

# Use of antibacterial chemotherapeutics in the treatment of small mammals. Analysis of clinical cases from 2015 to 2024

© SYLWIA LEWANDOWSKA<sup>1</sup>, © JERZY ZIĘTEK<sup>1</sup>,  
© OLIWIA BRZEZIŃSKA<sup>2</sup>, © ŁUKASZ ADASZEK<sup>1</sup>

<sup>1</sup>Department of Epizootiology and Clinic of Infectious Diseases, Faculty of Veterinary Medicine,  
University of Life Sciences in Lublin, Głęboka 30, 20-612 Lublin

<sup>2</sup>Department and Clinic of Internal Animal Diseases, Faculty of Veterinary Medicine,  
University of Life Sciences in Lublin, Głęboka 30, 20-612 Lublin

Received 06.02.2026

Accepted 05.03.2026

Lewandowska S., Ziętek J., Brzezinska O., Adaszek Ł.

## Use of antibacterial chemotherapeutics in the treatment of small mammals. Analysis of clinical cases from 2015 to 2024

### Summary

This article presents an analysis of medical records of patients treated at the Veterinary Clinic of the Faculty of Veterinary Medicine at the University of Life Sciences in Lublin, from 1 October 2015 to 1 October 2024. This period saw an increase in the number of small mammal patients in the Small Mammal Unit. The development of diagnostic methods, including more frequent use of additional diagnostic tests, enables faster accurate diagnosis and shortens treatment duration. This is particularly important in view of the frequent and prolonged overuse of chemotherapeutic agents in small mammal medicine.

**Keywords:** small mammals, antibiotic resistance

Small mammals, also known as “micromammals” or “pet mammals” are increasingly being kept as companion animals (21, 32) and, consequently, their share in the total number of patients admitted to veterinary facilities is steadily increasing (8). The opportunity to specialize in rodent and small mammal diseases, easy access to courses and training, and the growing number of available scientific publications allow veterinarians to extend their knowledge of the physiology, husbandry, and treatment of these patients. A growing number of facilities are also being established that specialize exclusively in small mammal medicine (33) and are equipped with the appropriate personnel and diagnostic capabilities to provide these patients with the most specialized care possible. Moreover, owners become increasingly involved in the prevention and treatment of their small pets, which translates into the provision of appropriate veterinary care. The most common problems encountered in veterinary clinics in the case of these animals include bacterial infections of the respiratory and gastrointestinal system, skin, as well as dental abscesses requiring antibiotic therapy. In times of globally increasing drug resistance of microorganisms, it seems that the use of antibiotics

in small mammals, even though they are administered in low doses, should be rational and based on appropriate guidelines (1, 5, 9, 19). In view of the above, the aim of this study was to analyze changes in the use of antibacterial chemotherapeutics in small companion mammals between 2015 and 2024 and to identify clinical and diagnostic factors that contribute to limiting their unjustified use.

### Material and methods

The study material consisted of patient records from the Small Mammal Outpatient Clinic of the University of Life Sciences in Lublin, Poland. The analysis included records of 25,665 patients admitted between 1 October 2015 and 1 October 2024, who received antibiotic therapy. The analysis concerned clinical visits during which the decision was made to administer an antibacterial chemotherapeutic agent as part of the treatment. The patients analyzed belonged to the following species: rabbit (*Oryctolagus cuniculus* f. *domesticus*), guinea pig (*Cavia porcellus*), chinchilla (*Chinchilla*), degu (*Octodon*), hamster (*Cricetinae*), rat (*Rattus*), mouse (*Mus*), gerbil (*Gerbilliscus*), white-bellied hedgehog (*Atelerix albiventris*), and ferret (*Mustela furo*) (Tab. 1). Their records were analyzed taking into account

whether antibacterial chemotherapeutics were used in their therapy and the percentage of patients who were prescribed antibiotics and chemotherapeutics safe for a given species was determined (3, 4, 13, 16, 24). Attention was also paid to the type of antibacterial chemotherapeutics used, grouping them according to their chemical structure according to the classification criteria generally accepted in pharmacology (19). These were:

- tetracyclines (doxycycline and oxytetracycline)
- fluoroquinolones (enrofloxacin, marbofloxacin, pradofloxacin)
- macrolides (azithromycin, tulathromycin)
- beta-lactams (penicillin, cephalosporins, amoxicillin)
- sulfonamides (sulfamethoxazole, sulfadoxine, sulfadiazine in combination with trimethoprim).

