



**UNIVERSITI PUTRA MALAYSIA**

***IDENTIFICATION AND ANTIMICROBIAL SUSCEPTIBILITY  
OF ENTEROCOCCAL SPECIES ISOLATED FROM CATS  
EXPOSED  
TO DIFFERENT ANTIBIOTICS***

**NOR AZIMAH BINTI MOHD AMIN**

**FPV 2016 16**

IDENTIFICATION AND ANTIMICROBIAL SUSCEPTIBILITY  
OF ENTEROCOCCAL SPECIES ISOLATED FROM CATS EXPOSED  
TO DIFFERENT ANTIBIOTICS

The logo of Universiti Putra Malaysia (UPM) is a shield-shaped emblem. It features a red and white color scheme. At the top left, the letters 'UPM' are written in white on a red background. In the center, there is a stylized white book with red text on its pages. The shield is divided into several sections by white lines, and the overall design is symmetrical.

NOR AZIMAH BINTI MOHD AMIN

A project paper submitted to the  
Faculty of Veterinary Medicine, Universiti Putra Malaysia  
in partial fulfillment of the requirement for the  
DEGREE OF DOCTOR OF VETERINARY MEDICINE  
Universiti Putra Malaysia, Serdang,  
Selangor DarulEhsan

MARCH 2016

It is hereby certified that I have read this project paper entitled “Identification and Antimicrobial Susceptibility of Enterococcal Species Isolated from Cats Exposed to Different Antibiotics”, by Nor Azimahbinti Mohd Amin and in my opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the

requirement for the course

VPD 4999 – Final Year Project.

---

**ASSOC. PROF. DR. SITI KHAIRANI BEJO**

**DVM (UPM), MSc. (UPM), PhD (UPM)**

Associate Professor

Faculty of Veterinary Medicine,

Universiti Putra Malaysia

(Supervisor)

*This project is specially dedicated to*

**MY PARENTS**

Mohd Amin bin Mohd Akhir

NorLailibinti Ahmad

**MY SIBLINGS**

Mohd Nizam and Sally Shahreena

Mohd Nazim and Zahidah

**MY NIECE**

NurNa'ila Sara

**MY CATS**

Tokin

Zorro

## ACKNOWLEDGEMENT

I would like to thank Allah S.W.T. for giving me the strength to run this project smoothly, making it at ease, and turning all the impossibilities into possibilities. I would like to express my deepest appreciation to my supervisor, Assoc. Prof. Dr. SitiKhairaniBejo for her continuous support and encouragement, guidance in helping me to coordinate this project, supervision, patience throughout this project, and for giving the permission to use all the required equipment and the necessary materials in Bacteriology laboratory to complete this project. Moreover, I would like to express my gratitude to Dr. Zulkefle for giving the permission to collect the samples from his veterinary clinic, Dr. ZuAzuwana and all the staff of the clinic for helping me in collecting samples. Furthermore, I would like to acknowledge with much appreciation the Bacteriology unit staff, Miss Kriss, Mr. Azri, Miss Adawiyah, Mrs. Razimah and Dr. Sabri for their kindness in sharing their knowledge, helping in providing technical support and getting the equipment, helping in identifying the bacteriological findings and for always welcome the students. Besides, not to forget, AimiNajwa for her kindness, for the times spent, and for the constructive, and fruitful discussion throughout this project. I would like to express my deepest gratitude to my parents and family for their love, care, patience, support and encouragement to complete this study. Last but not least, special thanks to my friends, AinaLiyana, Nabila and Suzana as well as to my housemates for always be there in this journey.

