

Bone and Vertebral Infections by *Listeria monocytogenes*

Subjects: **Infectious Diseases**

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Listeria monocytogenes is a Gram-positive pathogenic bacterium which can be found in soil or water. Infection with the microorganism can occur after ingestion of contaminated food products. Small and large outbreaks of listeriosis have been described in the past. *L. monocytogenes* can cause a number of different clinical syndromes, most frequently sepsis, meningitis, and rhombencephalitis, particularly in immunocompromised hosts. *L. monocytogenes* systemic infections can develop following tissue penetration across the gastrointestinal tract or to hematogenous spread to sterile sites, possibly evolving towards bacteremia. *L. monocytogenes* only rarely causes bone or joint infections, usually in the context of prosthetic material that can provide a site for bacterial seeding.

L. monocytogenes

imaging

microbiological diagnosis

surgical approach

antibiotic treatment

infections

1. Introduction

Listeria monocytogenes is a Gram-positive, motile, facultative, anaerobe bacteria that inhabits a broad ecologic niche [1][2]. The microorganism can be isolated from soil, water, and vegetation, including raw vegetables intended for human consumption without further processing [3][4]. Newer chromogenic media may offer advantages in the detection of contaminated food [5][6]. The surface contamination of meat and vegetables is common, with up to 15% of these foods harboring the microorganism. Furthermore, *L. monocytogenes* is a transient inhabitant of both animal and human gastrointestinal tracts; intermittent carriage suggests possible frequent exposure [7][8]. Usually, the gut is the source for microorganisms in case of invasive listeriosis; the virulence factor ActA is associated with carriage development [9]. The microorganism has a competitive advantage against other Gram-positive and Gram-negative bacteria in cold environments, such as refrigerators; it is also amplified in spoiled food products, possibly leading to increased alkalinity. Feeding of spoiled silage with a high pH has resulted in epidemics of listeriosis in sheep and cattle [10]. Several foodborne outbreaks of listeriosis have been the result of animal epidemics; the first one occurred in Canada and was associated with the ingestion of contaminated coleslaw [11]. Subsequently, many other foodstuffs have been implicated in different outbreaks, including cheeses made with raw or pasteurized milk or milk derivates [12][13][14][15][16][17][18][19][20][21][22][23], meat products [24][25][26][27][28][29], and fruits and vegetables [30][31][32][33][34]. **Table 1** summarizes the food products that are usually implicated in the occurrence of foodborne listeriosis. In addition, hospitalized individuals also seem to be at risk of acquiring *L. monocytogenes* infections [35]. To optimize the tracking of listeriosis cases, whole-genome sequencing has been developed; this has replaced

older techniques, such as serotyping [36][37]. However, the question of why outbreaks of listeriosis can occur in humans remains incompletely understood; a possible enhancement of organism-specific virulence factors may play a role in developing epidemic dissemination.

Table 1. Foods that are usually implicated in foodborne listeriosis.

Dairy Products	Fruits and Vegetables	Meat Products	Fish Products
Pasteurized whole milk	Coleslaw (cabbage)	Delicatessen foods (deli meats)	
Chocolate milk	Lettuce	Pâté	
Soft cheese (different types)	Corn	Foie gras	
Hard cheese	Rice salad	Uncooked hot dogs	
Mexican-style cheese	Salted mushrooms	"Rillettes"	
Goat cheese	Sprouts	Pork tongue in aspic	Shrimp salad Tuna salad
Ice cream	Strawberries	Pork pie	Smoked fish
Fresh cream	Nectarines	Beef	
	Apples	Turkey franks	
	Cantaloupes	Jellied pork	
	Blueberries	Cooked ham	
	Stone fruit	Ox tongue	
		Undercooked chicken	

L. monocytogenes only rarely causes bone and joint infections; this usually occurs in the context of prosthetic material that can provide a site for bacterial seeding.

1. Welshimer, H.J.; Donker-Voet, J. *Listeria monocytogenes* in nature. *Appl. Microbiol.* 1971, 21, 516–519.

2. Imaging Techniques

2. Linke, K.; Ruckerl, I.; Brugger, K.; Karpiskova, R.; Walland, J.; Muri-Klinger, S.; Tichy, A.; Wagner, M.; Stessl, B. *Reservoirs of Listeria species in three environmental ecosystems*. *Appl. Environ. Microbiol.* 2014, 80, 5583–5592.

of the disease; during the early stage of infection, no significant finding is usually detected. Furthermore, spinal stability must be assessed among patients in whom surgical management is being considered. Indeed, vertebral

collapse, kyphotic deformity, and loss of normal lordosis can be found in advanced infections. CT also provides

guidance for percutaneous aspirations in order to provide specimens for bacteriologic analysis in the presence of a fluid collection. MRI is the gold standard and represents the diagnostic imaging modality of choice. It should be performed among all patients for whom a spinal infection is suspected, unless contraindicated. Unenhanced T1-weighted images usually reveal a hypointense signal at the level of the end plates in the vertebral body and loss of

a normal hyperintense fat signal in the vertebral bone marrow. T2-weighted imaging reveals a high signal corresponding to edema in the disk space and occasionally in the bone and paravertebral soft tissues. Gadolinium-enhanced T1-weighted imaging can demonstrate the contrast enhancement of the vertebral body, end plates, the

prevertebral and paravertebral soft tissues, and the epidural space. Whenever the MRI is contraindicated or non-diagnostic (e.g., due to the presence of metallic implants causing artifacts), other imaging modalities should be considered. CT myelography provides another way of visualizing the spinal cord and ruling out compression in the

Surveillance of *Listeria* in food and foodborne infections in Europe: a review of the literature. *Food Environ Virol*. 2004; 6: 19–31. *Listeria* infections can occasionally be multifocal, so the whole spine should be scanned if an infectious focus is detected.

