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Research Progress on the Effects of Antibiotics that Act on Bacterial Cell Wall Pentapeptide Cross-Linked Bridge on Patient Biochemical Indexes

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Abstract

In this paper, the effects of drugs acting on bacterial cell wall pentapeptin cross-linked Bridges on patient biochemical indices were investigated. The five-peptide cross-linked bridge of bacterial cell walls is an important component of bacterial cell walls, and the development of drugs targeting it has become a hot field in anti-infection treatment. This article reviews the various drugs that act on bacterial cell wall pentapepin cross-linked Bridges and their mechanisms of action, and focuses on the analysis of the effects of these drugs on liver and kidney function, blood system, electrolyte balance and glucose metabolism indexes of patients. By systematically describing the relationship between drug effects and changes in biochemical indicators, this paper provides a theoretical basis for clinical rational drug use and patient monitoring, and also provides a reference for future drug development and optimization.

Keywords

pentapeptide cross-linked Bridge, Antibiotics, Biochemical indicators, Mechanism of drug action, Adverse reactions, Monitoring of patients

Introduction

The increasing severity of bacterial resistance makes the development and use of new antibacterial drugs imminent[1]. As a unique structure of bacteria, bacterial cell wall has become an important target of anti-infective drugs[2]. Among them, the pentapeptide cross-linked bridge is a key component of the peptidoglycan layer of Gram-positive bacteria cell wall, which is involved in the synthesis and maintenance of bacterial cell wall[3]. Drugs acting on pentapeptide cross-linked bridge can effectively

inhibit bacterial growth and reproduction by interfering with this process.

In recent years, due to the extensive use of antibacterial drugs, the increase in bacterial resistance has become an important factor threatening the prognosis of patients[4]. Therefore, the combined use of antibiotics[5] and the continuous development of new antibiotics[6] have provided new options for the clinical treatment of multi-drug resistant bacterial infections. However, while these drugs exert their antibacterial effects, they may also affect the biochemical indicators of patients, thereby influencing the treatment outcomes and prognosis of patients. Therefore, in-depth research on the impact of antibacterial drugs acting on the pentapeptide cross-linked bridge structure of the cell wall of Gram-positive bacteria on the biochemical indicators of patients is of great significance for optimizing treatment plans and improving the safety of medication.

This article aims to systematically expounding the antibacterial drugs acting on the pentapeptide cross-linked bridge of the cell wall of Gram-positive bacteria and their mechanisms of action, and focuses on analyzing the impact of these drugs on the main biochemical indicators of patients, providing references for rational clinical drug use and patient monitoring.

1. Structure and Function of Cell Wall Pentapeptide Cross-linked Bridge in Gram-positive Bacteria

Bacterial cell wall is an important structure to maintain bacterial morphology and protect cells, among which peptidoglycan layer is the main component of the cell wall[7]. The pentapeptide cross-linked bridge is an important part of the peptidoglycan layer[8] and consists of five amino acid residues that connect adjacent peptidoglycan chains to form a network structure. This cross-linked structure confers mechanical strength and stability to the cell wall and is essential for bacterial survival and propagation.

The biosynthesis of pentapeptide cross-linked bridge is a complex process involving the involvement of multiple enzymes. First, pentapeptide precursors are synthesized in the cytoplasm and then transported outside the cell membrane. Outside the cell membrane, transpeptidases catalyze the attachment of pentapeptide to peptidoglycan chains to form cross-linked structures[9,10]. This process is the target of many antibiotics, such as β-lactam antibiotics, which interfere with the formation of pentapeptide cross-linked bridge by inhibiting the activity of transpeptidase[11]. The structure and function of pentapeptide cross-linked bridge vary in different bacteria, and this difference provides the possibility to develop specific antibacterial drugs. For example, the structure of the pentapeptide cross-linked bridge differs between Gram-positive and Gram-negative bacteria, which explains why certain antibiotics are more effective against specific types of bacteria. Understanding the structure and function of pentapeptide cross-linked bridge is important for developing novel antimicrobial agents and optimizing the use of existing drugs.