## TABLE OF CONTENTS

	Page
<b>TITLE</b> .....	i
<b>CERTIFICATION</b> .....	ii
<b>DEDICATION</b> .....	iii
<b>ACKNOWLEDGEMENT</b> .....	iv
<b>TABLE OF CONTENTS</b> .....	v
<b>LIST OF TABLES</b> .....	vii
<b>LIST OF FIGURES</b> .....	viii
<b>LIST OF PLATES</b> .....	ix
<b>LIST OF APPENDICES</b> .....	x
<b>LIST OF ABBREVIATIONS</b> .....	xi
<b>ABSTRACT</b> .....	xii
<b>ABSTRAK</b> .....	xiv
<b>1.0 INTRODUCTION</b> .....	1
1.1 Objectives.....	3
1.2 Hypothesis.....	3

<b>2.0 LITERATURE REVIEW</b> .....	4
2.1 Enterococci.....	4
2.2 Enterococci in nature.....	5
2.3 Enterococcal infections in human.....	5
2.4 Enterococcal infections in animals.....	6
2.5 Pets (dogs and cats) as source of transmission to human.....	8
2.6 Multidrug-resistant (MDR), extensively drug-resistant (XDR) and pandrug resistant (PDR) of Enterococci.....	9
2.7 Vancomycin resistant enterococci (VRE).....	9
<b>3.0 MATERIALS AND METHODS</b> .....	11
3.1 Animal selection.....	11
3.2 Collection of samples.....	11
3.3 Isolation and identification of enterococci.....	11
3.4 Biochemical tests for enterococci.....	12
3.5 Antimicrobial susceptibility test.....	13
<b>4.0 RESULTS</b> .....	16
4.1 Isolation and identification of enterococci.....	16
4.2 Antimicrobial susceptibility test.....	17
<b>5.0 DISCUSSION</b> .....	20
<b>6.0 CONCLUSION AND RECOMMENDATIONS</b> .....	24
<b>7.0 REFERENCES</b> .....	25