All factors that could influence (directly or indirectly) the veterinarian's decision to use chemotherapeutic agents in a given case were also taken into account, including the frequency of ordering additional diagnostic tests: hematological examinations, urinalysis, and also bacteriological, parasitological, imaging, and cardiological examinations. All of these factors could have influenced the accuracy of the medical diagnosis, thereby minimizing the risk of unjustified use of antibiotics, so-called "blind" therapy.

Additionally, the frequency of preventive treatments, such as vaccinations, deworming, and periodic preventive examinations, was taken into account, that, according to the authors, may influence the incidence of infections requiring the use of chemotherapy. Attention was also paid to the frequency of surgical and dental procedures. Clinical experience indicates that well-considered and decisive surgical or dental intervention allows for a relatively rapid achievement of a lasting therapeutic effect that would otherwise be difficult or impossible to obtain and would certainly require the long-term administration of multiple drugs, including antibacterial chemotherapeutics.

## Results and discussion

Table 1 presents the number of patients analyzed in subsequent years of observations. During the study period, there was a significant and systematic increase in the number of small mammals kept as companion animals. The number of patients increased from 188 in the 2015/2016 academic year to 5,371 in 2023/2024, indicating a more than 28-fold increase in the number of consultations over the analyzed period.

Table 2 provides the percentage distribution of patient species. Rabbits were the most frequently represented species, with an average percentage of admissions at 39.7% throughout the study period, and observed to increase. The second largest group were guinea pigs, whose percentage remained relatively stable (average 21.43%). Rats accounted for 18.65% of the patients on average, with their percentage peaking in 2017-2019. Other species (chinchillas, degus, hamsters, mice, gerbils, white-bellied hedgehogs, and ferrets) constituted a smaller but constant percentage of the patient population.

Table 3 presents the percentage of patients in each year of observation who received specific chemotherapeutic agents. Over the analyzed period, a clear downward trend was observed in the overall use of antibiotics – from 63.82% of cases in the 2015/2016 academic year to 32.52% in 2023/2024. A particularly significant decline was noted after the 2017/2018 academic year, when the percentage of patients administered antibiotics decreased below 40% and remained low in the subsequent years. The most pronounced changes concerned fluoroquinolones, the use of which decreased from 34.04% of cases in the 2015/2016 academic year to 8.47% in 2023/2024. In contrast,

**Tab. 1. Changes in the number of patients (small mammals kept as companion animals) admitted to the Veterinary Clinic of the University of Life Sciences in Lublin. The presented data were collected within the so-called academic year, calculated from 1 October of a given year to 1 October of the next year**

Years	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Number of patients	188	275	993	1,706	2,857	4,109	4,516	5,650	5,371

**Tab. 2. Percentage (%) of individual species of small mammals admitted to the Veterinary Clinic of the University of Life Sciences in Lublin. The presented data were collected within the so-called academic year, calculated from 1 October of a given year to 1 October of the next year**

Years	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	Average
Rabbits	38.22	30.90	35.85	34.05	35.31	38.11	40.81	41.98	43.32	39.70
Guinea pigs	20.21	22.54	19.23	17.01	21.14	26.55	21.22	21.24	21.24	21.43
Rats	14.89	16.72	25.27	25.43	22.12	17.69	18.33	16.19	17.27	18.65
Chinchillas	4.78	4.00	2.51	4.57	3.01	3.06	3.56	3.87	3.18	3.45
Degus	1.06	1.09	0.70	0.64	0.87	0.90	0.08	0.58	1.00	0.81
Hamsters	8.51	5.09	6.54	7.79	13.05	10.44	14.30	11.43	8.67	10.86
Mice	1.06	1.45	2.61	1.81	1.15	2.48	2.14	1.80	1.60	1.88
Gerbils	3.19	3.27	0.20	0.58	1.50	1.46	0.44	0.38	0.52	0.77
White-bellied hedgehogs	2.12	2.54	3.12	1.64	2.10	1.19	2.25	1.80	2.02	1.91
Ferrets	4.78	4.72	3.62	2.93	2.94	2.09	0.57	0.63	0.37	1.40

**Tab. 3. Percentage (%) of clinical cases of small mammals kept as companion animals administered antibacterial chemotherapeutics. The presented data were collected within the so-called academic year, calculated from 1 October of a given year to 1 October of the next year**