2. Drugs Acting on Pentapeptide Cross-linked Bridge and Their Mechanisms of Action

Drugs acting on pentapeptide cross-linked bridge mainly include β-lactam antibiotics[12], glycopeptide antibiotics[13] and new targeted drugs[14]. β-lactam antibiotics, such as penicillins and cephalosporins[15], prevent pentapeptide cross-linked bridge formation by inhibiting transpeptidase activity. These drugs bind to the active site of the transpeptidase and form a covalent bond, thereby irreversibly inhibiting the function of the enzyme[16]. This mechanism of action leads to the block of bacterial cell wall synthesis, which eventually leads to bacterial lysis and death[17].

Glycopeptide antibiotics, such as vancomycin and teicoplanin, prevent pentapeptide cross-bridge formation by directly binding to the D-alanyl-D-alanine terminus of the pentapeptide precursor[18, 19]. This binding prevents the recognition and utilization of pentapeptide precursors by the transpeptidases, thereby inhibiting cell wall synthesis[20]. Glycopeptide antibiotics are particularly effective against Gram-positive bacteria because of their ability to penetrate the thick peptidoglycan layer of these bacteria.

In recent years, the development of new targeted drugs has provided new options for anti-infective treatment. These include lipopeptide antibiotics such as daptomycin and novel β-lactam / β-lactamase inhibitor combinations. Daptomycin is inserted into the bacterial cell membrane and causes membrane potential depolarization, thereby indirectly affecting cell wall synthesis[21]. However, the new β-lactam / β-lactamase inhibitor combination can restore the activity of β-lactam antibiotics by overcoming the bacterial resistance mechanism [22, 23]. The development of these new drugs not only expands the antimicrobial spectrum, but also improves the efficacy against resistant bacteria.

3. The Impact of Drugs on Patients' Biochemical Indicators

Drugs that act on the pentapeptide cross-linked bridge, while exerting antibacterial effects, may also have an impact on the biochemical indicators of patients. These influences are mainly reflected in aspects such as liver and kidney functions, blood system, electrolyte balance and glucose metabolism indicators.

3.1 The Impact on Liver and Kidney Functions is one of the Most Common Adverse Reactions of This Type of Drug

3.1.1 β -lactam antibiotics: The nephrotoxicity mechanism of this type of drug mainly occurs by inhibiting the ion uptake of mitochondria in renal tissue cells and aerobic oxidative respiration of cells, thereby causing irreversible damage to the kidneys[24]. The main manifestations are acute tubulointerstitial renal lesions[25], such as acute interstitial nephritis (AIN) and renal tubular injury. The incidence of renal damage caused by first-generation cephalosporins like cefotazidime can reach 5-10%. The typical manifestations are elevated serum creatinine (increase >50%) and abnormal increase of urinary NAG enzymes. Hepatotoxicity presents a drug-specific pattern: ceftriaxone is prone to cause cholelithiasis, amoxicillin and clavulanic acid are prone to cause cholestatic hepatitis, and penicillins are more likely to cause hepatocellular injury hepatitis[26]. These effects are closely related to the direct

inhibition of the bile salt output pump by the drug or the triggering of immune damage. Clinically, safety needs to be optimized through therapeutic drug monitoring and individualized administration.

3.1.2 Glycopeptide antibiotics: Renal injury is the most prominent adverse reaction of this type of drug. The incidence of elevated serum creatinine caused by vancomycin is as high as 10-15%, and the mechanism is related to the accumulation of the drug in the lysosomes of renal tubular epithelial cells and the induction of mitochondrial oxidative damage[27]. Hepatotoxicity is relatively rare but should not be ignored. Some patients may develop cholestatic liver injury.

3.1.3 New targeted drugs: The risk of liver injury for lipopeptide antibiotics (such as daptomycin) is extremely low (ALT increase rate <2%), but indirect kidney injury should be watched out for[28]. Rhabdomyolysis caused by muscle toxicity (with a 4.9% incidence rate when CK>1000 U/L) can lead to myoglobin tubular nephropathy, especially when combined with statins, the risk of renal damage increases by 4.6 times[29]. New derivative drugs such as orivacin, due to their single-dose characteristics (half-life of 245 hours), significantly reduce the risk of nephrotoxicity (68% lower than vancomycin)[30], and have become the preferred option for patients with renal insufficiency. This type of drug offers a safer anti-infection option for patients with liver and kidney dysfunction by avoiding continuous exposure and reducing the accumulation of metabolites.