**LIST OF TABLES**

**Table 1:**Antimicrobial susceptibility test result for each *Enterococcus* spp.  
isolated..... 18



© COPYRIGHT UPM

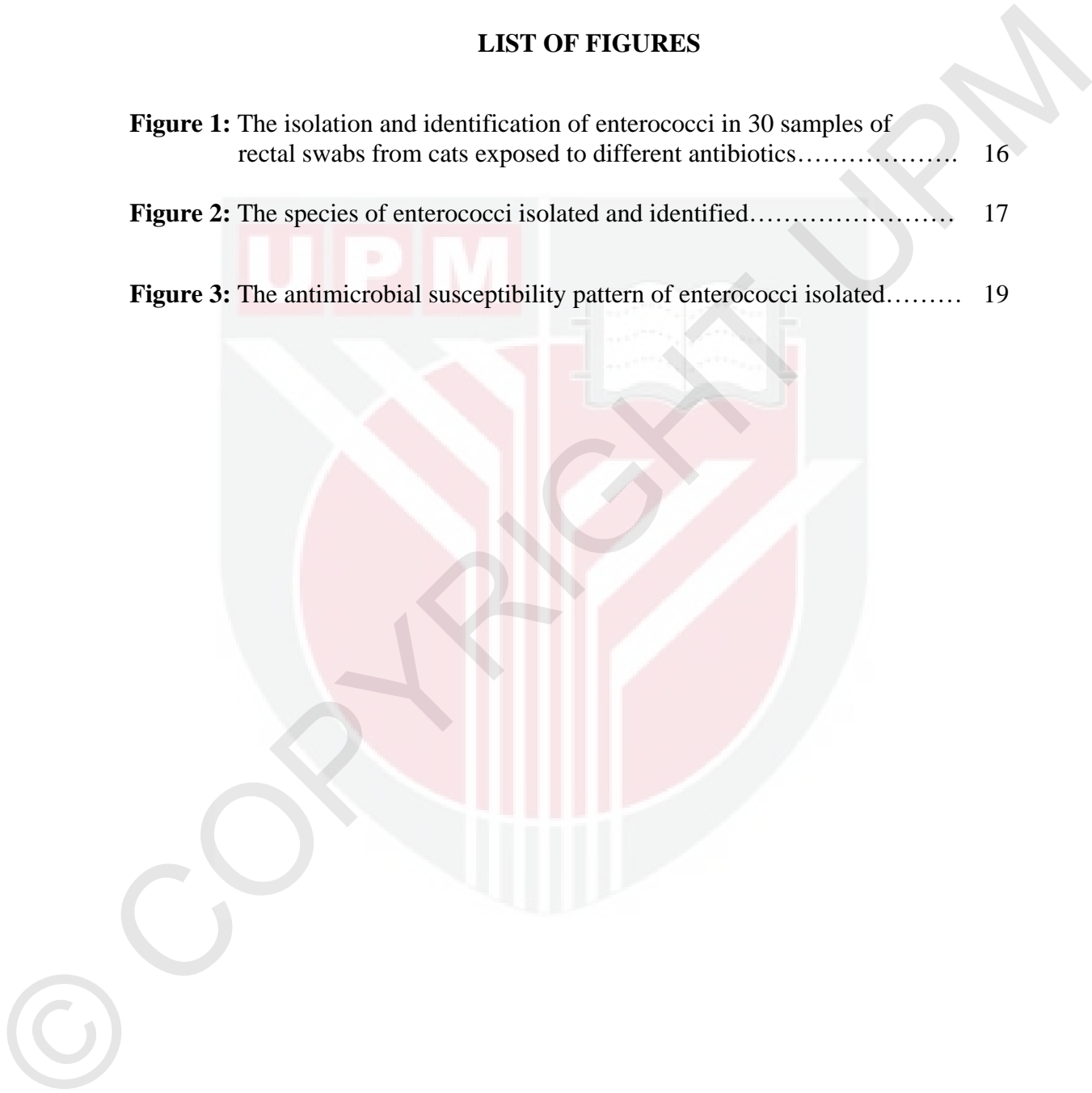


**LIST OF FIGURES**

**Figure 1:** The isolation and identification of enterococci in 30 samples of rectal swabs from cats exposed to different antibiotics..... 16

**Figure 2:** The species of enterococci isolated and identified..... 17

**Figure 3:** The antimicrobial susceptibility pattern of enterococci isolated..... 19



**LIST OF PLATES**

<b>Plate 1:</b> Pure culture of enterococci grown on blood agar.....	14
<b>Plate 2:</b> Antimicrobial susceptibility test on blood agar.....	15



**LIST OF APPENDICES**

<b>Appendix 1:</b> The flow chart for isolation and identification of enterococci and antimicrobial susceptibility test.....	30
<b>Appendix 2:</b> Gram staining technique.....	31
<b>Appendix 3:</b> Biochemical tests for <i>Enterococcus</i> spp. identification.....	32
<b>Appendix 4:</b> Additional tests to differentiate among certain animal enterococci	33
<b>Appendix 5:</b> The colony morphology, gram staining and biochemical test results for each enterococci isolated.....	35

## LIST OF ABBREVIATIONS

<b>%</b>	Percentage
<b>µg</b>	Microgram
<b>µm</b>	Micrometer
<b>°C</b>	Degree Celcius
<b>AST</b>	Antimicrobial Susceptibility Test
<b><i>E. avium</i></b>	<i>Enterococcus avium</i>
<b><i>E. Coli</i></b>	<i>Escherichia coli</i>
<b><i>E. durans</i></b>	<i>Enterococcus durans</i>
<b><i>E. faecalis</i></b>	<i>Enterococcus faecalis</i>
<b><i>E. faecium</i></b>	<i>Enterococcus faecium</i>
<b><i>E. gallinarum</i></b>	<i>Enterococcus gallinarum</i>
<b><i>E. hirae</i></b>	<i>Enterococcus hirae</i>
<b>FLUTD</b>	Feline Lower Urinary Tract Disease
<b>ICU</b>	Intensive Care Unit
<b>ILD</b>	Inflammatory Liver Disease
<b>MDR</b>	multidrug resistant
<b>PDR</b>	pandrug resistant
<b>UTIs</b>	urinary tract infections
<b>VRE</b>	vancomycin resistant enterococci
<b>XDR</b>	extensively drug resistant
<b>mm</b>	Millimeter

**ABSTRACT**

An abstract of the project paper presented to the Faculty of Veterinary Medicine in partial fulfillment of the course VPD 4999 – Final Year Project.

