Susceptibility of Polish *Bartonella henselae* Strains

EDYTA PODSIADŁY*, DOROTA ZABICKA1, URSZULA DEMKOW1, WALERIA HRYNIEWICZ2 AND STANISŁAW TYLEWSKA-WIERZBANOWSKA1

1National Institute of Public Health – National Institute of Hygiene, Warsaw, Poland
2 National Medicines Institute, Warsaw, Poland, 3Warsaw Medical University

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**Abstract**

Due to the fastidious nature of *B. henselae* and the limited number of available isolates worldwide, there are few data on its *in vitro* susceptibility to antibiotics. We determined the minimal inhibitory concentrations (MIC) of ten antimicrobial agents against 11 feline isolates of *B. henselae* by Etest method. The lowest MICs were obtained for rifampicin ≤ 0.002 mg/L. MICs of all isolates were <0.016 mg/L for ampicillin, amoxicillin/clavulanic acid, tetracycline and ranged from 0.016 to 0.032 mg/L for azithromycin. The MICs for two tested fluoroquinolones: ciprofloxacin and levofloxacin ranged from 0.016 to 0.125 mg/L. The highest MICs were obtained for gentamicin ranging from 0.025 to 2.0 mg/L. Sulphonamide resistance genes *sul*1, *sul*2, *sul*3 were not found in any of the tested isolates. Etest methodology seems to be a reliable method for determination of *B. henselae* susceptibility, however standardization is strongly desired.

**Key words:** *Bartonella henselae*, MIC, antibiotics

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Over the last decade the number of *Bartonella* species has increased rapidly. Simultaneously some new species have been associated with clinical syndromes in humans (Chomel et al., 2006). Treatment of human bartonellosis depends on the clinical presentation of the disease. Recommendations for treatment are based on a few case reports and a few clinical studies (Rolain et al., 2004). Because of limited number of isolates, specially human isolates, also data regarding *in vitro* susceptibility are very limited. Isolation of *Bartonella* spp. from clinical specimens requires long incubation times, special growth conditions and is rarely possible. As feline strains are easier to culture, susceptibility testing can be done on these isolates. The aim of the present study was to determine the MICs of 10 antibiotics by Etest method for 11 *B. henselae* feline strains. Moreover, the presence of *sul* genes conferring sulphonamide resistance was determined in the examined isolates.

Eleven *B. henselae* strains were collected from healthy, stray cats in 2004–2005 in urban areas of Warsaw and surroundings. For susceptibility study the strains were recovered from frozen stocks onto chocolate blood agar supplemented with VITOX (Choc V, Oxoid) and cultured at 37°C in 5% CO2 enriched atmosphere. Microorganisms were harvested, from second passage after refreezing, from logarithmic growth on chocolate agar (7–8 days), centrifuged and suspended in 2 ml of sterile 0.9% NaCl and adjusted to a McFarland standard of 3.0. The suspension was swabbed on the entire surface of a chocolate blood agar plate supplemented with VITOX (Choc V, Oxoid) 3 times, rotating the plate approximately 90 degrees each time. Excess moisture was allowed to absorb for about 10 to 15 minutes. Susceptibility testing was performed for: trimethoprim-sulphamethoxazole (0.002–32), ampicillin (0.016–256), amoxicillin/clavulanic acid (0.016–256), cefotaxime (0.016–256), azithromycin (0.016–256), ciprofloxacin (0.002–32), levofloxacin (0.002–32), tetracycline (0.016–256), gentamicin (0.016–256), clindamycin (0.016–256), rifampicin (0.002–32) using E-tests (bioMérieux, former AB BIODISK, Sweden). Zones of inhibition were recorded on the 4th and 7th day of incubation as a point of intersection between the inhibition ellipse edge and Etest strip. A growth control plate was inoculated with each test run.

In order to check the performance of Etest CLSI reference strains: *Enterococcus faecalis* ATCC 29212 for gentamicin and clindamycin, *E. coli* ATCC 35218 for amoxicillin/clavulanic acid and *Haemophilus influenzae* ATCC 49247 for remaining tested antibiotics were used as the quality control.

Studied strains of *B. henselae* were screened for *sul*1, *sul*2 and *sul*3 genes using specific oligonucleotide primers, as previously described (Kerrn et al., 2002; Perreten et al., 2002; Perreten et al., 2004). Because of limited number of isolates, specially human isolates, also data regarding *in vitro* susceptibility are very limited. Isolation of *Bartonella* spp. from clinical specimens requires long incubation times, special growth conditions and is rarely possible. As feline strains are easier to culture, susceptibility testing can be done on these isolates.
and Boerlin, 2003). Total genomic DNA was extracted from Bartonella isolates, cultured for 7 days in conditions described above with QIAamp Tissue kit (Qiagen, Hilden, Germany) according to manufacturer instructions. The PCR conditions were as follows: initial denaturation 94°C for 5 min followed by 35 cycles: 94°C for 1 min, 60°C (sul 1, sul 2)/51°C (sul 3) 1 min, 72°C 1 min and final extension 72°C 10 min (Gradient Mastercycler, Eppendorf). Two E. coli strains susceptible and two resistant to trimethoprim-sulphamethoxazole in a standard disc diffusion method were run as controls.

Among 11 tested feline isolates of B. henselae by Etest method the lowest MICs were obtained for rifampicin ≤ 0.002 mg/L (Table I). All isolates were highly susceptible to tetracycline with MICs ≤ 0.016 mg/L. Also the macrolide – azithromycin was highly active with MICs ranging from 0.016 to 0.032 mg/L.

