

## Cat Scratch Disease

40

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## ABSTRACT

The transmission and prevalence of contagious diseases are intricately connected to interactions among humans, animals, and the broader ecosystem. Many infectious diseases affecting humans have their origins in animals, with a global escalation in both incidence rates and geographical distribution. The proximity and contact between humans and animals, particularly those serving as reservoirs for emerging zoonotic diseases, pose a significant risk for disease transmission. The contemporary surge in pet ownership amplifies concerns regarding potential infections transmitted from animals to humans. Among the spectrum of zoonotic diseases, Cat Scratch Disease (CSD) stands out as a global Anthrozoosis associated with *Bartonella henselae*, a Gram-negative bacterium. This disease was discovered in 1983. The transmission occurs anywhere cats and their fleas are present, leading to serious public health implications. Although CSD typically manifests as a self-limiting bacterial infection of regional lymph nodes, approximately 4% to 9.6% of cases develop severe symptoms necessitating hospitalization. These symptoms encompass retinitis/neuro-retinitis, brain or spinal cord inflammation, hepatosplenic disease, osteomyelitis, and skin rashes. The therapeutic approach to *Bartonella* infection is tailored based on the patient's clinical presentation and immune status, with a favorable prognosis observed in the majority of CSD cases, characterized by spontaneous resolution. The use of antibiotics for the treatment of CSD always remained a topic of debate, however, antibiotics can be used to shorten the course of CSD. Azithromycin, rifampicin, ciprofloxacin or trimethoprim-sulfamethoxazole can be used for the treatment of CSD. Scratches, bites and licks from kittens or stray cats should be avoided to minimize the risk of CSD. Moreover, A Comprehensive flea control system/treatment for cats can help to lower the risk of human infection.

**Keywords:** Zoonotic Diseases, Cat Scratch Disease, *Bartonella henselae*, Disease transmission, Public Health.

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## CHAPTER HISTORY

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## 1. INTRODUCTION

Humans, animals, and the ecosystem all have a substantial impact on the onset and spread of various contagious illnesses (Thompson and Kutz, 2019). The majority of diseases that afflict humans have their roots in animals. According to the "2010 Asia Pacific Strategy for Emerging Diseases" report, it was estimated that roughly 60% of emerging human infections are zoonotic (WHO, 2020). While in recent years, the newly emerged human diseases have been predominantly of animal origin (Rahman 2020). Emerging zoonosis refers to zoonotic diseases that are either recently identified, newly evolved, or previously known but are now experiencing a surge in incidence or expanding into new geographical areas, hosts, or vectors (Rahman et al. 2020). Over the past seven decades, at least 250 zoonosis have been identified as emerging or re-emerging zoonotic diseases. These diseases have been spreading rapidly on a global scale, both in terms of incidence and geographical distribution. Humans are at risk of contracting these diseases due to close contact with animals, which often serve as reservoirs for these emerging and re-emerging zoonotic diseases (Woolhouse and Gowtage-Sequerua 2005).

### 1.1. ZOONOTIC DISEASES OF PETS AND COMPANION ANIMALS

The presence of pets in bedrooms, allowed by approximately 14% to 62% of pet owners, poses an increased risk of zoonotic diseases (Chomel and Sun 2016). The population of companion and pet animals has significantly grown in recent decades, but it's important to recognize that these animals can also serve as a substantial reservoir for disease-causing agents. This surge in pet ownership has raised concerns about the potential transmission of infections to humans. In many contemporary households, animals are cherished as pets, placing a significant portion of the population at risk of contracting zoonotic diseases from their pets, companion animals, and even exotic birds and animals. Various types of infectious diseases, including viral, bacterial, parasitic, and fungal, are associated with these animals (Halsby KD et al. 2014).