**IDENTIFICATION AND ANTIMICROBIAL SUSCEPTIBILITY OF  
ENTEROCOCCAL SPECIES ISOLATED FROM CATS EXPOSED TO  
DIFFERENT ANTIBIOTICS**

By

**Nor Azimahbinti Mohd Amin**

**2016**

**Supervisor: Assoc. Prof. Dr. Siti Khairani Bejo**

Enterococci are part of normal microbial flora in the gastrointestinal tract of human and animals. They have emerged to pose a significant public health concern through its emergence of being opportunistic in causing nosocomial infections as well as acquiring high level of resistance to many antimicrobial agents. Vancomycin-resistant enterococci (VRE) appearance has caused serious problems in human and veterinary medicine. The objectives of this study were to isolate and identify enterococci in cats exposed to different antibiotics and to determine its antimicrobial susceptibility pattern. Thirty (30) rectal swabs of cats were collected from a veterinary clinic and processed for isolation and identification of enterococci by inoculating the samples onto blood agar

and followed by biochemical tests. The isolates were then subjected to antimicrobial susceptibility test (AST) to six antibiotics namely amoxicillin, amoxicillin and clavulanic acid, enrofloxacin, marbofloxacin, doxycycline, and vancomycin. Six rectal swab samples were positive for enterococci. The enterococci isolates were consists of *E. faecalis*(3 isolates), *E. durans*(3 isolates) and *Enterococcus* sp.(1 isolate). None of the isolates were resistant to all six antibiotics tested. *Enterococcus* sp. isolate was resistant to five antibiotics (amoxicillin, amoxicillin and clavulanic acid, enrofloxacin, marbofloxacin, and doxycycline). One isolates of *E. faecalis* was resistant to four antibiotics (amoxicillin and clavulanic acid, enrofloxacin, marbofloxacin, and doxycycline). One *E. faecalis* and one *E. durans* were resistant to three antibiotics (amoxicillin and clavulanic acid, enrofloxacin, and marbofloxacin). Two *E. durans* and one *E. faecalis* were resistant to two antibiotics (enrofloxacin and marbofloxacin). All enterococci isolates were resistant to enrofloxacin and marbofloxacin whilst vancomycin was the antibiotic that all the isolates were sensitive to. Two multidrug-resistant (MDR) enterococci and two extensively drug resistant (XDR) enterococci were detected in this present study.

**Keywords:** cat, rectal swab, enterococci, AST

**ABSTRAK**

Abstrakdaripadakertasprojek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada keperluan luakursus VPD 4999 – Projek Ilmiah Tahun Akhir.

**IDENTIFIKASI DAN KERENTANAN ANTIMIKROB OLEH SPESIS  
ENTEROCOCCUS DARI KUCING YANG TERDEDAH KEPADA  
ANTIBIOTIK YANG BERBEZA**

Oleh

**Nor Azimah binti Mohd Amin**

2016

**Penyelia: Prof. Madya Dr. Siti Khairani Bejo**

Enterokoki adalah sebahagian daripada flora normal di dalam saluran gastrousus manusia dan haiwan. Ianya telah muncul untuk menimbulkan kebimbangan terhadap kesihatan awam melalui kemunculannya sebagai organisma oportunist dalam menyebabkan jangkitan nosokomial serta memperoleh kerentanan pada tahap yang tinggi terhadap banyak agen antimikrob. Kemunculan enterokoki yang rentan terhadap vancomycin telah menyebabkan masalah yang serius dalam perubatan manusia dan perubatan veterinar. Objektif kajian ini adalah untuk mengasingkan dan mengidentifikasi enterokoki daripada kucing yang

pernah terdedah kepada antibiotik yang berbeza serta menentukancorak kerentanannya terhadap antimikrob. Sebanyak 30 swab rektum kucing telah diperolehdaripadasebuah klinik veterinar dan diproses untuk pengasingan enterokokidengancaramenginokulasikannyakeatas agar-agar

darahsertadiikutiolehujian biokimia.