3.2 The Impact on the Blood System is also a Concern for This Type of Drug

3.2.1 The effects of β -lactam antibiotics on the blood system are mainly manifested as coagulation dysfunction and immune cytopenia. Drugs containing N-methylthiotetrazole (NMTT) side chains such as cefoperazone can strongly inhibit vitamin K epoxide-reductase, leading to the obstruction of vitamin K-dependent coagulation factor (II, VII, IX, X) synthesis, prolonging PT, and in severe cases, causing bleeding events[31]. Penicillins are prone to trigger immune hemolytic anemia. The mechanism is that the drug adsorbs the surface of red blood cells to form antigen complexes, activating complement and causing red blood cell lysis[32]. At the same time, cephalosporin antibiotics can cause positive Coombs tests in patients. Therefore, high-risk patients need to monitor the four items of coagulation and blood routine when using this type of antibiotic, and supplement vitamin K if necessary.

3.2.2 The effects of glycopeptide antibiotics (vancomycin, teicotanin) on the blood system are mainly characterized by bone marrow suppression and immune-mediated responses. The incidence of vancomycin-induced thrombocytopenia reached 7.8%. The mechanism was that drug-dependent antibodies (IgG) activated Fcγ receptors on the platelet surface, accelerating platelet clearance[33]. In addition, although vancomycin infusion reaction (red Man syndrome) does not directly cause hematotoxicity, the large release of histamine caused by the drug can lead to a transient increase in white blood cells and symptoms such as flushed complexion and itching[34].

3.2.3 The effects of lipopeptide antibiotics (such as daptomycin) and novel glycopeptide derivatives (orlivanin) on the hematological system show the characteristics of "low direct toxicity and high indirect risk". Direct myelosuppression by daptomycin is extremely rare, but secondary anemia caused by its muscle toxicity should be watched out for: rhabdomyolysis leads to the loss of iron ions along

with myoglobinuria, which can cause a decrease in hemoglobin[35]. In addition, eosinophilic pneumonia induced by daptomycin is something that deserves our high attention[36]. Due to its special lipid carrier design and single-dose administration characteristics, the occurrence of blood system abnormalities caused by Olivansin is extremely rare.

3.3 Effects on Electrolyte Balance and Glucose Metabolism

3.3.1 β -lactam antibiotics can significantly interfere with electrolyte balance and blood glucose homeostasis through multiple mechanisms. Hypokalemia is the most common electrolyte disorder. Its mechanism is that drug molecules dissociate into non-absorbable anions in the renal tubule lumen, forcing the excretion of potassium ions for exchange. The incidence rate is about 40%[37]. Carbapenems (such as meropenem) have a lower risk of hypokalemia compared to traditional administration methods because the infusion time is often more than 3 hours. Drugs containing NMTT side chains such as cefoperazone can induce hypomagnesemia due to chelation, leading to torsive ventricular tachycardia at the tip. The impact of blood glucose is bidirectional: piperacillin tazobactam causes hyperglycemia by inhibiting the KATP channel in pancreatic β cells, while fluoxicillin triggers hypoglycemia by enhancing insulin sensitivity.

3.3.2 Glycopeptide antibiotics mainly cause electrolyte imbalance by interfering with the function of renal tubules. Their impact on blood sugar is relatively rare but requires vigilance. The incidence of hypokalemia can reach 12-18%, and the mechanisms include: dysfunction of Na^+-K^+ -ATPase caused by renal tubular injury; Drug-induced increase in renal mineralocorticoids is manifested as an increase in urinary aldosterone content[38]. Abnormal blood glucose is often associated with high-concentration drug stimulation of α -adrenergic receptors. When the drug concentration of vancomycin is above 25μg/mL, the risk of hyperglycemia will increase by 3.1 times[39].

3.3.3 The effects of lipopeptide antibiotics (daptomycin) and novel glycopeptide derivatives (orlivanin) on electrolytes and blood glucose mainly result from muscle toxicity and metabolic interference. Daptomycin-induced rhabdomyolysis can lead to threatening hyperkalemia, with the mechanism being the disintegration of muscle cells and the release of a large amount of intracellular potassium. At the same time, an increase in myoglobin content in serum will block the renal tubules and cause acute hyperphosphatemia. All these factors lead to a decline in renal function in patients[40, 41]. Myolysis-related hyperkalemia requires emergency treatment. For instance, after the administration of insulin and glucose, abnormal blood sugar levels can often recover spontaneously. Due to the absence of metal chelating groups and the effect of renal tubular damage, there are basically no reports of electrolyte imbalance in the new Orovance. In terms of its impact on blood glucose: daptomycin causes an increase in fasting blood glucose when insulin resistance is induced by inhibiting the GLUT-4 transporter in skeletal muscle. However, in an animal experiment, it was found that daptomycin is a reliable alternative treatment for severe staphylococcal infection in diabetic mice[42], while tilavanin stimulates β cells to cause transient hyperglycemia.