Pets and companion animals are frequently associated with various zoonotic diseases, including but not limited to brucellosis, campylobacteriosis, chlamydiosis, cat scratch fever (caused by *Bartonella henselae*), ehrlichiosis, giardiasis, hantavirus, hookworm infections, influenza, rabies, Lyme disease, rocky mountain spotted fever, leptospirosis, monkeypox, pasteurellosis, Q fever, plague, roundworm infections, salmonellosis, methicillin-resistant *Staphylococcus aureus* (MRSA) infections, streptococcal infections, toxoplasmosis, and tularemia etc. These zoonotic diseases, including salmonellosis, staphylococcosis, and rabies, can be found across a broad spectrum of pets and companion animals (Halsby et al 2014; Day 2016; Jacob and Lorber 2016).

## 2. INTRODUCTION TO CAT SCRATCH DISEASE

Cat Scratch Disease (CSD) occurs worldwide, anywhere cats and their fleas are found. It is a self-limiting bacterial infection of the regional lymph nodes associated with a Gram-negative bacterium of *Bartonella* species. In humans, the disease usually becomes clinical after one to two weeks, following a feline scratch with primary signs of inflammatory nodules at the site of the scratch. Different *Bartonella* species cause diseases termed as bartonellosis in humans. *Bartonella* bacteria can infect humans through fleas, body lice, sand flies, or flea-infested animals.

### 2.1. HISTORICAL NOTES

The genus *Bartonella* belongs to the Alphaproteo bacteria class and Bartonellaceae family. It shares a close genetic relationship with *Brucella* and *Agrobacterium* while being less closely related to members

## ZOONOSIS

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of the Rickettsiaceae family (Rose and Koehler 2020). Debre et al. (1905) first reported the clinical syndrome of cat scratch disease in 1950 but until 1983, the causative agent was not recognized despite several studies. In the same year, Wear et al (1883) used Warthin-Starry silver stain and found small, gram-negative, pleomorphic bacillus in infected lymph nodes of CSD patients. What originally was known as "Cat Scratch Bacillus" was named as *Afipia felis* by Brenner et al. (1991). In 1993, there was a proposal to merge the genera *Bartonella* and *Rochalimaea* into a single genus and to exclude the Bartonellaceae family from the Rickettsiales order, based on genetic similarities (Rose and Koehler 2020).

### 2.2. ETIOLOGY

Cat scratch disease, an Anthropozoonosis with a global spread, is associated with *Bartonella henselae* and poses serious public health issues (Alonso et al, 2021). The causative agent of CSD was discovered in 1983, after 50 years of being unknown. At first, *Afipia felis* was suspected as the causative agent, but later studies did not support this hypothesis. In the 1990s, it was proven beyond doubt that *Rochalimaea henselae*, which was later renamed as *Bartonella henselae*, is associated with CSD. *Bartonella henselae* (*B. henselae*) can be found in the blood of cats and can infect other cats through fleas. However, it is unlikely that fleas directly transmit the bacterium to humans, but they may help increase the number of infected cats (Windsor 2001).

### 2.3. IDENTIFICATION OF BARTONELLA SPECIE

The initial isolated colonies of a specific *Bartonella* species can exhibit morphologies. For instance, in the case of *B. henselae*, it may appear as either (Koehler et al. 1883; Rose and Koehler 2020):

- Irregular, elevated, whitish, rough, and dry in texture, often described as "cauliflower", "molar tooth," or "verrucous." These colonies exhibit agar pitting and adhere strongly to the agar. or
- Flat, circular, with a moist appearance, and less adherent. These colonies are sometimes present alongside the rough ones within the same primary culture. The extent of colony heterogeneity varies depending on the species. *B. henselae* typically displays a higher proportion of rough colonies, whereas primary cultures of *B. quintana* colonies are almost always uniformly smooth, albeit varying in size. Subsequent subcultures of *B. henselae* on agar tend to show an increasing proportion of smooth colonies over time (Koehler et al. 1883; Rose and Koehler 2020).