Years	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Antibiotics	63.82	61.45	43.80	36.92	37.45	31.76	34.07	29.88	32.52
Macrolides	10.63	14.18	10.77	6.03	4.51	6.86	6.79	10.01	9.79
Tetracyclines	1.59	1.09	1.61	2.63	3.74	2.00	1.74	1.22	1.21
Sulfonamides	15.95	12.00	9.86	8.32	7.91	3.65	3.72	3.38	3.74
Beta-lactams	1.59	4.00	6.14	4.16	4.90	6.15	7.83	10.77	9.30
Fluoroquinolones	34.04	30.18	15.40	15.76	16.38	13.09	11.73	11.39	8.47

**Tab. 4. Percentage (%) of cases involving additional diagnostic tests, surgical procedures, and dental procedures. The presented data were collected within the so-called academic year, calculated from 1 October of a given year to 1 October of the next year**

Years	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Prevention	3.16	5.81	6.34	9.78	10.29	9.25	9.85	10.23	10.09
Biochemistry and morphology	7.97	12.36	18.83	18.64	19.21	20.22	19.88	20.37	19.87
Hormonal tests	0	0	0	0.11	0.17	0.68	1.32	1.45	1.48
Urine tests	2.19	2.90	2.81	3.57	3.41	3.04	3.39	3.86	3.88
X-ray examinations	2.25	2.36	2.51	3.16	3.25	3.30	3.80	5.13	6.44
Ultrasound examination	2.12	2.90	3.22	3.93	3.65	3.60	3.87	4.26	4.30
Cardiological examinations	1.65	2.27	3.52	4.04	3.90	4.23	4.03	3.96	4.20
Parasitological analyses	1.59	2.54	2.71	3.10	4.55	7.98	7.79	7.84	8.09
Microbiological analyses	0	0.72	1.81	2.11	2.10	2.80	2.62	2.86	2.98
Surgical procedures	0	0	0	1.23	2.38	17.25	26.88	26.51	27.23
Dental procedures	0	0	0	0.11	0.10	2.99	7.21	6.93	7.07

a successive increase was noted in the percentage of administered  $\beta$ -lactams; i.e., from 1.59% to 9.3%, that could in part be due to the increased number of surgical and dental procedures (Tab. 4), in which these drugs are used as part of perioperative prophylaxis or treatment of postoperative infections. The proportion of patients treated with sulfonamides steadily decreased (from 15.95% to 3.74%), which may be due to a reduction in combination therapy, including combined therapy with fluoroquinolones. The use of tetracyclines remained relatively stable (approximately 1-3%), which may reflect their established role in the treatment of specific diseases in small mammals. The variability in the use of macrolides, particularly their less frequent prescription between 2018 and 2022, has not been clearly explained; but may be related to changes in therapeutic protocols and the availability of alternative treatment options.

Table 4 presents factors that, in the authors' opinion, may have influenced the reduced need for the use of antibacterial chemotherapeutics.

The increased percentage of preventive visits reflects owners' awareness, while early detection of a problem made during a routine check-up may help eliminate the disease process before it enters the chronic or acute phase, requiring long-term treatment, including antibacterial therapy, like e.g., mycoplasma pneumonia in rats (34), urinary tract infection (1), or chronic inflammatory processes of the intestines (22,

30). Over the analyzed period, a successive increase was noted in the frequency of ordering laboratory tests, diagnostic imaging, cardiological examinations as well as parasitological and microbiological tests. One of the key elements that cannot be overlooked in the context of reducing the duration of antibiotic therapy and promoting targeted antimicrobial use is bacteriological testing combined with antimicrobial susceptibility testing. Such diagnostics enable the identification of the causative pathogen and the selection of the most appropriate chemotherapeutic agent. In this context, a fourfold increase in the number of microbiological examinations performed should be emphasized. However, due to the lack of archiving of detailed results in the Klinika 3000 system and the partial submission of samples to an external laboratory, the authors were unable to conduct a comprehensive analysis of all tests performed. The system records only the information that samples were submitted for analysis, while not all obtained results were subsequently entered into the database. Consequently, an analysis based solely on the available records could lead to conclusions burdened with a significant risk of bias and would not constitute a fully reliable source of information. Despite the observed upward trend, the proportion of microbiological examinations performed still appears insufficient according to the authors. One of the potential limiting factors may be the reluctance

of animal owners to cover the additional costs associated with diagnostic testing. These observations highlight the need to intensify educational efforts and to further promote the justification for performing microbiological diagnostics in clinical practice.