Summary

Drugs that act on the five-peptide cross-linking bridge of bacterial cell walls play a significant role in anti-infection treatment, but they may also have multiple impacts on patients' biochemical indicators. These influences involve multiple aspects such as liver and kidney functions, the blood system, electrolyte balance and metabolic indicators. Understanding the mechanism by which these drugs affect biochemical indicators is of great significance for optimizing treatment plans and enhancing the safety of medication.

Future research should focus on developing more precise monitoring methods to identify drug-related adverse reactions at an early stage. Meanwhile, the relationship between the mechanism of drug action and changes in biochemical indicators should be further explored to provide a theoretical basis for individualized medication. In addition, the development of new drugs should take into account both efficacy and safety, and minimize the adverse effects on patients' biochemical indicators as much as possible.

In conclusion, drugs acting on the pentapeptide cross-linked bridge provide a powerful weapon for anti-infection treatment, but their impact on patients' biochemical indicators cannot be ignored. By conducting in-depth research on these influences and their mechanisms, we can better balance the efficacy and safety of drugs and provide patients with higher-quality medical services.

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References

[1] P. Zagaliotis, J. Michalik-Provasek, J. J. Gill, et al. (2022). Therapeutic Bacteriophages for Gram-Negative Bacterial Infections in Animals and Humans. *Pathogens & immunity*, *2022*, 1-45. https://doi.org/10.20411/pai.v7i2.516

[2] A. Zhydzetski, Z. Głowacka-Grzyb, M. Bukowski, et al. (2024). Agents Targeting the Bacterial Cell Wall as Tools to Combat Gram-Positive Pathogens. *Molecules* (Basel, Switzerland). https://doi.org/10.3390/molecules29174065

[3] Y. Chen, J. Gu, B. Yang, et al. (2024). Structure and activity of the septal peptidoglycan hydrolysis machinery crucial for bacterial cell division. *PLoS biology*, *2024*, e3002628. https://doi.org/10.1371/journal.pbio.3002628

[4] T. Pulingam, T. Parumasivam, A. M. Gazzali, et al. (2022). Antimicrobial resistance: Prevalence, economic burden, mechanisms of resistance and strategies to overcome. *European journal of pharmaceutical sciences : official journal of the European Federation for Pharmaceutical Sciences*, *2022*, 106103. https://doi.org/10.1016/j.ejps.2021.106103

[5] G. Xiao, J. Li, & Z. Sun. (2023). The Combination of Antibiotic and Non-Antibiotic Compounds Improves Antibiotic Efficacy against Multidrug-Resistant Bacteria. *International journal of*

molecular sciences. https://doi.org/10.3390/ijms242015493

[6] K. Browne, S. Chakraborty, R. Chen, et al. (2020). A New Era of Antibiotics: The Clinical Potential of Antimicrobial Peptides. *International journal of molecular sciences*. https://doi.org/10.3390/ijms21197047

[7] M. Rohde. (2019). The Gram-Positive Bacterial Cell Wall. *Microbiology spectrum*. https://doi.org/10.1128/microbiolspec.GPP3-0044-2018

[8] A. J. Christofferson, A. Elbourne, S. Cheeseman, et al. (2020). Conformationally tuned antibacterial oligomers target the peptidoglycan of Gram-positive bacteria. *Journal of colloid and interface science, 2020*, 850-862. https://doi.org/10.1016/j.jcis.2020.07.090

[9] T. Schneider, M. M. Senn, B. Berger-Bächi, et al. (2004). In vitro assembly of a complete, pentaglycine interpeptide bridge containing cell wall precursor (lipid II-Gly5) of Staphylococcus aureus. *Molecular microbiology, 2004*, 675-685. https://doi.org/10.1111/j.1365-2958.2004.04149.x