Preliminary identification of either *B. henselae* or *B. quintana* can be established if the following characteristics are observed:

- Prolonged incubation time exceeding 7 days before colonies become visible.
- The appearance of small, curved, gram-negative bacilli in Gram stain.
- Negative reactions for catalase and oxidase (Dumler et al. 2019; Welch et al. 1993).

### 2.4. GEOGRAPHICAL DISTRIBUTION

Cat-scratch disease often exhibits a seasonal pattern, with the highest incidence during the autumn and winter months. This phenomenon could be attributed to cat breeding cycles or the tendency for people to acquire new young pets during these specific times of the year. (Windsor 2001). *B. henselae* is found all across the globe (Yehudina and Trypilka 2021). After the identification of the bacterial source of Cat Scratch Disease (CSD), the connection between cats and human infections caused by *B. henselae* was confirmed. Over 90% of patients had a documented history of contact with cats. In a case-control study, the highest correlation with CSD incidence was found in individuals who owned kittens aged 12 months

## ZOONOSIS

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or younger, had been licked on the face, scratched or bitten by a kitten, or possessed a kitten with fleas. (Allizond et al. 2019).

### 2.4.1. HUMANS

Cat scratch disease, an infection caused by *B. henselae*, is prevalent across the globe (Pal 2018a). However, it is important to mention that in most countries, cat scratch disease is not subject to mandatory reporting in human cases. (Sutu et al., 2020) Reports of this have been documented in numerous countries including the United States, Canada, Germany, The Netherlands, Switzerland, France, Spain, Italy, the UK, Japan, and Australia (Carithers 1985; Windsor 2001; Tsukahara, 2002; Willams et al. 2002; Pal 2018a). Following the late 1970s, the UK recorded a notably reduced number of cases, a change likely linked to the removal of the skin antigen test due to safety concerns. In regions with temperate climates, there is a heightened risk of CSD cases during the autumn and winter seasons. (Yehudina and Trypilka 2021). In the United States, cat scratch disease leads to approximately 22,000 reported cases each year, resulting in over 2,000 hospitalizations and causing an annual economic impact of \$12 million. (Pal 2007; Pal 2018a).

### 2.4.2. CATS

Serological studies have revealed that *B. henselae* infection is widespread among domestic cats, with antibodies ranging from 4% to 80%. Bacteremia in domestic cats can persist for varying periods, ranging from a few weeks to several years. (Theel and Ross 2019). Bacteremia is more frequently observed in young cats, particularly those under a year old, compared to older cats. Across domestic cat populations, significant regional differences have been noted in the prevalence of *B. henselae* type I (Houston I) and type II (Marseille). While in most parts of Europe, *B. henselae* type II is the predominant strain, in eastern Asia, type I accounts for the majority, comprising 70% to 80% of *B. henselae* isolates. (Nguyen 1952).

## 2.5. ROUTE OF TRANSMISSION AND CYCLE

Bartonellosis follows a typical pattern of vector-borne diseases. The reservoir host usually has intra erythrocyte bacteria. *Ctenocephalidis felis* is the arthropod vector responsible for horizontal transmission among cats (Baranowski 2022). The arthropod vector feeds on blood, picks up the infection and passes it on to another reservoir or accidental host (Regier et al. 2016). Recent investigations have revealed that arthropod vectors, like ticks, lice, chiggers, and mosquitoes are responsible for transmission (Regier et al. 2016), however, transmission of the disease to man depends upon environmental factors and type of contact (Greer and Keefer 1951).

The primary route of entry for *B. henselae* into the body is typically through a scratch that has been contaminated with flea feces. Furthermore, cat saliva carries microorganisms that can be transmitted to humans through either cat bites or through areas of the skin that the cat licks and causes abrasions. (Pal 2018a). The infection happens more often in colder seasons, which might be related to the way cats breed (Windsor 2001).