Ujian kerentanan antimikrob dengan enam antibiotik iaitu amoxicillin, amoxicillin dan clavulanic acid, enrofloxacin, marbofloxacin, doxycycline dan vancomycin kemudiannyadilakukan terhadap enterokoki yang terasing. Enam swab rektum didapati positif untuk enterokokidanterdiridaripada *E. faecalis* (3), *E. durans* (3) dan *Enterococcus* sp. (1). Tiada enterokokiterasing yang rentanterhadap keenam-enam antibiotik yang diuji. *Enterococcus* sp. rentanterhadap lima antibiotik (amoxicillin, amoxicillin dan clavulanic acid, enrofloxacin, marbofloxacin dan doxycycline). Satu *E. faecalis* rentanterhadap empat antibiotik (amoxicillin dan clavulanic acid, enrofloxacin, marbofloxacin, dan doxycycline). Satu *E. faecalis* dan satu *E. durans* rentanterhadap tiga antibiotik (amoxicillin dan clavulanic acid, enrofloxacin dan marbofloxacin). Dua *E. faecalis* dan satu *E. durans* rentanterhadap dua antibiotik

(enrofloxacin dan marbofloxacin). Kesemua enterokokiterasing rentanterhadap enrofloxacin dan marbofloxacin manakalavancomycin adalah antibiotik yang sentitif oleh kesemua enterokokiterasing. Dua enterokoki yang rentanterhadap antimikrob pelbagai dan dua enterokoki yang rentanterhadap antimikrob meluastelah dikenalpasti di dalam ujian ini.



***Kata kunci:*** kucing, swab rektum, enterokoki, kerentanan antibiotik



© COPYRIGHT UPM

## 1.0 INTRODUCTION

The enterococci are part of normal microbial flora in the gastrointestinal tract of human and animals. They are also common to be found in the environments contaminated from fecal materials of human and animals as well as food products derived from animals. *Enterococcus faecalis*, *Enterococcus faecium* and *Enterococcus durans* are the major enterococcal species (Akhteret *al.*, 2011). Generally, they are non-pathogenic bacteria and do not cause any illness in healthy human and animals. However, they have emerged to pose a significant public health concern through its emergence of being opportunistic pathogens in causing nosocomial infections as well as acquiring high level of resistance to many antimicrobial agents (Kataoka *et al.*, 2013). Recently, vancomycin-resistant enterococci (VRE) appearance has cause serious problems in human and veterinary medicine.

Enterococci is known to cause infections in human include urinary tract infections, hepatobiliary sepsis, endocarditis, surgical wound infection, bacteraemia and neonatal sepsis (Pohet *al.*, 2006). Besides, it has been reported that enterococci is the second most cause of wound and urinary tract infection and the third most common cause of bacteraemia (De Fátima Silva Lopes *et al.*, 2005). Based on clinical information from hospital Kuala Lumpur (HKL) Malaysia, 244 cases of enterococci infected patients were identified (Ibrahim *et al.*, 2010).

In animals, particularly cats, enterococci were commonly isolated from cats with bacterial urinary tract infections (UTIs) (Dorsch *et al.*, 2015), from Norwegian cats with

feline lower urinary tract disease (FLUTD) that have higher prevalence of bacterial cystitis (Lundet *al.*, 2015), from livers of cats with inflammatory liver disease (ILD) (Twedt *et al.*, 2014) and from the ileum mucosa of terminally ill kittens with clinical signs of diarrhea (Ghosh *et al.*, 2013).

The increasing amount of resistant bacteria causing infections in pets indicates increase amount of antimicrobials used in pets, including agents used in human medicine (Lloyd, 2007). Human particularly pet owners and veterinary staffs have more opportunities for physical contact with pets. Thus, there is possible transmission of such bacteria from pets to human in which later may have impact on the use of antimicrobials in human medicine.

The transmission of pathogenic and antimicrobial-resistant bacteria from pets to their owners has been described in numerous reports (Buma *et al.*, 2006). There are 3.8 million pet populations in Malaysia in 2012 (Lee and Kok, 2015). However, few studies have been conducted and reported on the presence of enterococci in pets particularly in Malaysia. Therefore, as the ownership of pets has risen, monitoring enterococci in pets is important for public health and veterinary medicine.

## 1.1 Objectives

The objectives of this study were:

1. To isolate and identify enterococci bacteria in cats exposed to different antibiotic.
2. To determine antibiotic susceptibility pattern of enterococci bacteria isolated from cats exposed to different antibiotic.

