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Antibiotics and is Bacteriostatic and Bactericidal

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Editorial

Antibiotics are one of the most important treatments available to doctors around the world. They are used in both inpatient and outpatient settings. Penicillin was the first antibiotic extracted from a mould, discovered by Alexander Fleming in the early 1800s. By modifying a red dye used in the chemical industry, Dr. Gerhard Domagk created synthetic sulpha medicines. Since then, several antibiotic classes with varied antimicrobial properties have been found, allowing them to be used empirically or in specific clinical circumstances. Antibiotics can be bactericidal or bacteriostatic depending on their method of action. Multiple trials, however, have found little clinical relevance between tidal and static antibiotics. Their existence has resulted in less invasive deep surgery, advanced cancer chemotherapy, and organ transplantation. Antibiotic overuse has led to serious hospital-acquired illnesses such as nosocomial pneumonia, Clostridioides difficult infection, multidrug-resistant invasive bacterial infections, allergic responses, and other serious side effects. Antibiotic stewardship is a process that advocates for the judicious use of antibiotics for the proper duration in the modern day. They are essential in medical and surgical intensive care units, where they deal with the many difficulties that these patients face. Antibiotics are essential in the treatment of severe acute infections in order to reduce overall mortality and morbidity [1].

The term "antibiotic" refers to a chemical compound produced by one bacterium that inhibits the metabolism and development of other organisms. The term antibiotic was originally used to refer to naturally occurring antimicrobial agents, but it is now used to refer to both natural and manmade antimicrobial substances. Although penicillin was the first antibiotic isolated from mould, it was eventually surpassed by sulpha medicines, which are now widely used by doctors to treat infections. Infectious disease fatality rates have decreased from 280 per 100,000 in the 1950s to 60 per 100,000 now, thanks to antibiotic use [2]. There is a popular perception that tidal antibiotics are more effective than static antibiotics, however there is no clinical evidence to back this up. In vitro terminology such as tidal and static refers to the effect of antibiotic concentrations on bacterial growth at a predetermined threshold. They are unable to predict the outcome of an infection in vivo. Antibiotics that target the cell wall of an organism are usually bactericidal, but those that target protein synthesis are bacteriostatic [3]. The lowest antibiotic concentration that suppresses observable growth after 24 hours is known as the MIC (minimum inhibitory concentration). The MBC (minimum bactericidal concentration) is the lowest antibiotic concentration that kills bacteria. In vitro terminology such as tidal and static refers to the effect of antibiotic concentrations on bacterial growth at a predetermined threshold. They are unable to predict the outcome of an infection in vivo. Antibiotics that target the cell wall of an organism are usually bactericidal, but those that target protein synthesis are bacteriostatic. The lowest antibiotic concentration that suppresses observable growth after 24 hours is known as the MIC (minimum inhibitory concentration). The MBC (minimum bactericidal concentration) is the lowest antibiotic concentration that kills bacteria [4].

The relevance of classifying antibiotics as bacteriostatic or bactericidal has been questioned due to the reliance of these categories on drug concentrations and the treated organisms. The manner in which these pharmacodynamics properties are used in specific clinical scenarios is beyond the scope of this paper. Instead, we propose that this binary classification is a useful initial step in determining when two drugs in combination would result in strong antagonism and thus should be evaluated, to exploit the varied effects of this specific interaction [5].

The tests set by the Clinical and Laboratory Standards Institute to determine whether an antibiotic is bacteriostatic or bactericidal involve assessing the degree of survival of a liquid culture of bacteria after a certain period of drug exposure. The moderate killing effect that defines a bacteriostatic agent therefore implies induction of cellular stasis [6]. Here we show that, while bacteriostatic drugs result in prevalent patterns of antagonistic interactions with bactericidal drugs, their effects at the single-cell level may differ considerably. We found that tetracycline effectively induced stasis in antibiotic-sensitive bacteria. In contrast, treatment with erythromycin reduced the elongation rate to a similar degree as did tetracycline, while division rates were not as strongly decreased; this resulted in long filamentous cells [7].

The disparities in growth dynamics with similarly antagonistic antibiotic combinations suggest that different cellular mechanisms underlie the increased survival rates with these pairs of drugs. However, the results of our time-lapse image analysis suggest a new perspective on how and when cells can elude killing by antibiotics. This method allowed for the examination of cell growth as distinct rates of elongation and division. The similar reductions in division rates produced by different bacteriostatic-bactericidal drug pairs could be the basis of antagonism. In relation to the morphological effects we quantified, other antibiotics are capable of eliciting changes in cell shape [8-10]. For example, members of the beta-lactam class induce cell lysis via a bulge-mediated process in which the cytosol leaks out through defects produced in the peptidoglycan layer. Future work should consider whether such structural effects are capable of modulating rates of cell division and therefore would be similarly capable of producing antagonism.

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Conflict of Interest

None

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