There is no supporting evidence to support the transmission of zoonotic *Bartonella* from one individual to another through casual contact. (Menezes et al. 2020). On the contrary, (Konstantinou et al. 2020) *Bartonella henselae* was successfully cultured from human red blood cell (RBC) units that were contaminated with the bacteria and incubated at 40°C for 35 days, indicating a potential risk of transmission through blood transfusions (Fig. 1).

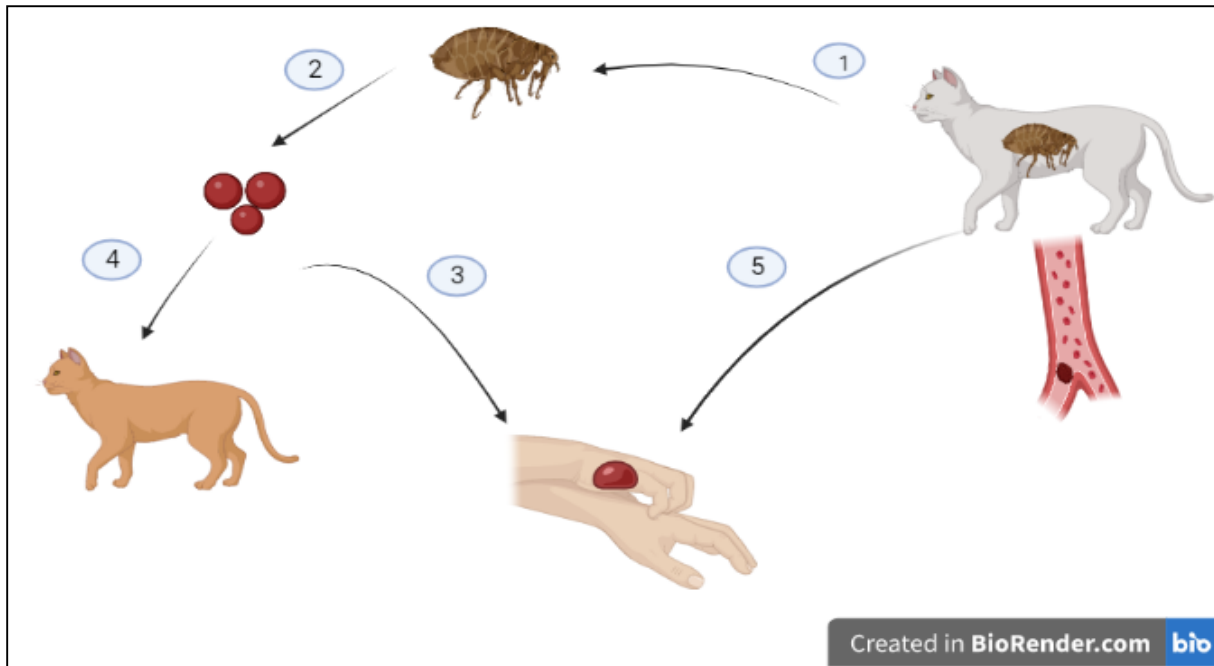


Fig. 1: Pattern of Transmission of Bordetellosis

## 2.6. PATHOGENESIS

The reaction to *Bartonella henselae* infection varies based on the immune system's condition in the infected individual. In those with a strong immune system, the response tends to be characterized by the formation of granulomas and the presence of pus, whereas immunocompromised patients typically exhibit a vasoproliferative response (Bass et al. 1997; Blagova et al. 2021), along with arteriolar proliferations and dilatations and lymphoid hyperplasia. Bartonella infection triggers a T-helper-cellular response mediated by interferon- $\alpha$ , resulting in the mobilization and activation of macrophages, leading ultimately to development of the granulomatous disease (Schweyer et al. 2002; Blagova et al. 2021).

