Legionnaire's Disease
Cardiac Manifestations

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KEYWORDS

• Legionnaire's • Legionella • Endocarditis • Cardiac infections

KEY POINTS

- Most cardiac infections with *Legionella* are secondary to bacteremias arising from a pulmonary focus. Other possible sites of origin are infected sternotomy wounds or equipment such as transesophageal echocardiography probes contaminated by *Legionella* spp.
- Legionella endocarditis is truly a "stealth" infection, with almost no hallmarks of bacterial endocarditis. Echocardiography fails to detect any vegetations in most cases. There are no classic peripheral stigmata of endocarditis. Fever if present is quite low-grade. Standard blood cultures are negative.
- The key step in making the diagnosis of *Legionella* endocarditis is for the physician be aware of the clinical causes of culture-negative infective endocarditis (CNIE) and to include in *Legionella* cardiac involvement in this differential. It is the onset of congestive heart failure that his the usual stimulus to look for unusual causes of valvular infection. The most common infectious causes of CNIE in this country are *Bartonella* and the organism of Whipple disease.
- The most frequent profile of *Legionella* valvular infection is an individual with prosthetic valve in place that was implanted in an institution in which there have been outbreaks of Legionnaire's disease. Many times these individuals will have postoperative pneumonia.
- The initial diagnostic approach should be urinary antigen testing for *Legionella*. This is the most available test with the caveat that it will consistently detect only *Legionella* pneumobilia type I. Blood endocarditis cultures should then be redrawn and subcultured on special media. Many times the issue of endocarditis arises only on examination of resected valvular material.

OVERVIEW

Legionella organisms currently are considered to cause fewer than 1% of all types of bacterial cardiac infections. The incidence of *Legionella* endocarditis, myocarditis, and pericarditis may be underestimated simply because they are not thought of as

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part of the differential of an extremely ill patient who is not responding to empiric treatment and for whom no definitive diagnosis has been established. Clinicians are often unfamiliar with the various manifestations of extrapulmonary *Legionella* infection and may not be aware of which diagnostic tests should be ordered and when. *Legionella* valvular infection is often stumbled on during the workup for more common causes of culture-negative infective endocarditis (CNIE) or when the patient fails to respond to appropriate therapy of *Legionella* pneumonia.[1] Legionella endocarditis is truly a "stealth" type of valvular infection. It is not recoverable from the usual types of blood cultures. Echocardiographically fails to demonstrate any valvular vegetations. It is without peripheral stigmata of endocarditis. This review is timely because of the recent recognition of the rapid rise of Legionnaire's disease, a primary source of *Legionella* cardiac infection, in the United States. It has increased almost fourfold from 2000 to 2014. The mortality rate is approximately 10%.[2]

THE ORGANISM

Legionellae are quite tiny gram-negative bacteria that are found in a variety of watery sites. Individuals are infected by breathing organisms that have been aerosolized from sites of potable hot water or air conditioning systems. Most cases of cardiac *Legionella* infection are caused by *Legionella pneumophilia*. Other species of *Legionella*, such as *Legionella dumoffii* and *Legionella longbeachae*, have been involved.[3]

L pneumophila serves as a model of the effectiveness of the multiple virulence factors that are possessed by the intracellular pathogens. *L pneumophila* is resistant to chlorination of various water reservoirs. This may be because of their ability to produce biofilms within hot water and air conditioning systems. Biofilm production also promotes their ability infect prosthetic heart valves. Their intracellular status within various protozoans, including amebae, allows them both to multiply and meet their nutritional needs.[4]

The organism's uptake by macrophages is promoted by opsonization with complement C3. Binding to C1 and CR3 receptors enhances its intracellular survival by dampening the macrophage's oxidative burst. After entering the cell, it lives within its phagosomes. This organelle protects it from being killed by vacuolar acidification and by lysosomal enzymes. The organism continues to multiply within an enlarging phagosome but eventually their luxuriant growth ruptures the macrophage. The pathogens then are free to infect the adjacent tissue.[5]

It appears that iron is essential for intracellular and extracellular replication. Low levels of thiamine and thymidine trigger expression of various virulence genes.

Despite being excised by monocytes and polymorphonuclear leukocytes, *Legionella* spp are resistant to being killed by these cells.[6] Some of the important pathogenic properties of *Legionella* spp are displayed in **Table 1**.