The tested B. henselae strains were highly susceptible to β-lactams. MICs of tested antibiotics from this group were as follows: ampicillin and amoxicillin/clavulanic acid < 0.016 mg/L. Also the macrolide – azithromycin was highly active with MICs ranging from 0.016 to 0.032 mg/L.

The highest MICs were obtained for gentamicin, ranging from 0.25 mg/L to 2.0 mg/L. MICs determined for gentamycin were higher than for other antibiotics and ranged up to 2.0 mg/L. Among aminoglycosides netilmicin was reported to be the most active agent (Dorbecker et al., 2006).

For two tested fluoroquinolones: ciprofloxacin and levofloxacin MICs ranged from 0.016 to 0.125 mg/L. Eight of 11 (72.7%) tested strains had MIC for levofloxacin higher or equal to 0.094 mg/L whereas for ciprofloxacin for the majority of strains (63.3%, 7/11) values of MIC were 0.047 mg/L and lower. Comparing the obtained MICs for ciprofloxacin and levofloxacin it seems that ciprofloxacin is slightly more active against Bartonella spp. than levofloxacin however, a higher dosage is applied in case of the latter. Despite the fact that fluoroquinolones have the ability to achieve high intracellular concentrations, their potential role in the therapy of Bartonella infections remains unclear. Although successful treatment of Bartonella infections with fluoroquinolones has been reported, there have also been failures and relapses with these drugs (Wolfson et al., 1996). Recently Angelakis et al. (2009) reported that B. henselae can easily become resistant to fluoroquinolones. A ciprofloxacin-resistant strain of B. henselae was obtained in vitro after only four passages, MIC for the strain increased from 0.38 to > 32 mg/L. Bartonella spp. present a natural Ser-83-Ala mutation (E. coli numbering) in the QRDR region of the DNA gyrase that is responsible for decreased susceptibility to fluoroquinolones. Additional mutation Asp-87-Gly in the gyrase A protein results in a high level of resistance to all quinolone compounds (Angelakis et al., 2008). According to some authors, a second mutation may be obtained easily with consequent high level of resistance to fluoroquinolones. It is suggested that fluoroquinolone compounds should be avoided for treatment of Bartonella. Bacterial resistance to fluoroquinolones developing during treatment is not restricted to Bartonella but is also observed in other bacteria species. According to EUCAST (version 2.0, valid from January 1, 2012, www.eucast.org) for the non-species

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<th>AZ</th>
<th>CI</th>
<th>LE</th>
<th>TC</th>
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</table>

1profiles shown as numbers (alleles) corresponding in order with the loci BHV-A, BHV-B, BHV-C, BHV-D, BHV-E; nd – not detectable; Am - ampicillin, XL - amoxicillin/clavulanic acid, CT - cefotaxim, AZ - azithromycin, CI - ciprofloxacin, LE - levofloxacin, TC - tetracycline, TC - trimetoprim/sulphamethoxazole (1/19), GM - gentamicin, CM - clindamycin, RI - rifampicin
related breakpoints based on standard dosages and pharmacokinetic and pharmacodynamic properties of an antibiotic all analyzed drugs were in the range of susceptible values. However the gentamicin MIC \(=2.0\) mg/L obtained for one strain in our study is the highest possible value for susceptible strains.

Reading and interpretation zones of inhibition for sulphonamides and trimethoprim was not possible because the point of complete inhibition was not distinguishable at the edge of E-test. PCR testing for the presence of sulphonamide resistance genes was applied. In none of our tested strains sulphonamide resistance genes sul1, sul2, sul3 were found. Sulphonamides, especially in the combination as trimethoprim-sulfamethoxazole, are widely used to treat bacterial and protozoal infections (Perreten and Boerlin, 2003). These agents are also effective in the treatment of CSD (Rolain et al., 2004). Sulphonamides alone are widely used to prevent and treat diarrhea and other infectious diseases in intensive animal husbandry. That can have an impact on the spread of sulphonamide resistance genes, which are associated with class 1 integrons residing in plasmids or the bacterial chromosome. Especially that persistent asymptomatic bacteriemia in cats is reported to last up to 2 years (Chomel et al., 2006). This is to our knowledge the first study searching for the presence of sulphonamide resistance genes in Bartonella.

The susceptibility of the strains was set against previous molecular characteristics of the strains (Podsiadly et al., 2012). No significant variation in susceptibility with genotype (16S rRNA type) was detected. However, three already described profiles for BHV A-B-C-D-E (9-15-2-1-1, 10-14-2-2-1 and 9-15-2-2-1) corresponding to three common European VNTR profile for feline isolates, presented four dilutions higher MIC for gentamicin and six dilutions higher MICs for ciprofloxacin (Table 1).

Etest methodology seems to be a reliable method for determination of B. henselae susceptibility. Our results correlate with MICs reported by Pendle et al. (2006) and Angelakis et al. (2009). MICs obtained for fluoroquinolones and gentamicin are compatible with the results of testing other Bartonella spp. isolates (Tsuneoka et al., 2010). However, the differences in MICs between studies are also visible. For example in the study by Dorbecker et al. (2006) MICs for gentamicin were up to 8 mg/L whereas in our study only in 1 of 11 strains MIC equaled 2 and in 3 strains MIC = 1.0 mg/L. A similar situation was found for the MICs of ciprofloxacin and levofloxacin for which recorded MICs were 4 times higher than in our study. The discrepancies in MIC values might be influenced by many factors such as: medium, inoculum and others. Standardization should be proposed to monitor the development of resistance in isolates and to enable comparison of results reported in the different studies.

Routine susceptibility testing of B. henselae isolates is impossible, therefore the surveillance studies made by specialized reference centres are important to review treatment recommendations, specially of persistent Bartonella infections and for monitoring the emergence of resistance in this group of bacteria.

**Literature**