At the same time, a significant increase was recorded in the number of surgical and dental procedures performed, especially after the academic year 2020/2021. An appropriate decision to undertake this type of intervention reduces the need for alternative internal medicine treatments, which are often less effective or ensure solely symptomatic or supportive effect, and frequently require long-term use of antibacterial chemotherapeutics (2, 10, 12, 18, 23, 29, 34). The increased availability and more frequent use of laboratory diagnostics, imaging, and microbiological tests supports more precise identification of the underlying causes of the disease, enabling targeted treatment and reducing the need for empirical use of antibiotics (5, 9).

The most important finding of this study is the change in the profile of chemotherapeutic agents used, in particular the reduction in the use of antibiotics critically important for human medicine. According to WHO guidelines, antibiotics of critical importance for human medicine should be protected from excessive use in veterinary practice (31). In the present study, the observed decrease in the use of antibiotics classified as CIA (Critically Important Antimicrobials) may indicate the gradual implementation of the principles of rational antibiotic therapy, which is in line with global recommendations. The study showed a successive reduction in the use of fluoroquinolones, including enrofloxacin, in the treatment of small mammals. Similar trends have been described in companion animals in other countries where the implementation of antimicrobial stewardship (AMS) principles has led to a significant reduction in the use of fluoroquinolones in clinical practice. Studies conducted in dogs and cats have shown that the reduced use of drugs from this group was associated with improved adherence to therapeutic guidelines, increased availability of microbiological testing, and a preference for first-line antibiotics (7, 14, 20, 26, 28).

There is a significant gap in the literature regarding recommendations for small mammals and other less common companion animal species. Literature reviews indicate that the lack of standardized, evidence-based clinical guidelines for dosing and treatment protocols, as well as the absence of approved drugs for these species, hinders the rational use of antibiotics and may promote the development of microbial resistance (3, 17, 25).

Veterinarian-owner collaboration also appears to be crucial. A study conducted in 2017 in the UK by Smith et al. (27) describes how relationships and communication between veterinarians and animal owners influence decisions about antibiotic use and, consequently, the development of antimicrobial resistance (AMR) in companion animals. Time pressure and veterinarian's

concern about displeasing an uninformed owner may result in unjustified antibiotic administration (27). Due to the growing interest in small mammals as companion animals (8, 33) and the observed dynamic development of diagnostics and therapy for the above-mentioned species, treatment cannot be solely symptomatic. Observations from our own practice indicate that less experienced veterinarians, when encountering a species they were unfamiliar with, acted exactly as described in the aforementioned article (27). In addition, the pressure from the veterinarian and a lack of systematic knowledge often led to the excessive use of antibiotics, particularly fluoroquinolones, described in many publications as safe for small mammals (3, 4, 12, 15, 23). These veterinarians most often acted in good faith, attempting at all means to protect their patients, administering these agents as a precaution. Furthermore, they were influenced by information indicating that some preparations containing enrofloxacin are essentially the only widely available drugs registered in Poland and labelled by the manufacturer as intended for use in small mammals. This approach is unacceptable for many reasons, given the current state of knowledge and the awareness of the risks posed by the overuse of antibiotics critical in human medicine (31). Despite the lack of authorized veterinary antibiotics for a given indication or species, the cascade principle, regulated under Articles 112-114 of Regulation (EU) 2019/6 of the European Parliament and of the Council, allows veterinarians to administer a medicinal product outside the conditions specified in its marketing authorization when no suitable veterinary medicinal product is authorized for use in the species concerned.

This article aims to draw attention to the possibility of improving the current situation through enhanced diagnostic methods and the continuous extension of knowledge and development of skills in the dynamically evolving field of veterinary medicine focused on the diagnosis and treatment of small mammals kept as companion animals.

