

MODELING ZONE DIAMETER MEASUREMENTS TO INFER ANTIBIOTIC SUCCEPTIBILITY OF BACTERIA

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ABSTRACT: Disk diffusion tests are employed to determine the susceptibility of bacteria to antibiotics by measuring the zone diameter (ZD) of inhibition. Previous work suggested to use a composite model when modeling minimum inhibitory concentration measurements. This model combines a parametric distribution covering the range of observations from the susceptible component with a non-parametric distribution capturing the range of observations containing also resistant observations. We investigate the use of this model for ZD data and also consider a two-component mixture model combining the parametric distribution with the non-parametric distribution relaxing the split of the support for both distributions. We present maximum likelihood and penalized maximum likelihood estimation of both models using a normal or a skew-normal distribution as parametric distribution while taking the restricted support and the rounding of the data into account. We illustrate the use of these models in a simulation study on artificial data and on data available from the web page of the European Committee on Antimicrobial Susceptibility Testing (EUCAST).

KEYWORDS: antibiotic susceptibility, composite model, disk diffusion test, mixture model, zone diameter measurement.

References

- AZZALINI, A. 1985. A Class of Distributions Which Includes the Normal Ones. *Scandinavian Journal of Statistics*, **12**(2), 171–178.
- JASPERS, STIJN, AERTS, MARC, VERBEKE, GEERT, & BELOEIL, PIERRE-ALEXANDRE. 2014. Estimation of the Wild-Type Minimum Inhibitory Concentration Value Distribution. *Statistics in Medicine*, **33**(2), 289–303.