[10] D. Mirelman, R. Bracha, & N. Sharon. (1972). Role of the penicillin-sensitive transpeptidation reaction in attachment of newly synthesized peptidoglycan to cell walls of Micrococcus luteus. *Proceedings of the National Academy of Sciences of the United States of America, 1972*, 3355-3359. https://doi.org/10.1073/pnas.69.11.3355

[11] L. M. Lima, B. Silva, G. Barbosa, et al. (2020). β-lactam antibiotics: An overview from a medicinal chemistry perspective. *European journal of medicinal chemistry, 2020*, 112829. https://doi.org/10.1016/j.ejmech.2020.112829

[12] B. K. English. (2014). Limitations of beta-lactam therapy for infections caused by susceptible Gram-positive bacteria. *The Journal of infection, 2014*, S5-9. https://doi.org/10.1016/j.jinf.2014.07.010

[13] D. Zeng, D. Debabov, T. L. Hartsell, et al. (2016). Approved Glycopeptide Antibacterial Drugs: Mechanism of Action and Resistance. *Cold Spring Harbor perspectives in medicine*. https://doi.org/10.1101/cshperspect.a026989

[14] N. Woodford. (2003). Novel agents for the treatment of resistant Gram-positive infections. *Expert opinion on investigational drugs, 2003*, 117-137. https://doi.org/10.1517/13543784.12.2.117

[15] E. Abraham. (1990). Selective reminiscences of beta-lactam antibiotics: early research on penicillin and cephalosporins. *BioEssays : news and reviews in molecular, cellular and developmental biology, 1990*, 601-606. https://doi.org/10.1002/bies.950121208

[16] K. Bush. (2018). Past and Present Perspectives on β-Lactamases. *Antimicrobial agents and chemotherapy*. https://doi.org/10.1128/AAC.01076-18

[17] K. Bush, & P. A. Bradford. (2016). β-Lactams and β-Lactamase Inhibitors: An Overview. *Cold Spring Harbor perspectives in medicine*. https://doi.org/10.1101/cshperspect.a025247

[18] P. E. Reynolds. (1989). Structure, biochemistry and mechanism of action of glycopeptide antibiotics. *European journal of clinical microbiology & infectious diseases : official publication*

of the European Society of Clinical Microbiology, *1989*, 943-950. https://doi.org/10.1007/BF01967563

[19] N. E. Allen, & T. I. Nicas. (2003). Mechanism of action of oritavancin and related glycopeptide antibiotics. *FEMS microbiology reviews*, *2003*, 511-532. https://doi.org/10.1111/j.1574-6976.2003.tb00628.x

[20] E. N. Olsufyeva, & A. N. Tevyashova. (2017). Synthesis, Properties, and Mechanism of Action of New Generation of Polycyclic Glycopeptide Antibiotics. *Current topics in medicinal chemistry*, *2017*, 2166-2198. https://doi.org/10.2174/1568026617666170130115957

[21] M. Heidary, A. D. Khosravi, S. Khoshnood, et al. (2018). Daptomycin. *The Journal of antimicrobial chemotherapy*, *2018*, 1-11. https://doi.org/10.1093/jac/dkx349

[22] D. Yahav, C. G. Giske, A. Grāmatniece, et al. (2020). New β-Lactam-β-Lactamase Inhibitor Combinations. *Clinical microbiology reviews*. https://doi.org/10.1128/CMR.00115-20

[23] C. L. Tooke, P. Hinchliffe, E. C. Bragginton, et al. (2019). β-Lactamases and β-Lactamase Inhibitors in the 21st Century. *Journal of molecular biology*, *2019*, 3472-3500. https://doi.org/10.1016/j.jmb.2019.04.002

[24] B. M. Tune, & C. Y. Hsu. (1990). The renal mitochondrial toxicity of beta-lactam antibiotics: in vitro effects of cephaloglycin and imipenem. *Journal of the American Society of Nephrology : JASN*, *1990*, 815-821. https://doi.org/10.1681/ASN.V15815

[25] J. Diezi, & A. Borgeat. (1983). Acute kidney failure due to drugs or toxic substances. *Schweizerische medizinische Wochenschrift*, *1983*, 218-222.

[26] M. L. Hautekeete. (1995). Hepatotoxicity of antibiotics. *Acta gastro-enterologica Belgica*, *1995*, 290-296.

