“CAROL DAVILA” UNIVERSITY OF MEDICINE AND PHARMACY BUCHAREST
DOCTORAL SCHOOL
FIELD OF MEDICINE

Antimicrobial resistance, relevant emerging pathogens and diagnostic optimization in clinical microbiology: scientific, research and educational achievements and perspectives

HABILITATION THESIS SUMMARY

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2025

Introduction and Rationale

Clinical microbiology is currently facing one of the most significant challenges in modern medicine: the global threat of antimicrobial resistance (AMR). The rapid emergence and dissemination of multidrug-resistant organisms, coupled with the constant appearance of novel pathogens, place an immense burden on health systems worldwide. Against this background, research and innovation in diagnostic methods, infection control, and therapeutic approaches are essential to mitigate the impact of resistant pathogens and to ensure effective patient care.

This habilitation thesis brings together over twenty years of professional and academic activity in the field of microbiology, with contributions spanning clinical research, teaching, and active participation in international projects, with emphasis on the post-doctoral period. The main objective is to illustrate the interconnectedness of scientific discovery, diagnostic innovation, and the training of future medical professionals, with a specific focus on the challenges posed by AMR and the opportunities for developing modern diagnostic and therapeutic strategies.

Scientific Activity

My research activity has focused on the molecular epidemiology, pathogenicity, and diagnostic optimization of clinically relevant pathogens. A central line of investigation addressed **Enterobacterales and non-fermenting Gram-negative bacilli**, especially *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii*. An over five-year period study documented high rates of colonization and infection with carbapenemase-producing strains (OXA-48, NDM, KPC), highlighting the silent dissemination of multidrug-resistant organisms in local hospitals. Validation of rapid phenotypic methods, such as the immunochromatographic tests, provided practical alternatives to molecular techniques and contributed to improved infection control strategies.

Another research focused on **staphylococcal infections**, including *Staphylococcus aureus* and coagulase-negative staphylococci. Comparative studies of invasive and colonizing isolates revealed distinct virulence traits and enabled the development of the **Staphylococcal Aggressiveness Score (SAS)**, a predictive tool for clinical outcome and recurrence. Longitudinal surveillance of over 1,600 isolates showed dynamic MRSA prevalence, with a transient reduction during the COVID-19 pandemic, while resistance to

last-line antibiotics such as vancomycin and linezolid remained stable. Innovative studies also explored **bacteriophage-based inhibition of biofilm formation**, opening new avenues for alternative therapies in multidrug-resistant staphylococcal infections.

The research further addressed **emerging pathogens and healthcare-associated infections (HAIs)**. Pioneering studies documented the rapid spread of hypervirulent *Clostridioides difficile* ribotype 027 in Romania, the first national reports of *Candidozyma auris*, and analyses over five years of asymptomatic carriage of multidrug-resistant organisms. These findings established a solid foundation for national surveillance programs and provided critical data for clinical and epidemiological decision-making.

Finally, **diagnostic innovation** represented a cross-cutting theme of the research. Studies on blood culture optimization, molecular multiplex panels (FilmArray BCID), and prognostic biomarkers such as presepsin in severe burns demonstrated the value of combining classical microbiology with rapid molecular and immunological methods. This integrative approach has proven essential for timely antimicrobial stewardship and improved patient outcomes.

Didactic Activity

The academic trajectory has been closely linked to the scientific work, aiming to form the next generation of physicians and microbiologists. Teaching has included both undergraduate and postgraduate education, with emphasis on microbiology, antimicrobial resistance, infection control, and laboratory methods. Courses have been constantly updated to integrate European standards (EUCAST, ECDC, WHO guidelines), and practical teaching methods have been prioritized, including laboratory sessions, case-based learning, and simulation workshops.

Mentorship of residents, PhD students, and young researchers has been a cornerstone of this activity, fostering not only knowledge acquisition but also the development of critical thinking, scientific writing, and research ethics. Contributions to national curricula and participation as invited lecturer in postgraduate programs further strengthened the alignment of Romanian education with international standards.

Professional Achievements

Professional activity has been developed primarily within the National Institute for Infectious Diseases “Prof. Dr. Matei Balș”, where I currently serve as Head of the Clinical Microbiology Laboratory. Beyond daily diagnostic responsibilities, this position involved modernization of infrastructure, introduction of innovative methods such as implant sonication for prosthetic joint infections, and implementation of rigorous quality control standards.

At the national level, I contributed to the drafting of guidelines for antimicrobial resistance control within the Ministry of Health committees, and actively supported the activities of the Romanian Society of Microbiology. Internationally, I participated in ESCMID training programs, WHO regional initiatives on laboratory leadership, and European consortia dedicated to AMR surveillance and One Health approaches.

Future Development Plans

Future work will continue to strengthen existing research directions, while expanding into new frontiers. Three strategic axes are envisioned:

1. **Consolidation of AMR research** through genomic epidemiology, integration of whole genome sequencing into routine surveillance, and advanced studies on resistance gene transfer in Gram-negative and Gram-positive bacteria.
2. **Exploration of novel diagnostic and therapeutic tools**, including rapid point-of-care molecular assays, AI-based data integration, and clinical evaluation of bacteriophages and immunomodulators in multidrug-resistant infections.
3. **Capacity building and leadership training**, by developing curricula and mentorship programs in clinical microbiology, supporting One Health collaborations, and fostering Romania’s integration into European and global laboratory networks.

This habilitation thesis reflects a professional trajectory committed to advancing microbiology through the interplay of scientific innovation, teaching, and research collaboration. By focusing on antimicrobial resistance and diagnostic innovation, my work contributes to both the academic community and the health system, aligning national priorities with global challenges.