## 2.7. DISEASE IN HUMANS

Cat-scratch disease is usually a mild illness that goes away on its own. However, about 4% to 9.6% of people with CSD develop more serious symptoms that require hospitalization. These symptoms can include retinitis/ neuro-retinitis, inflammation of the brain or spinal cord, hepatosplenic disease, osteomyelitis, and skin rashes etc. (Mazur-Melewska et al. 2015).

CSD primarily impacts the lymph nodes that receive lymphatic drainage from the site of introduction, typically resulting from a scratch or bite inflicted by a young feline. Cat scratch disease has been clinically documented for more than five decades; however, the specific bacterium responsible for the disease remained unidentified for a considerable period. Dr. Douglas Wear, a pathologist, successfully isolated a novel bacterium from the lymph nodes of individuals suffering from cat scratch disease. Subsequently, extensive research efforts spanning several decades were dedicated to uncovering the precise bacteriologic agent involved in this condition (Baranowski 2022).

The onset of the disease is marked by the presence of a reddish raised lesion (erythema), either single or in clusters, at the site of infection. The diagnosis becomes easier if the doctor has access to the patient's medical

## ZOONOSIS

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history and information regarding cat scratches or identifies visible signs of animal aggression. The lesion typically appears 3 to 10 days after the initial infection and progresses through stages of erythema, vesicles, papules, and crusting. In cases of typical cat-scratch disease (CSD), localized swelling of the lymph nodes occurs 1 to 3 weeks after the infection and can persist for several months (Mazur-Melewska et al. 2015).

### 2.8. CLINICAL SIGNS

The infection often seems to be asymptomatic therefore, the importance of *Bartonella* spp. as animal infections remains largely unclear. The complexity of investigations is largely contributed by the prevalence of infections in healthy animals, uncertainties in organism-specific diagnostic tests, and the potential for co-infection with other bacteria.

#### 2.8.1. CATS

Cats that naturally carry *B. henselae* bacteremia typically do not show any noticeable symptoms. In controlled experiments where cats were intentionally exposed to it, the majority remained asymptomatic or displayed only mild clinical indications, such as localized responses at the injection site, minor non-specific fevers, brief and mild behavioral or neurological issues, temporary and mild anemia, eosinophilia, or reproductive abnormalities. An exception was observed in one cat heavily infested with fleas, which may not have developed an effective immune response, and as a result, became seriously ill. A post-mortem examination of this cat revealed myocarditis. Similarly, establishing conclusive evidence that *bartonella* causes illness in naturally infected cats has been a challenging task. (Johnson et al. 2020).

#### 2.8.2. HUMANS

*Bartonella henselae* has the potential to disseminate and affect various organs like the liver, spleen, eye, or central nervous system in specific individuals. When the infection is localized, patients typically experience a condition that resolves on its own, but those with a systemic infection can face severe, potentially life-threatening complications. The most common clinical sign of Cat Scratch Disease (CSD) is persistent swollen lymph nodes. (Keret et al. 1998).