CLINICAL *LEGIONELLA* CARDIAC INVOLVEMENT

Legionella spp have been documented to cause valvular infection, pericarditis, and myocarditis, with endocarditis being the most common.[7]

Legionella valvular infection was first described in a 60-year-old woman who had undergone replacement of the mitral and aortic valve with porcine prosthetic valves. Postoperatively, she developed a fever but there was no evidence of pneumonia. She received multiple courses of antibiotics. Seven months later, an echocardiogram was repeated when she developed a new aortic regurgitation murmur. On echocardiography, there was some suggestion of valvular vegetations on the aortic valve. Both valves were removed. *Legionella pneumophilia* serotype was documented by culture

Table 1
Some of the pathogenic properties of *Legionella* species

Property	Results
Production of biofilm	a. Survival in the watery collections of health care facilities despite the presence of usual disinfectants b. Promotes their ability to infect prosthetic material c. Provides a safe haven from the effect of antibiotics
Able to penetrate macrophages	Protection from a variety of host extracellular defenses
Establishment of a replicative phagosome within the macrophage	Allows the pathogen to replicate while being protected from the effect of the macrophages' intracellular endosomal and lysosomal bactericidal actions
Causes death of the macrophage	It uses the macrophage as a vehicle to circulate throughout the body; on its death, the organisms are deposited in various organs

and direct fluorescent antibody staining.[8] No route of infection was determined in this first-described case of cardiac Legionellosis.

Initially, it was speculated that local infection of sternal wounds was the primary cause of *Legionella* prosthetic valve endocarditis (PVE). Intuitively, it would seem most likely that the infection would start during the actual surgery; however, *Legionella* spp are infrequently recovered from the operating room environment. One of the first large series of nosocomial extrapulmonary infections occurred in cardiac surgical patients of the Stanford University Medical Center. There were 7 patients with PVE; 1 of whom also had a sternotomy infection. There were 2 separate strains of *L pneumophilia* serogroup 1 and 1 strain of *L dumoffii*. The same strains were retrieved from the hospital water supply as well as other reservoirs of water, such as nebulizers. Early on, it was documented that the sternal wound could become contaminated during its irrigation with tap water to remove the povidone iodine solution that was applied before surgery. These wounds are characteristically described as being nonpurulent with serosanguineous drainage and delayed healing.[9] The presence of a localized wound infection does not rule out disseminated *Legionella*. Eighty percent of those with such infections had evidence of disseminated *Legionella* on autopsy.[10]

It appears that *Legionella* can infect the heart and other extrapulmonary sites via hematogenous spread that originates in the infected pulmonary tissue. Autopsy studies of *Legionella* pneumonia have documented the presence of this pathogen in the myocardium, bone marrow, intrathoracic lymph nodes, pericardial effusions, kidneys, and prosthetic valves. Interestingly, there did not seem to be any inflammatory response to the embedded *Legionella* in these extrapulmonary sites. The organisms may arise from a primary pneumonia with *Legionella*. There may be an interval of several weeks before the extrapulmonary infection becomes clinically apparent. Ironically, a nosocomial outbreak of *L pneumophila* pneumonia was associated with contaminated transesophageal echocardiography probes.[11]

Although there was no proof of any cases of endocarditis, this outbreak highlighted the ubiquity of the organism throughout the hospital environment. Infections of cardiac prosthetic material also may occur outside of health care institutions.[12] This occurs usually following an attack of *Legionella* pneumonia. The clinical presentation of the valvular infection may be concurrent with the pulmonary infection or delayed by several weeks. The characteristic size of the vegetation in *Legionella* endocarditis, if present at all, is quite small.[13]

Most identified cases of *Legionella* endocarditis result from *L pneumophila* infection of prosthetic valves. Other *Legionella* spp also have been implicated. These include *Legionella micdadei* and *L dumoffii*.[14]

More recently, native valve endocarditis, due to *Legionella* spp has been described.[15,16]

The major risk factors for development of *L pneumophila* respiratory infection are older age (older than 58 years) and male sex (75%). In 55.6% of patients, there is at least one comorbid condition. These include heart disease, diabetes mellitus, and chronic lung disease due to smoking.[17]

It is not clear whether the risk factors for developing the complication of valvular infection are any different from those of *Legionella* pneumonia. Very likely, this is because of the small number of the studies available due to the low degree of recognition of *Legionella* cardiac infections. A distinctive exception is the presence of prosthetic heart valves. Twenty percent of patients are immunosuppressed, especially heart transplant recipients.[18] In addition, the presence of a post cardiotomy syndrome greatly increases the chance of developing *Legionella* valvular infection.