## References

1. Ataya H., Soliman S., Kayaf A., Marouf S., Alamry K.: Incidence, bacterial causes and antibiotic resistance patterns of urinary tract infection in pet animals. *J. Appl. Vet. Sci.* 2023, 8, 35-43, doi: 10.21608/javs.2023.179690.1199.
2. Benato L.: Odontogenic abscesses in pet rabbits. *Vet. Rec.* 2017, 181, 536-537, doi: 10.1136/vr.j5249.
3. Broens E. M., van Geijlswijk I. M.: Prudent use of antimicrobials in exotic animal medicine. *Vet. Clin. Exot. Anim.* 2018, 21, 341-353, doi: 10.1016/j.cvex.2018.01.014.
4. Carpenter J. W., Harms C. A.: *Carpenters Exotic Animal Formulary*. 6<sup>th</sup>ed., Elsevier, St. Louis 2023.
5. Crăciun S., Novac C. Ş., Fiş N. I., Bouari C. M., Bel L. V., Nadăş G. C.: Bacterial diversity in pet rabbits: Implications for public health, zoonotic risks, and antimicrobial resistance. *Microorganisms*. 2025, 13, 653.
6. Degerfeld M. M. von, Banchi P., Quaranta G.: Successful treatment of pyometra caused by *Pseudomonas aeruginosa* infection in a rabbit. *Topics in Companion Animal Medicine* 2020, 41, 100473, doi: 10.1016/j.tcam.2020.100473.
7. De Marchi L., Vernaccini M., Meucci V., Briganti A., Lippi L., Marchetti V., Intorre L.: Six-year prescription pattern of antimicrobial use in cats at the veterinary teaching hospital of the University of Pisa. *Animals (Basel)* 2024, 14 (3), 521, doi: 10.3390/ani14030521.