## 1.2 Hypothesis

The hypothesis for this study was that cats exposed to antibiotics have enterococci resistant to antimicrobials.

## 7.0 REFERENCES

- Akhter, S., Asna, Z. H. and Rahman, M. M. (2011). Prevalence and Antimicrobial Susceptibility of *Enterococcus* species Isolated from Clinical Specimens. *Mymensingh Med. J.* 20: 694–699.
- Arias, C. A., Contreras, G. A. and Murray, B. E. (2010). Management of Multidrug-Resistant Enterococcal Infections. *Clin Microbial Infect.* 16(6): doi:10.1111/j.1469-0691.2010.03214.x.
- Brain, P. H., Barrs, V. R., Martin, P., Baral, R. and Beatty, J. A. (2006). Feline Cholecystitis and Acute Neutrophilic Cholangitis: clinical findings, bacterial isolates and response to treatment in six cases. *Journal of Feline Medicine and Surgery* 8, 91-103.
- Buma, R., Maeda, T., Kamei, M. and Kourai, H. (2006). Pathogenic Bacteria Carried by Companion Animals and Their Susceptibility to Antibacterial Agents. *Biocontrol Sci.* 11(1): 1-9.
- Centers for Disease Control and Prevention. National Nosocomial Surveillance (NNIS) system Report, Data Summary from January 1992 through June 2003, issued August 2003. *Am J Infect Control* 2003; 31:481-98.
- Clinical and Laboratory Standards Institute (2010). Performance Standards for Antimicrobial Susceptibility Testing; Twentieth Informational Supplement. 30(1): 32.
- De Fátima Silva Lopes, M., Ribeiro, T., Abrantes, M., Figueiredo Marques, J. J., Tenreiro, R. and Crespo, M. T. B. (2005). Antimicrobial Resistance Profiles of Dairy and Clinical Isolates and Type Strains of Enterococci. *Int J Food Microbiol* 103, 191-198.

- Devriese, L. A., Cruz Colque, J. I., De Hart, P. and Haesebrouck, F. (1992). Identification and Composition of the Tonsillar and Anal Enterococcal and Streptococcal Flora of Dogs and Cats. *J Appl Bacteriol.* 73(5): 421-5.
- Dorsch, R., von Vopelius-Feldt, C., Wolf, G., Straubinger, R., K. and Hartmann, K. (2015). Feline Urinary Tract Pathogens: Prevalence of bacterial species and antimicrobial resistance over a 10-year period. *Veterinary Record* 176:201 doi:10.1136/vr.102630.
- Fischer, K. and Phillips, C. (2009). The Ecology, Epidemiology and Virulence of *Enterococcus*. *Microbiology*, 155, 1749-1757.
- Ghosh, A., Borst, L., Stauffer, H., Suyemoto, M., Moisan, P., Zurek, L. and Gookin, J. L. (2013). Mortality in Kittens is Associated with a Shift in Ileum Mucosa-Associated Enterococci from *Enterococcus hirae* to Bifilm-Forming *Enterococcus faecalis* and Adherent *Escherichia coli*. *Journal of Clinical Microbiology* 51(11): 3567-3578.
- Ghosh, A., KuKanich, K., E. Brown, C. and Zurek, L. (2012). Residents Cats in Small Animal Veterinary Hospitals Carry Multiple-Drug Resistance Enterococci and are Likely Involved in Cross-Contamination of the Hospital Environment. *Frontiers in Microbiology*. 62(3): 1-14.
- Gilmore, M. S. G., Clewell, D. B., Ike, Y. and Shankar, N. (2014). Enterococci: Commensals to Leading Causes of Drug Resistant Infection. Boston: Massachusetts Eye and Ear Infirmary.
- Giraffa, G. (2002). Enterococci from Foods. *FEMS Microbial Rev* 26, 163-171.
- Guardabassi, L., Schwarz, S. and Lloyd, D.H. (2004). Pet Animals as Reservoirs of Antimicrobial-Resistant Bacteria. *J Antimicrob Chemother* 54: 321-332.
- Hardie, J. M. and Whiley, R. A. (1997). Classification and Overview of the Genera *Streptococcus* and *Enterococcus*. *Journal of Applied Microbiology Symposium Supplement*. 83, 1S-11S.
- Holt, J. G., Krieg, N. R., Sneath, P. H. A., Staley, J. T. and Williams, S. T. (1994). Bergey's Manual of Determinative Bacteriology (9<sup>th</sup> Edition): Gram Positive Cocci. Philadelphia, USA: Lippincott Williams & Wilkins: 527-529.
- Ibrahim, R., Mohamad, M. and Rahman, M. (2010). Enterococci: Emerging Drug Resistant Bacteria in Hospital Acquired Infections at Hospital Kuala Lumpur, Malaysia. *The Internet Journal of Microbiology*. 9(2).