Legionella PVE and native valve endocarditis are characteristically incredibly chronic infections that can extend for 3 to 19 months after surgery. They are characterized by low-grade fever, weight loss, malaise, and fatigue. If undiagnosed, the slowly progressive valvular destruction will lead to congestive failure. Leukocytosis is quite unusual. Thrombocytopenia can occur. The degree of the anemia is associated with the chronicity of the infection. The peripheral stigmata and other complications of acute and subacute endocarditis, such as Osler nodes and Janeway lesions are absent. This is because there does not appear to be any significant degree of septic emboli or immune complex disease. Echocardiograms often are unremarkable. *Legionella* endocarditis has been described as fibrinous without prominent vegetations. **Box 1** presents this lack of clinical clues that make its diagnosis so difficult.[19,20]

DIFFERENTIAL DIAGNOSES

Legionella endocarditis is classified as CNIE. This term describes valvular infections that are diagnosed on the basis of the Duke Criteria, in which at least 3 sets of standard blood cultures have remained negative after 5 to 7 days of incubation and subculturing. The more common causes of CNIE are listed in **Box 2**.

CNIE, due to poor blood culture techniques can be divided into individuals previously given antibiotics and those in whom an insufficient amount of blood was cultured. In the case of the fastidious, intracellular organisms that we are discussing, proper blood culture techniques are aimed at avoiding unnecessary diagnostic delays when 3 sets of properly drawn blood cultures would have retrieved the usual pathogens of endocarditis.

Box 1
Challenges to diagnosing *Legionella* endocarditis

Negative standard blood cultures.

Although infection may be related to *Legionella* pneumonia, manifestation of the valvular infection may be separated by weeks from this event.

Little clinical evidence that valvular infection exists: rare embolic or immune complex manifestations of endocarditis. Often normal echocardiogram. No spiking temperatures.

Effects may mimic those of noninfectious diseases.

Box 2
Causes of culture-negative endocarditis

Prior antibiotic therapy: most common cause in the United States

Difficult to culture organisms

Right-sided endocarditis: weakly pathogenic organism such as *Streptococcal viridans* species that are filtered out in the pulmonary circulation

Infected pacemaker wires and prosthetic valves: probably due to biofilm laid down by coagulase-negative staphylococci

Because the concentration of organisms in the blood in endocarditis is fewer than 100 colony-forming units per milliliter, it is not the number of blood cultures that are obtained, but the volume of blood placed in each bottle. It appears that 10 mL of blood injected into each bottle is the optimum volume. Three sets of such prepared blood cultures will retrieve approximately 99% of the usual pathogens.[21]

The blood cultures should be obtained from a peripheral venipuncture. If at all possible, they should not be collected from central venous catheters because of the risk of contamination.[22]

Antibiotics that are administered before obtaining blood cultures certainly can sterilize those samples. It is the streptococci, especially viridans streptococci, whose growth is most susceptible. *Staphylococcus aureus* and enterococci are markedly less so.[23,24]

State-of-the-art blood culture techniques have reduced the percentage of CNIE cases from 30% to 5%. Infective endocarditis due to members of the HACEK (*Haemophilus*, *Aggregatibacter*, *Cardiobacterium*, *Eikenella*, *Kingella*) group, *Brucella* spp, and *Abiotrophia* spp are no longer classified as CNIE. Current blood culture techniques detect pathogens within 1 week. HACEK organisms usually grow out within 5 days. *Brucella* spp and *Abiotrophia* spp will often require longer than 1 week to retrieve.[25]

Resins or charcoal may be added to the media to neutralize the suppressive effects of antibiotics. There is a wide variation in their effectiveness. They themselves may inhibit bacterial growth as advised "As far as possible," blood cultures should be obtained before initiating antibiotic therapy.

