuspid and Pulmonic Valve Pathology. *Curr Cardiol Rep* 2019;21:54.
- Lee AS, Dyer JR. Severe Streptococcus zooepidemicus infection in a gardener. *Med J Aust* 2004;180:366.
- Poulin M-F, Boivin G. A case of disseminated infection caused by Streptococcus equi subspecies zooepidemicus. *Can J Infect Dis Med Microbiol* 2009;20:59–61.
- Villamil I, Serrano M, Prieto E. Streptococcus equi subsp. *Zooepidemicus* endocarditis. *Rev Chil Infectol* 2015;32:240–1.
- Redondo Calvo FJ, Valencia Echeverri JD, Esteban Alvarez V, *et al.* Fiebre prolongada por Streptococcus equi spp. zooepidemicus (endocarditis aórtica complicada con aneurisma micótico infrarrenal). *Enferm Infecc Microbiol Clin* 2016;34:72–3.
- Høyer-Nielsen AK, Gaini S, Kjerulf A, *et al.* Sepsis, Endocarditis, and Purulent Arthritis due to a Rare Zoonotic Infection with *Streptococcus equi* Subspecies *zooepidemicus*. *Case Rep Infect Dis* 2018;2018:3265701.
- Chang A, Webster D. An Atlantic Canada case of disseminated Streptococcus equi subspecies zooepidemicus infection. *J Assoc Med Microbiol Infect Dis Can* 2018;3:238–43.
- Sleutjens J, Meijer D, Meregalli PG, *et al.* Zoonotic Endocarditis in a Man, the Netherlands. *Emerg Infect Dis* 2019;25:180–2.
- Daubié AS, Defrance C, Renvoisé A, *et al.* Illustration of the difficulty of identifying Streptococcus equi strains at the subspecies level through a case of endocarditis in an immunocompetent man. *J Clin Microbiol* 2014;52:688–91.
- Merchant SS, Falsey AR. Staphylococcus aureus cholecystitis: a report of three cases with review of the literature. *Yale J Biol Med* 2002;75:285–91.
- Brewer L, Lavan AH, Cullen L, *et al.* Streptococcus agalactiae endocarditis presenting as acalculous cholecystitis in a previously well woman. *BMJ Case Rep* 2013;2013:bcr2012008278.
- Huffman JL, Schenker S. Acute acalculous cholecystitis: a review. *Clin Gastroenterol Hepatol* 2010;8:15–22.

Copyright 2023 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <https://www.bmj.com/company/products-services/rights-and-licensing/permissions/> BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

Customer Service

If you have any further queries about your subscription, please contact our customer services team on +44 (0) 207111 1105 or via email at support@bmj.com.

Visit casereports.bmj.com for more articles like this and to become a Fellow