- Jackson, C. R., Fedorka-Cray, P. J., Davis, J. A., Barrett, J. B. and Frye, J. G. (2009). Prevalence, Species Distribution and Antimicrobial Resistance of Enterococci Isolated from Dogs and Cats in the United States. *Journal of Applied Microbiology* 107: 1269-1278.
- Kataoka, Y., Ito, C., Kawashima, A., Ishii, M., Yamashiro, S., Harada, K., Ochi, H. and Sawada, T. (2013). Identification and Antimicrobial Susceptibility of Enterococci Isolated from Dogs and Cats Subjected to Differing Antibiotic Pressures. *J. Vet. Med. Sci.*75(6): 749-753.
- Kataoka, Y., Umino, Y., Ochi, H., Harada, K. and Sawada, T. (2014). Antimicrobial Susceptibility of Enterococcal Species isolated from Antibiotic-Treated Dogs and Cats. *Vet. Med. Sci.* 76 (10): 1399-1402.
- Kenzaka, T., Takamura, N., Kumabe, A. and Takeda, K. (2013). A Case of Subacute Infective Endocarditis and Blood Access Infection Caused by *Enterococcus durans*. *BMC Infectious Diseases*.13:594.
- KuKanich, K., Ghosh, A., Skarbek, J., Lothamer, K. and Zurek, L. (2012). Surveillance of Bacterial Contamination in Small Animal Veterinary Hospitals with Special Focus on Antimicrobial Resistance and Virulence Traits of Enterococci. *J. Am. Vet. Med. Assoc.*240, 437–445.
- Lebreton, F., van Schaik, W., McGuire, A. M., Godfrey, P., Griggs, A., Mazumdar, V., Corander, J., Cheng, L., Saif, S., Young, S., Zeng, Q., Wortman, J., Birren, B., Willems, R. J. L., Earl, A. M. and Gilmore, M. S. (2013). Emergence of Epidemic Multidrug-Resistant *Enterococcus Faecium* from Animal and Commensal Strains. *mBio* 4(4):e00534-13. doi:10.1128/mBio.00534-13.
- Lee, A. H. C. and Kok, H. Y. (2014). Self-Extension and Purchase Behavior of Dog Related Products and Services: An In-Depth Interview among Selected Malaysian Dog Owners. *Asian Social Science* 11(3): 27-36.
- Leener, E.D., Decostere, A., De Graef, E.M., Moyaert, H. and Haesebrouck, F. (2005) Presence and Mechanism of Antimicrobial Resistance among Enterococci from Cats and Dogs. *Microb Drug Resist.* (11) 395–403.
- Linden, P. K. (2008). Enterococci: Resistance Update and Treatment Options. In Owens R. C., & Lautenbach E. *Antimicrobial Resistance: Problem Pathogens and Clinical Countermeasures* (pp. 89-110). New York: Informa Healthcare USA, Inc.
- Lloyd, D. H. (2007). Reservoirs of Antimicrobial Resistance in Pet Animals. *Clin. Infect. Dis.*, 45(2): 148-152.