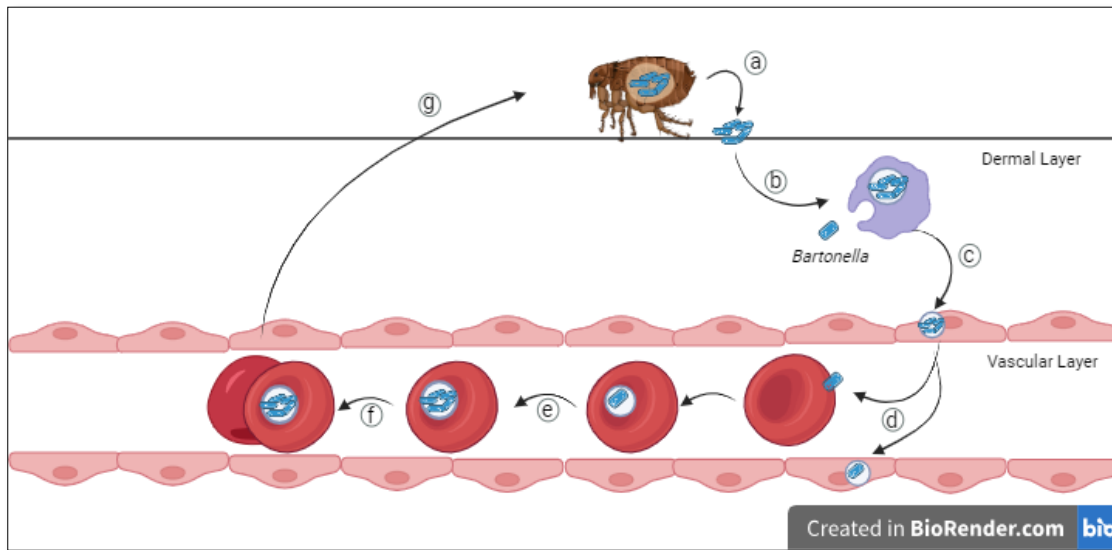
Common manifestations include warm, painful, and red nodes. Patients may also experience minor symptoms such as fever, as well as systemic issues like fatigue, general discomfort, loss of appetite, and headaches (Fig. 2). Typically, the majority of patients (around 50-85%) have only one affected node, with the most frequently involved nodes being in the axillary and epitrochlear regions, as well as the head and neck, and inguinal areas (Theel and Ross 2019).

### 2.9. DIAGNOSIS

Despite the fact that the CSD syndrome was originally described in 1950, the causative agent and diagnostic procedures weren't identified until the middle of the 1980s and later. Therefore, due to advancements in diagnostic procedures and other illnesses that resemble CSD, the epidemiology of CSD may have changed in recent decades (Meshar et al. 2016).

Diagnosing CSD can be difficult because the symptoms are often not specific to the disease (Amin et al. 2022). Additionally, it is difficult to culture the bacterium in the lab and there is no single test that is always accurate. However, the following tests can aid in the diagnosis of CSD (Pennisi et al. 2013);

- CSD may be diagnosed clinically in patients with typical signs and symptoms along with history.
- Blood tests can be used to look for antibodies to *B. henselae*, but these tests are not always reliable.



**Fig. 2:** The typical infection strategy employed by Bartonellae involves several stages, as depicted in the illustration. It begins with transmission through an arthropod vector (a). The bartonellae initially establish themselves in a primary location, likely by entering migratory cells (b) and eventually reaching the vascular endothelium (c), where they maintain an intracellular presence. Subsequently, these bacteria move into the bloodstream (d), where they infect erythrocytes and circle back to re-infect the primary site. Following limited replication within red blood cells (e), they persist within the intraerythrocytic environment (f), which is conducive to transmission by bloodsucking arthropods (g).

- Polymerase chain reaction (PCR) testing can be used to look for *B. henselae* DNA in tissue samples. To reduce false-negative results, repeated blood cultures are required, or PCR should be performed on multiple biological samples i.e., blood, lymph nodes, oral swab, etc.).
  - Serology (ELISA) can be more useful for exclusion than for confirmation of the infection. Although cross-reactivity with other *Bartonella* species may limit the interpretation.
- In the conventional approach, the identification of CSD used to necessitates meeting three out of four specific conditions (Barajas et al. 2017):
- Having had contact with a cat and exhibiting a primary inoculation site.
  - Receiving a positive result in the CSD skin test.
  - Obtaining negative findings in investigations ruling out other potential causes of subacute lymphadenopathy.
  - Displaying distinct histopathological characteristics in the biopsy results.

However, when patients do not present with a systemic illness, the isolation of *B. henselae* is often unsuccessful. In such cases, the most commonly employed diagnostic test involves serological examination for the presence of antibodies to *B. henselae*.