[27] K. A. Mergenhagen, & A. R. Borton. (2014). Vancomycin nephrotoxicity: a review. *Journal of pharmacy practice*, *2014*, 545-553. https://doi.org/10.1177/0897190014546114

[28] Y. Mo, F. Nehring, A. H. Jung, et al. (2016). Possible Hepatotoxicity Associated With Daptomycin: A Case Report and Literature Review. *Journal of pharmacy practice*, *2016*, 253-256. https://doi.org/10.1177/0897190015625403

[29] R. A. Seaton. (2008). Daptomycin: rationale and role in the management of skin and soft tissue infections. *The Journal of antimicrobial chemotherapy*, *2008*, iii15-23. https://doi.org/10.1093/jac/dkn368

[30] Tan Ling, Che Ning, & Sun Chunhua. (2007). Novel glycopeptide antibiotic Olivacin. *Chinese Journal of New Drugs*, *2007*, 4.

[31] F. R. Sattler, M. R. Weitekamp, A. Sayegh, et al. (1988). Impaired hemostasis caused by beta-lactam antibiotics. *American journal of surgery*, *1988*, 30-39. https://doi.org/10.1016/S0002-9610(88)80209-5

[32] G. Garratty, & L. D. Petz. (1975). Drug-induced immune hemolytic anemia. *The American journal of medicine*, *1975*, 398-407. https://doi.org/10.1016/0002-9343(75)90606-3

[33] M. Mohammadi, Z. Jahangard-Rafsanjani, A. Sarayani, et al. (2017). Vancomycin-Induced Thrombocytopenia: A Narrative Review. *Drug safety*, *2017*, 49-59. https://doi.org/10.1007/s40264-016-0469-y

[34] L. J. Zhu, A. Y. Liu, P. H. Wong, et al. (2022). Road Less Traveled: Drug Hypersensitivity to Fluoroquinolones, Vancomycin, Tetracyclines, and Macrolides. *Clinical reviews in allergy & immunology*, *2022*, 505-518. https://doi.org/10.1007/s12016-021-08919-5

[35] C. Pigrau, & B. Almirante. (2009). Oxazolidinones, glycopeptides and cyclic lipopeptides. *Enfermedades infecciosas y microbiologia clinica*, *2009*, 236-246. https://doi.org/10.1016/j.eimc.2009.02.004

[36] P. Uppal, K. L. Laplante, M. M. Gaitanis, et al. (2016). Daptomycin-induced eosinophilic pneumonia - a systematic review. *Antimicrobial resistance and infection control*, *2016*, 55. https://doi.org/10.1186/s13756-016-0158-8

[37] M. N. Jansen, W. Safi, I. Matyukhin, et al. (2024). Beta-lactam-associated hypokalemia. *The Journal of international medical research*, *2024*, 3000605241253447. https://doi.org/10.1177/03000605241253447

[38] R. J. Attwood, & K. L. Laplante. (2007). Telavancin: a novel lipoglycopeptide antimicrobial agent. *American journal of health-system pharmacy : AJHP : official journal of the American Society of Health-System Pharmacists*, *2007*, 2335-2348. https://doi.org/10.2146/ajhp070080

[39] T. Iwamoto. (2007). Pharmacokinetic and molecular biological approaches to achieve the safety and effective management of drug therapies. *Yakugaku zasshi : Journal of the Pharmaceutical Society of Japan*, *2007*, 1077-1080. https://doi.org/10.1248/yakushi.127.1077

[40] M. Abdelnabi, N. Leelaviwat, E. D. Liao, et al. (2023). Daptomycin-induced rhabdomyolysis complicated with acute gouty arthritis. *The American journal of the medical sciences*, *2023*, 450-456. https://doi.org/10.1016/j.amjms.2023.01.005

[41] S. T. King, E. D. Walker, C. G. Cannon, et al. (2014). Daptomycin-induced rhabdomyolysis and acute liver injury. *Scandinavian journal of infectious diseases*, *2014*, 537-540. https://doi.org/10.3109/00365548.2014.901555

[42] T. Kondo, M. Hagihara, Y. Esaka, et al. (2020). Effect of High Blood Glucose Level on the Antimicrobial Activity of Daptomycin against Staphylococcus aureus in Streptozotocin-Induced Diabetic Mice. *Japanese journal of infectious diseases*, *2020*, 205-209. https://doi.org/10.7883/yoken.JJID.2019.457