The organisms that cause CNIE have strong associations with specific geographic areas. However, with globalization of infections, the clinician must have a worldwide awareness of those pathogens that have been associated with valvular infections. For example, among 348 cases of CNIE collected in southern France, 48% were attributed to *Coxiella burnetii*, and 28% to *Bartonella* spp. Approximately 1% were caused by a combination of organisms, including *Tropheryma whipplei*, *Legionella pneumophila*, *Abiotrophia* spp, and *Mycoplasma hominis*; 28% of patients had been given antibiotics before culturing of their blood.[1] In the United States, *Bartonella* spp appear to be the most common cause of CNIE.

It is important for the clinician to be aware of the epidemiology of clinical presentations when empirically choosing an initial antibiotic regimen that would need to cover 1 or more of these fastidious intracellular organisms. **Boxes 2** and **3** and **Tables 2–6** present helpful clinical characteristics of the most common causes of true CNIE.

MIMICS OF ENDOCARDITIS

The diseases that most commonly mimic CNIE are forms of vasculitis, marantic endocarditis, and atrial myxomas (**Table 7**).

Box 3
Mimics of culture-negative endocarditis

Marantic endocarditis

Rheumatologic diseases such as lupus

Atrial myxomas

Myocarditis and pericarditis also may complicate *Legionella* infection. They most likely are a consequence of bacteremia, originating from a pulmonary focus of *Legionella* infection. Clinical signs of pneumonia may or may not be present. Cardiac tamponade and constrictive pericarditis are fairly frequent complications. There are no distinctive symptoms or signs of *Legionella* pericarditis. Fever, chest pains, and myalgias are often present. Because it may respond temporarily to nonsteroidal anti-inflammatory drugs, it may be misdiagnosed as a viral process.

Myocarditis, due to *Legionella*, may be asymptomatic or present as flagrant congestive heart failure. Cases may be mistaken as viral myocarditis. However, most cases occur in the setting of clinical pneumonia. Usually, they respond to appropriate antibiotic treatment of the primary *Legionella* infection.[9,26,27]

DIAGNOSTIC APPROACHES

The most important step making the diagnosis of *Legionella* is for the clinician to suspect the possibility of such. Then, laboratory testing for *Legionella* cardiac infection should be based on a reasonable pretest probability that the patient has this disease: "Don't order a test just because you can."[28] This diagnosis should be considered in patients with prosthetic valves, no matter how long after their implantation and in whom blood cultures that have been properly obtained and negative. Under these conditions, if the patient has had *Legionella* pneumonia within the past few years or any other pneumonia without an etiologic diagnosis should further raise concern. The history of having been an inpatient in a facility that has had nosocomial outbreaks of Legionellosis is another point favoring the diagnosis. Certainly the lack of echocardiographic findings actually strengthens the likelihood that a given patient has *Legionella* endocarditis.

Legionella spp will grow out in standard blood culture media, but the concentration of the organisms is below that detectable by subculturing on routine media. However,

Table 2
Leading bacterial causes of culture-negative endocarditis

Organism	Comments
Bartonella spp	Most common cause of CNIE in the United States. Fever, acute heart failure, murmur with vegetation on echocardiogram. *Bartonella quintana* associated with homelessness. *Bartonella henselae* associated with cats.
Coxiella burnetii	Occurs in immunosuppressed individuals and in those with prosthetic valves. Usually no vegetation on echocardiogram.
Tropheryma whipplei	Multiorgan involvement especially gastrointestinal neurologic and musculoskeletal systems. Vegetation on echocardiogram. Acute cardiac failure.
Legionella spp	Highly associated with prosthetic valves, mechanical or bioprosthetic. Mild heart failure. Negative for vegetations on echocardiogram.

Table 3
Distinguishing clinical characteristics of chronic Q fever CNIE

1. Epidemiology	Typical patient is 60-year-old man who is exposed to farm animals and parturient cats. 10% of patients drink raw milk. 9% have various immunosuppression states. Currently remains an unusual cause of CNIE in the United States.
2. Clinical course	This chronic type of endocarditis can be present for up to a decade before the diagnosis is made.
3. Heart disease	90% have underlying valvular disease with prosthetic valves in >50% of patients. 39% of cases of chronic Q fever develop valvular infection. Valvular vegetations are really identified on either TTE or TEE. 20% develop arterial embolization, especially to the CNS. 67% develop CHF.
4. Peripheral stigmata	Splenomegaly is present in 50% of cases. There is a high rate of clubbing and purpuric rashes of the mucosa and of the extremities. These are secondary to the deposition of immune complexes. Immune complex disease can lead to glomerulonephritis with microscopic hematuria and renal insufficiency.
5. Mortality rate is approximately 30%	Comment: Q fever is the CNIE that most resembles Legionnaire's disease, especially with regard to the lack of valvular vegetations.[37]