However, when patients do not present with a systemic illness, the isolation of *B. henselae* is often unsuccessful. In such cases, the most commonly employed diagnostic test involves serological examination for the presence of antibodies to *B. henselae*. (Annoura et al. 2020).

### 2.9.1. DIFFERENTIAL DIAGNOSIS

The differential diagnosis for typical Cat Scratch Disease (CSD) encompasses various causes of unilateral lymphadenopathy, including typical or atypical mycobacterial infections, tularemia, plague, brucellosis,

## ZOONOSIS

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syphilis, sporotrichosis, histoplasmosis, coccidioidomycosis, toxoplasmosis, infectious mononucleosis syndromes, lymphoma, and other types of neoplasms (Koehler and Duncan 2005). It is important to note that the diagnosis of CSD can be missed if the healthcare provider fails to obtain a comprehensive medical history, especially in cases of atypical CSD syndromes. This oversight can also occur in adult patients with typical CSD when internists without experience in diagnosing CSD are involved, as opposed to pediatricians. Additionally, in elderly adults over 60 years of age, manifestations of CSD can be less typical, further complicating diagnosis (Ben-Ami et al. 2005). Given that domestic cats are the most common type of companion animals in the United States, it is crucial to gather a thorough history of animal exposure when evaluating a patient exhibiting signs consistent with CSD. Fortunately, in the majority of CSD cases, typical or atypical, typically a spontaneous resolution occurs.

### 2.10. TREATMENT

The therapeutic approach for Bartonella infection is determined by the patient's clinical symptoms and immune status (Mazur-Melewska et al. 2015). Given the natural progression of uncomplicated CSD, antibiotics are not recommended for localized CSD (Klotz et al. 2011). In immunocompetent patients with mild-to-moderate infections, management involves reassurance, regular follow-up, and pain relievers (Mazur-Melewska et al. 2015; Zangwill 2021). If the lymph nodes become suppurative, aspiration is advised to alleviate discomfort, while caution is advised against incision and drainage due to the potential development of chronic sinus tracts. During aspiration, it is recommended to target multiple locations since multiple septate pockets containing coalesced microabscesses are often present (Mazur-Melewska et al. 2015).

The use of antibiotics for the treatment of CSD always remained a topic of debate, however, antibiotics can be used to shorten the course of CSD (Mazur-Melewska et al. 2015). In cases of significant lymphadenopathy, azithromycin can be used @ 10 mg/kg on the first day, followed by 5 mg/kg per day on days 2 to 5. Other options include rifampicin @ 20 mg/kg/day divided into two doses for 2-3 weeks, ciprofloxacin @ 20-30 mg/kg/day in two doses for 2-3 weeks, or trimethoprim-sulfamethoxazole (trimethoprim @ 8 mg/kg/day and sulfamethoxazole @ 40 mg/kg/day, divided into two doses).

### 2.11. PROGNOSIS

Immunocompetent patients with CSD typically have an excellent prognosis, with a high likelihood of complete recovery. However, in about 5-10% of cases, notable morbidity may arise, typically resulting from the involvement of the central or peripheral nervous system or the manifestation of disseminated disease affecting multiple body systems. It should be emphasized that experiencing a single episode of cat-scratch disease confers lifelong immunity to all affected individuals (Mazur-Melewska et al. 2015).

### 2.12. PREVENTION AND CONTROL

It is not advised to remove cats from households just because they are able to transmit *B. hensalea* (Konstantinou et al. 2020). Cat scratch disease can be prevented and controlled by the following measures (Mesher et al. 2016):

- Scratches, bites and licks from kittens or stray cats should be avoided to minimize the risk of CSD. Immunocompromised people should take special care about that.
- A Comprehensive flea control system/treatment for cats can help to lower the risk of human infection as CSD is a zoonotic infection that is sustained and transmitted among cats by fleas.



Washing hands after handling them might help lessen the risk by removing possibly contagious flea feces that could get inside the skin through cuts or abrasions.

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