Development and validation of two Shiny applications for β-lactam dose individualisation in critically ill patients

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Population pharmacokinetic (popPK) models combined with Bayesian estimation can improve dosing precision; however, clinical implementation remains limited by the lack of user-friendly tools. Web-based applications may bridge this gap and support antimicrobial stewardship programs

Aim and objectives

To develop two interactive Shiny applications based on published popPK models for meropenem and piperacillin–tazobactam, and to validate their predictive performance before and after Bayesian adjustment using real-world ICU data.

Materials and methods

Two R Shiny applications developed to perform population simulations and Bayesian dose optimization based on validated popPK model.

MeroDose-UCI | **PiperDose-UCI**

Predictive performance	Observed versus predicted concentrations for population and individual (Bayesian) estimates.
Accuracy and precisión	Coefficient of determination (R^2)
	Mean absolute error (MAE)
	Mean relative error (MRE).

- **Retrospective validation was conducted using plasma concentration data from ICU patients.**
- **Visual Predictive Checks (VPCs) were additionally performed to evaluate model predictive distribution against observed data.**

Results

36 plasma samples (14 meropenem and 22 piperacillin) from 26 patients (13 per antibiotic) were included.

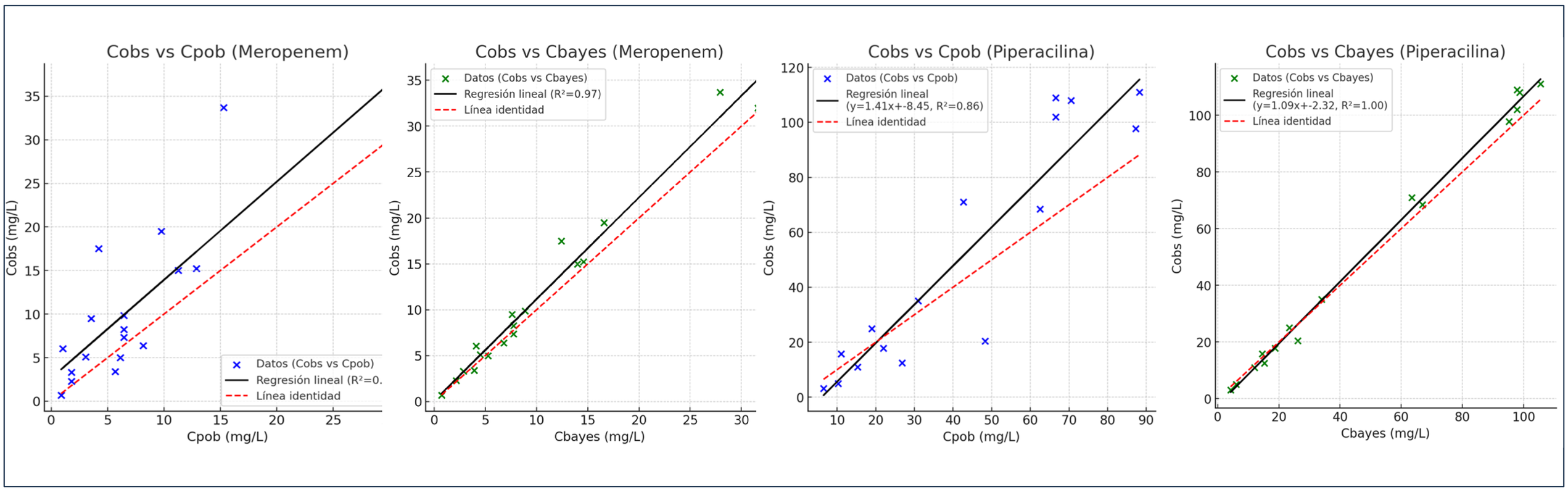
Meropenem

- **Population: R^2 0.80 | MAE 3.61 mg/L | MRE 38.6%**
- **Bayesian: R^2 0.95 | MAE 1.15 mg/L | MRE 11.5%**

Piperacillin-tazobactam

- **Population: R^2 0.86 | MAE 9.31 mg/L | MRE 38.4%**
- **Bayesian: R^2 0.99 | MAE 2.21 mg/L | MRE 9.1%**

VPCs confirmed that both models adequately captured the central tendency and variability of observed concentrations:



Conclusion and relevance

- **Two Shiny applications were successfully developed and validated for Bayesian-guided TDM of meropenem and piperacillin–tazobactam. Bayesian adjustment and VPC analysis confirmed the robustness and predictive reliability of the implemented models.**
- **These validated tools provide a practical and innovative solution to support pharmacists in optimising β-lactam therapy in critically ill patients.**