Abbreviations: CHF, congestive heart failure; CNIE, culture-negative infective endocarditis; CNS, central nervous system; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography.
Data from Refs.[24,36,37]

Table 4
Distinguishing clinical features of *Bartonella* CNIE

1. Epidemiology	Essentially all cases are caused by *Bartonella quintana* and *Bartonella henselae*. Patients with *B henselae* are infected from close contact with chronically bacteremic cats. The organism is transmitted by bites of cat fleas or by cat scratches. Typical patients with *B quintana* are homeless alcoholic men (70% of cases) who live in shelters. They are infected by body lice.
2. Clinical course	The course of *Bartonella* CNIE is typical of subacute endocarditis. The symptoms are nonspecific of low-grade fever and weight loss.
3. Heart disease	There is underlying heart disease present in 88% of individuals with *B henselae* and in 30% of those with *B quintana*. 96% of infected valves exhibit large and often calcified vegetations. There is a high rate of prior cardiac surgery in patients with *B henselae* infection.
4. Peripheral stigmata	These may be due to antineutrophil cytoplasmic antibody–positive pauci-immune necrotizing vasculitis that can lead to glomerulonephritis and other manifestations of immune complex disease.
5. Mortality rate	<20%

Abbreviation: CNIE, culture-negative infective endocarditis.
Data from Refs.[24,38,39]

Table 5
Distinguishing clinical features of *Chlamydophila psittaci* CNIE

1. Epidemiology	90% of patients have history of exposure to domestic or wild psittacine birds. Although unusual, human-human transmission has been documented in the hospital setting. Patients are usually younger than those suffering from Q fever or *Bartonella* CNIE.
2. Clinical course	It is usually subacute in nature.
3. Heart disease	Underlying aortic valve disease is common.
4. Peripheral stigmata	There does not seem to be any increased incidence of vasculitic type of rashes.
5. Mortality rate	Remains high at approximately 40% despite the combined use of surgery and antibiotics.

Abbreviation: CNIE, culture-negative infective endocarditis.
Comment: In the past, with the use of the polyclonal antibody test, which cross-reacts between *Chlamydia* and *Bartonella*, there had been a high rate of *Bartonella* valvular infection being ascribed to *C psittaci*.
Data from Refs.[24,36,40,41]

periodic subculturing on buffered, charcoal yeast extract (BCYE) will recover the organism in approximately 40% of patients. Full identification of the organism on this media requires special staining and use of a dissecting microscope. Retrieval and identification of the organism may take up to 3 to 5 days.[8,13]

The most commonly used test for diagnosing Legionellosis is the urinary antigen test. Results are available within a few hours. It is reliable only for diagnosis of

Table 6
Distinguishing characteristics of *Tropheryma whipplei* CNIE

1. Epidemiology	The typical patient with this form of CNIE is a 50-year-old male white of European descent. Valvular infection may be part of the classic presentation of Whipple disease with polyarthritis, central nervous system involvement, fever or weight loss, diarrhea and abdominal pain, or it may be an isolated event. Endocarditis may occur in up to 55% individuals with *T whipplei* infection. This organism may be the third most common cause of CNIE.
2. Clinical course	Those with isolated Whipple disease suffer from minimal systemic symptoms of malaise and anorexia. It may well be discovered on examination of the valve that was resected due to significant incompetence. Often there is no fever. In those with Whipple disease, clinical course may range from seronegative migratory polyarthritis to full-blown Whipple disease.
3. Heart disease	There may be associated myocarditis and pericarditis.
4. Peripheral stigmata	There does not seem to be any significant rash associated with valvular involvement.
5. Mortality rate	There are no reliable figures for mortality due to valvular infection because of the difficulty in separating the effect of localized valvular infection from the consequences of systemic infection.