8. *DeMello M.*: Rabbits multiplying like rabbits: The rise in the worldwide popularity of rabbits as pets. Pręgowski M.: Companion Animals in Everyday Life. New York, NY: Palgrave Macmillan 2016.
9. *Fernández M., Garcias B., Duran I., Molina-López R. A., Darwich L.*: Current situation of bacterial infections and antimicrobial resistance profiles in pet rabbits in Spain. *Vet. Sci.* 2023, 10, 352, doi: 10.3390/vetsci10050352.
10. *Gardhouse S., Sanchez-Migallon Guzman D., Paul-Murphy J., Byrne B. A., Hawkins M. G.*: Bacterial isolates and antimicrobial susceptibilities from odontogenic abscesses in rabbits: 48 cases. *Vet. Rec.* 2017, 181, 538, doi: 10.1136/vr.103996.
11. *Giraldi G., Montesano M., Napoli C., Frati P., La Russa R., Santurro A., Scopetti M., Orsi G. B.*: Healthcare-associated infections due to multidrug-resistant organisms: A surveillance study on extra hospital stay and direct costs. *Curr. Pharm. Biotechnol.* 2019, 20, 643-652, doi: 10.2174/1389201020666190408095811.
12. *Harcourt-Brown F.*: Dental disease in pet rabbits 3. Jaw abscesses. *Practice* 2009, 31, 496-505, doi: 10.1136/inpract.31.10.496.
13. *Hedley J.*: Antibiotic usage in rabbits and rodents. *Practice* 2018, 40, 230-237, doi: 10.1136/inp.k2642.
14. *Hopman N. E. M., Portengen L., Heederik D. J. J., Wagenaar J. A., van Geijlswijk I. M., Broens E. M.*: Time trends, seasonal differences and determinants of systemic antimicrobial use in companion animal clinics (2012-2015). *Vet. Microbiol.* 2019, 235, 289-294, doi: 10.1016/j.vetmic.2019.07.016.
15. *Hutchings M. L., Truman A. W., Wilkinson B.*: Antibiotics: past, present and future. *Curr. Opin. Microbiol.* 2019, 51, 72-80.
16. *Ivey E. S., Morrissey J. K.*: Therapeutics for rabbits. *Vet. Clin. North. Am. Exot. Anim. Pract.* 2000, 3, 183-220.
17. *Jelinski D. C., Orsel K., Weese J. S., Conly J. M., Julien D. A.*: Antibacterial treatment for exotic species, backyard ruminants and small flocks: A narrative review highlighting barriers to effective and appropriate antimicrobial treatment. *BMC Vet. Res.* 2022, 18, 220.
18. *Levy I., Mans C.*: Diagnosis and outcome of odontogenic abscesses in client-owned rabbits (*Oryctolagus cuniculus*): 72 cases (2011-2022). *J. Am. Vet. Med. Assoc.* 2024, 262, 658-664, doi: 10.2460/javma.23.12.0718.
19. *Moruzi R. F., Tirziu E., Muselin F., Dumitrescu E., Hutu I., Mircu C., Tulcan C., Doma A., Degi J., Degi D. M., Boboc M. G., Chirila A. B., Inacu I., Baraitareanu S., Cristina R. T.*: The importance of databases to manage the phenomenon of resistance to antimicrobials for veterinary use. *Rev. Med. Vet.* 2019, 29, 40-57.
20. *Motegi T., Fukuoka R., Tsuyuki Y., Nagakubo D., Maeda S., Yonezawa T., Nishimura R., Momoi Y.*: Evaluating a targeted antimicrobial stewardship program and its temporal association with resistance trends in a veterinary referral hospital. *Vet. Sci.* 2025, 12 (8), 743, doi: 10.3390/vetsci12080743.
21. *Ness R. D.*: Clinical pathology and sample collection of exotic small mammals. *Vet. Clin. North. Am. Exot. Anim. Pract.* 1999, 2, 591-620, doi: 10.1016/S1094-9194(17)30112-3.
22. *Oglesbee B. L., Lord B.*: Ferrets, rabbits, and rodents, [in:] *Gastrointestinal diseases of rabbits*. Elsevier, Amsterdam 2020, p. 174-187.
23. *Palma-Medel T., Marcone D., Alegria-Morán R.*: Dental disease in rabbits (*Oryctolagus cuniculus*) and its risk factors – A private practice study in the Metropolitan Region of Chile. *Animals (Basel)* 2023, 13, 676, doi: 10.3390/ani13040676.
24. *Quesenberry K. E., Carpenter J. W. (eds.)*: *Ferrets, Rabbits, and Rodents: Clinical Medicine and Surgery*. WB Saunders, Philadelphia 2004, p. 461.
25. *Romero B., Susperregui J., Sahagún A. M., Fernández N., López C., de la Puente R., Altónaga J. R., Díez R.*: Drug prescription pattern in exotic pet and wildlife animal practice: a retrospective study in a Spanish veterinary teaching hospital from 2018 to 2022. *Front. Vet. Sci.* 2024, 10, 1328698, doi: 10.3389/fvets.2023.1328698.
26. *Singleton D. A., Rayner A., Brant B., Smyth S., Noble P. M., Radford A. D., Pinchbeck G. L.*: A randomised controlled trial to reduce highest priority critically important antimicrobial prescription in companion animals. *Nat. Commun.* 2021, 12, 1593, doi: 10.1038/s41467-021-21864-3.
27. *Smith M., King C., Davis M., Dickson A., Park J., Smith F., Currie K., Flowers P.*: Pet owner and vet interactions: exploring the drivers of AMR. *Antimicrob. Resist. Infect. Control.* 2018, 7, 46.
28. *Suwanpakdee S., Chantong B., Wiratsudakul A., Tangcharoensathien V., Lekagul A., Sakcamduang W.*: Antibiotic use in companion animals in veterinary teaching hospitals in Thailand. *PLoS One* 2025, 20 (8), e0330750, doi: 10.1371/journal.pone.0330750.
29. *Tyrrell K. L., Citron D. M., Jenkins J. R., Goldstein E. J. C.*: Periodontal bacteria in rabbit mandibular and maxillary abscesses. *J. Clin. Microbiol.* 2002, 40, 1044-1047, doi: 10.1128/JCM.40.3.1044-1047.2002.
30. *Tzika E. D., Saoulidis K.*: Rabbit enteritis. *J. Hell. Vet. Med. Soc.* 2017, 55, 145-155, doi: 10.12681/jhvms.15183.
31. World Health Organization (WHO). *Global Action Plan on Antimicrobial Resistance*. WHO, Geneva 2015. Accessed 10 June 2023.
32. *Ziętek J., Adaszek Ł., Kutrzuba J., Humelt K.*: Podawanie leków gryzoniom. *Weterynaria w Praktyce* 2014, 11, 69-72.
33. *Ziętek J., Wilczyńska A., Jabłoński M., Sajdak S., Romanowska A., Teodorowski O., Mazurek Ł., Stanić M.*: Problemy kliniczne stwierdzone u drobnych ssaków – jedenastoletnie badania retrospektywne. *Med. Weter.* 2021, 77 (2), 95-98.
34. *Ziętek J., Wilczyńska A., Łyp P., Panasiuk-Flak K., Adaszek Ł., Ziętek A., Salińska I.*: Mykoplazmoza szczurów – etiologia, leczenie i zapobieganie. *Mag. Wet.* 2019, 7-8, 12-18.
35. *Ziętek J., Wilczyńska A., Sajdak S., Mazur M., Dąbrosiak Ł., Kalinowski M., Adaszek Ł., Winiarczyk S.*: Use of vaccines in rabbits kept as companion animals based on an analysis of clinical cases at the Clinic of Infectious Diseases, Faculty of Veterinary Medicine, University of Life Sciences in Lublin in 2011-2020. *Med. Weter.* 2022, 78 (6), 304-308.

**Corresponding author:**