7. Grif, K.; Hein, I.; Wagner, M.; Brandl, E.; Mpamugo, O.; McLauchlin, J.; Dierich, M.P.; Allerberger, F. Prevalence and characterization of *Listeria monocytogenes* in the feces of healthy Austrians.

3. Microbiological Diagnosis

8. Gahan, C.G.; Hill, C. *Listeria monocytogenes*: Survival and adaptation in the gastrointestinal tract. The determination of a microbiological diagnosis of *L. monocytogenes* bone or vertebral infection is challenging, especially in the absence of referred exposures or negative blood tests. In this context, aspiration biopsy or surgical sampling represent the optimal method of providing a valid microbiological diagnosis. As a consequence, empirical antibiotic therapy should be delayed if the patient is hemodynamically stable and has no neurological signs

9. Ravier, L.; Guadagnini, S.; Gouain, E.; Dufour, A.; Cheral-Francisque, V.; Cossart, P.; Olive, M.; Gouin, J.M.; Dusson, O.; Lelat, M. *ActA* promotes *Listeria monocytogenes* aggregation, intestinal colonization and carriage. *PLoS Pathog*. 2013; 9, e1003131.

10. Low, J.C.; Renton, C.P. Septicaemia, encephalitis and abortions in a housed flock of sheep involvement [38]. However, the initiation of an antibiotic treatment does not always preclude undertaking a biopsy caused by *Listeria monocytogenes* type 1/2. *Vet. Rec.* 1985, 116, 147–150.

[39]; in those cases where antibiotic treatment has already been started, it has been demonstrated that interrupting antibiotic therapy for a few days before performing a biopsy [40].

11. Schleicher, W. Antibioticavage, Weeks Bortolassetti, R. A. Altemarre; Baldarelli, F. V. V. W. A. J. re-biopsy [40]. The high rate of antibiotic resistance in *Listeria* isolates [41] is a major concern for the safety of food

12. Bula, C.J.; Bille, J.; Glauser, M.P. An epidemic of food-borne listeriosis in Western Switzerland: therapeutic issues should be taken into consideration when managing *L. monocytogenes* vertebral infections. Description of 57 cases involving adults. *Clin. Infect. Dis.* 1995, 20, 66–72.

4. Surgical Approach

13. Centers for Disease Control and Prevention (CDC). Outbreak of listeriosis associated with homemade Mexican-style cheese: North Carolina, October 2000–January 2001. *MMWR Morb. Mortal. Wkly. Rep.* 2001; 50, 560–562.

In the absence of neurological deficits or sepsis, the optimal therapeutic approach comprises medical management with adequate intravenous antibiotics and immobilization of the affected spinal segment. Antibiotic therapy should

14. Frei, R.; Pichler, J.; Sager, O.; Mück, P.; Rappitsch, W.; Pletzna, A.T.; Stoger, A.; Hantusescu, S.; Heuberger, S.; Appi, G.; et al. Update: Multinational listeriosis outbreak due to quarg, a soft vertebral disc and prevent the occurrence of a neurological deficit or painful deformity. The duration of antibiotic therapy varies depending on the extent of bone involvement and the status of the patient's immune system. *Euro Surveill.* 2010; 15, 19543.

15. Carrique-Mas, J.J.; Hökeberg, I.; Andersson, Y.; Arneborn, M.; Tham, W.; Danielsson-Tham, M.L.; as well as the extent of bone erosion and the specific vertebral level involved. The principles of surgical treatment Osterman, B.; Leffler, M.; Steen, M.; Eriksson, E.; et al. Febrile gastroenteritis after eating on-farm, include debridement of infected tissue, 'decompression' of neural elements, and the restoration of spinal alignment manufactured fresh cheese: An outbreak of listeriosis? *Epidemiol. Infect.* 2003, 130, 79–86. and/or correction of spinal instability. The presence of neurological deficits is considered to be the most important

16. Loeffelholz, M.; de la Maza, L.; Loeffelholz, J.; Lopez, D.; Gaudet, V.; May, S.; Gualtieri, C.; Hidalgo, D.; Venero, J.; Yarchoan, J. Surgical intervention for *Listeria* vertebral discitis. *Spine*. 1998; 23, 101–105.