Abbreviation: CNIE, culture-negative infective endocarditis.
Data from Refs.[25,36,42,43]

Table 7
Mimics of CNIE

Disease	Comments
1. Marantic endocarditis	Because cases have cardiac murmur cardiac vegetation and negative blood cultures, this entity is an almost perfect mimic of CNIE. This entity is associated with a host of chronic conditions. These include solid tumors, vasculitis, malnutrition. An important point of difference is that patients with marantic endocarditis are usually afebrile. Most types of CNIE will have some degree of fever.
2. Viral myocarditis	Patients will have fever, murmur, and peripheral emboli. Viral myocarditis is a disease of young adults. There are no valvular vegetations in viral myocarditis.
3. Systemic lupus erythematosus	Verrucous valvular vegetations (Libman–Sacks) may be seen uncommonly in systemic lupus erythematosus.
4. Atrial myxomas	Patients are often febrile with emboli, as well as positive rheumatoid factors. Because of fever and the presence of significant vegetations, these cases may be easily diagnosed as CNIE.

Abbreviation: CNIE, culture-negative infective endocarditis.
Adapted from Cunha BA. Mimics of endocarditis. In: Brusch JL, editor. Endocarditis essentials. Sudbury (MA): Jones and Bartlett; 2011. p. 157–9.

L pneumophilia primarily serotype 1. It does appear to also detect other *Legionella* spp; however, its sensitivity and specificity in doing so has not been established.[29,30]

In a recent study, the Binax urine antigen test was up to 96% sensitive for detecting *L pneumophila*. The Binax NOW Legionella Urinary Antigen Kit has been useful in detecting *Legionella pneumophila* 6.[26] The investigators emphasized the challenges of assessing the utility of a specific testing modality in the case of an extremely low prevalence disease such as *Legionella* cardiac infections.[31,32]

On resected valvular tissue, broad-range polymerase chain reaction (16 S rRNA) for CNIE is more sensitive (66.1%).[25] There does not seem to be a great deal of experience in using this technique for detection of *Legionella* spp in such tissue (**Box 4**). These diagnostic modalities are applicable for use in all 3 types of *Legionella* cardiac involvement.

TREATMENT

In the 1980s and 1990s, therapy for *Legionella* endocarditis consisted mainly of erythromycin 2 g intravenously with rifampin 600 to 1200 mg per day orally as a standard

Box 4
Suggested diagnostic approach to diagnosis of *Legionella* CNIE in the United States

1. Obtain urinary antigen
2. If available, any sputum and wound discharge for culture on buffered, charcoal yeast extract (BCYE) media
3. Direct fluorescent antibody testing of sputum *Legionella* if available
4. Obtain serologic testing for *Bartonella* spp and *Tropheryma whipplei*
5. Use appropriate staining, culture, and broad-range polymerase chain reaction testing of excised valvular tissue.

Box 5
Antibiotic treatment of *Legionella* endocarditis

Ciprofloxacin 400 mg intravenously (IV) every 12 hours + 500 mg azithromycin IV every 24 hours for 3 to 6 months[a]
or
Doxycycline 200 mg IV every 12 hours for 3 days and 100 mg IV every 12 hours for 3 to 6 months[a]
or
Doxycycline 200 mg every 12 hours by mouth (PO) for 3 days, then 100 mg PO every 12 hours for 3 to 6 months[a]

[a] In the presence of a prosthetic valve, consider addition of rifampin 300 mg PO every 8 hours.

regimen. Ciprofloxacin alone had been used as well as doxycycline. These antibiotics were administered for 5 months. Sixty-seven percent of patients required removal of the prosthetic valve.[13]

It is well recognized that the effectiveness of an antibiotic in treating Legionellosis is dependent on the degree of its intracellular penetration.

Based on clinical experience, primarily in treating *Legionella* pneumonia, the use of a quinolone combined with azithromycin has been advocated.[33]

In vitro techniques, such as high-throughput intracellular antimicrobial susceptibility testing of *L pneumophila*, indicate that combining ciprofloxacin with azithromycin or rifampin or minocycline resulted in significant synergism. However, these combinations with levofloxacin instead of ciprofloxacin did not do as well. In all probability, one could substitute doxycycline for minocycline (**Box 5**).[34,35] Overall, mortality rate approximates 10% for endocarditis.

Antibiotic regimens for *Legionella* peritonitis and myocarditis are identical to those used for treating Legionella endocarditis. What is in question is the duration of antibiotic therapy. Most likely it should be at least 2 to 3 months in duration. Pericardiectomy is usually required in cases of constrictive pericarditis.[5]

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