- Lund, H. S., Skogtun, G., Sorum, H. and Eggertsdottir, A. V. (2015). Antimicrobial Susceptibility in Bacterial Isolates from Norwegian cats with Lower Urinary Tract Disease. *Journal of Feline Medicine and Surgery* 17(6): 507-515.
- Magiorakos, A. P., Srinivasan, A., Carey, R. B., Carmeli, Y., Falagas, M. E., Giske, C. G., Harbarth, S., Hindler, J. F., Kahlmeter, G., Olsson-Liljequist, B., Paterson D. L., Rice, L. B., Stelling, J., Struelens, M. J., Vatopoulos, A., Weber, J. T. and Monnet, D. L. (2011). Multidrug-Resistant, Extensively Drug-Resistant and Pandrug-Resistant Bacteria: An International Expert Proposal for Interim Standard Definitions for Acquired Resistance. *ClinMicrobiol Infect* 18: 268-281.
- Manson, J. M., Keis, S., Smith, J. M. B. and Cook, G. M. (2003). Characterization of a Vancomycin-Resistant *Enterococcus faecalis* (VREF) Isolate from a Dog with Mastitis: Further Evidence of a Clonal Lineage of VREF in New Zealand. *Journal of Clinical Microbiology*. 41(7): 3331-3333
- NurulHusna, Z., Latiffah, H. and Zunita, Z. (2010). Presence of Vancomycin Resistance among Enterococcus Isolates from Stray Cats in Universiti Putra Malaysia and Selected Neighbourhood in Sri Serdang, Selangor, Malaysia. *5<sup>th</sup> Proceedings of the Seminar in Veterinary Sciences* 7-11.
- Poh, C. H., Oh, H. M. L. and Tan, A. L. (2006). Epidemiology and Clinical Outcome of Enterococcal Bacteraemia in an Acute Care Hospital. *J Infect* 52, 383-386.
- Prescott, J. F., Hanna, W. J. B., Reid-Smith, R. and Drost, K. (2002). Antimicrobial Drug Use and Resistance in Dogs. *Can. Vet. J.* 43, 107-116.
- Sorum, M., Johnsen, P. J., Aasnes, B., Rosvoll, T., Kruse, H., Sundsfjord, A. and Simonsen, G. S. (2006). Prevalence, Persistence, and Molecular Characterization of Glycopeptide-resistant Enterococci in Norwegian Poultry and Poultry Farmers 3 to 8 Years After the Ban on Avoparcin. *Appl. Environ. Microbiol.* 72, 516-521.
- Stepanovic', S., Jovanovic', M., Lavadinovic', L., Stos'ovic', B. and Pelemis, M. (2004). *Enterococcus durans* endocarditis in a patient with transposition of the great vessels. *Journal of Medical Microbiology*. 53: 259-261.
- Twedt, D. C., Cullen, J., McCord, K., Jeneczko, S., Dudak, J. and Simpson, K. (2014). Evaluation of Fluorescent in Situ Hybridization for The Detection of Bacteria in Feline Inflammatory Liver Disease. *Journal of Feline Medicine and Surgery* Vol 16(2) 109-117.



- Vijayakrishnan, R. and Rapose, A. (2012). Fatal *Enterococcus durans* aortic valve endocarditis: A case report and review of the literature. *BMJ Case Reports*.doi: 10.1136/bcr-02-2012-5855.
- Wagner, K. A., Hartmann, F. A. and Trepanier, L. A. (2007). Bacterial Culture Results from Liver, Gallbladder or Bile in 248 Dogs and Cats Evaluated for Hepatobiliary Disease: 1998-2003. *J Vet Intern Med* 21:417-424.
- Ward, D. M., Weller, R. and Bateson, M. M. (1990). 16S rRNA Sequence Reveal Numerous Uncultured Microorganisms in a Natural Community. *Nature* 345(6270): 63-5.
- Weigel, L. M., Clewell, D. B., Gill, S. R., Clark, N. C., McDougal, L. K., Flannagan, S. E., Kolonay, J. F., Shetty, J., Killgore, G. E. and Tenover, F. C. (2003). Genetic Analysis of a High Level Vancomycin-Resistant Isolate of *Staphylococcus Aureus*. *Science* 302,1569–1571.
- Willey, M. W., Sherwood, L. M. and Woolverton, C. J. (2011). Prescott's Microbiology (8<sup>th</sup> Edition): Chapter 21 – Bacteria: The Low G+ C Gram Positives. New York: McGraw-Hill: 559-567.