17. Choi, M.J.; Jackson, K.A.; Medius, C.; Beal, J.; Rigdon, C.E.; Cloyd, T.C.; Forsther, M.J.; Ball, J.; Bosch, S.; Botticchio, L.; et al. Multistate outbreak of listeriosis linked to soft-ripened cheese: United States, 2013. *MMWR Morb. Mortal. Wkly. Rep.* 2014, 63, 294–295.

better addressed with an open surgical approach. In addition, the optimal surgical approach is selected after consideration of the intrinsic features of each anatomic region of the spine and the likelihood of postoperative

Table 2 Characteristics of patients with *Listeria monocytogenes* vertebral osteomyelitis.

Author	Age	Gender	Co-Morbidities	Clinical Symptoms	Duration of Symptoms	Antibiotic Treatment and Duration	Surgery	of sis. Am.
Adebolu et al. [47]	60	M	Polymyalgia rheumatica	Back pain	12 months	Ampicillin, IV, 6 weeks Gentamicin, IV, 2 weeks	Yes	ekar,

Author	Age	Gender	Co-Morbidities	Clinical Symptoms	Duration of Symptoms	Antibiotic Treatment and Duration	Surgery
Khan et al. [48]	69	M	Prior spinal laminectomy	Back pain	5 months	Ampicillin, IV * Gentamicin, IV *	Yes
Camp et al. [49]	67	M	DM, prior lumbar surgery	Back pain	Unknown	Oxacillin, IV * Streptomycin, IV *	Yes
Chirgwin et al. [50]	57	M	DM, asthma	Fever, back pain	3 weeks	Ampicillin, IV, 6 weeks Tobramycin, IV, 6 weeks	Yes
Aubin et al. [51]	92	M	DM, heart failure, hip arthroplasty	Fever	1 week	Amoxicillin, IV, 6 days Gentamicin, IV, 4 days Trimethoprim-sulfamethoxazole, oral, 12 weeks	Yes
Hasan et al. [52]	63	M	DM, aortic valve replacement	Fever, back pain	2 days	Benzyl penicillin, IV, 6 weeks Rifampicin, oral, 4 weeks Amoxicillin, oral, 18 weeks	Yes
Duarte et al. [53]	65	M	DM	Fever	5 days	Ampicillin, IV, 2 weeks Amoxicillin, oral, 12 weeks	Yes
Al Ohaly et al. [54]	79	M	Hypertension, carotid bypass, repair of AAA	Back pain	3 weeks	Ampicillin, IV, 6 weeks	No

abscess due to *Listeria monocytogenes*—Case report and review of literature. *J. Bone Jt. Infect.* 2022, 7, 75–79.

48. Khan, R.M.; Pao, W.; Kehdler, J. *Epidural abscess and vertebral osteomyelitis caused by Listeria monocytogenes: Case report and literature review*. *Scand. J. Infect. Dis.* 2001, 33, 714–716.

49. Camp, C.; Luft, W.C. *Listeria monocytogenes osteomyelitis*. *Guthrie Bull.* 1973, 43, 32–38.

50. Chirgwin, K.; Gleich, S. *Listeria monocytogenes osteomyelitis*. *Arch. Intern. Med.* 1989, 149, 931–932.

51. Aubin, G.G.; Bouteille, D.; Bourcier, R.; Caillon, J.; Lepelletier, D.; Bémer, P.; Corvec, S. *Unusual Case of Spondylodiscitis due to Listeria monocytogenes*. *J. Bone Jt. Infect.* 2016, 1, 7–9.

52. Hasan, T.; Chik, W.; Chen, S.; Kok, J. *Successful treatment of Listeria monocytogenes prosthetic valve endocarditis using rifampicin and benzylpenicillin in combination with valve replacement*. *JMM Case Rep.* 2017, 4, e005085.

53. Duarte, F.; Moreira Pinto, S.; Trigo, A.C.; Guimaraes, F.; Pereira, R.; Neno, M.; Correia de Abreu, R.; Neves, I. A rare presentation of *Listeria monocytogenes* infection: Perianal abscess associated with lumbar spine osteitis. *IDCases* 2019, 15, e00488.

54. Al Ohaly, R.; Ranganath, N.; Saffie, M.G.; Shroff, A. *Listeria* spondylodiscitis: An uncommon etiology of a common condition; a case report. *BMC Infect. Dis.* 2020, 20, 559.

55. Bongiovanni, M.; Barda, B.; Martinetti Lucchini, G.; Gaia, V.; Merlani, G.; Bernasconi, E. Invasive Listeriosis in Southern Switzerland: A Local Problem That Is Actually Global. *Clin. Infect. Dis.* 2023, 77, 161–162.

56. Berbari, E.F.; Kanj, S.S.; Kowalski, T.J.; Darouiche, R.O.; Widmer, A.F.; Schmitt, S.K.; Hendershot, E.F.; Holtom, P.D.; Huddleston, P.M., 3rd; Petermann, G.W.; et al. Infectious Diseases Society of America (IDSA) Clinical Practice Guidelines for the Diagnosis and Treatment of Native Vertebral Osteomyelitis in Adults. *Clin. Infect. Dis.* 2015, 61, e26–e46.

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