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Review

The role of clinical pharmacist in the infectious diseases department: Bridging the gap between antimicrobial resistances and optimized patient health outcomes

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ABSTRACT

Antimicrobial resistance is a major global health challenge, leading to adverse clinical outcomes, increased healthcare costs, and diminished efficacy of antimicrobials. Clinical pharmacists, with advanced pharmacotherapy expertise and direct involvement in patient care, are well positioned to optimize treatment while helping to combat resistance. This narrative review compiles evidence from bibliographic databases covering literature published between January 2021 and October 2025. It assesses the clinical, economic, and operational impact of clinical pharmacists working within infectious diseases services and antimicrobial stewardship programs. The evidence indicates that these professionals enhance antimicrobial prescribing through stewardship leadership, pharmacokinetic/pharmacodynamic-guided dose optimization, rapid diagnostic stewardship, intravenous-to-oral switch programs, and the resolution of drug-related problems. Collaborative drug therapy management within antimicrobial stewardship programs can reduce antimicrobial expenditure by approximately 34.0%. Nevertheless, the available evidence remains heterogeneous and largely observational, with most data originating from high-income countries, which limits generalizability. Despite growing evidence of benefit, clinical pharmacy services remain underutilized in some low- and middle-income countries due to structural constraints, limited training opportunities, and workforce shortages. To optimize antimicrobial use and patient outcomes, health systems should better integrate infectious diseases clinical pharmacists into multidisciplinary teams, strengthen diagnostic capacity, and embed antimicrobial stewardship principles within pharmacy education. Clinical pharmacists have become integral clinical partners in infection management and prevention, with the potential to improve individual patient outcomes and contribute to greater antimicrobial resistance mitigation. Improving their role represents a strategic priority for preserving antimicrobial efficacy and enhancing patient safety.

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El papel del farmacéutico clínico en el departamento de enfermedades infecciosas: cerrar la brecha entre la resistencia a los antimicrobianos y optimizar los resultados de salud del paciente

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RESUMEN

La resistencia a los antimicrobianos es un importante desafío para la salud mundial, que conlleva resultados clínicos adversos, mayores costos de atención médica y una menor eficacia de los antimicrobianos. Los farmacéuticos clínicos, con experiencia avanzada en farmacoterapia y participación directa en la atención al paciente, están bien posicionados para optimizar el tratamiento y, al mismo tiempo, ayudar a combatir la resistencia. Esta revisión narrativa recopila evidencia de bases de datos bibliográficas que abarcan la literatura publicada entre enero de 2021 y octubre de 2025. Evalúa el impacto clínico, económico y operativo del trabajo de los farmacéuticos clínicos en servicios de enfermedades infecciosas y programas de optimización del uso de antimicrobianos. La evidencia indica que estos profesionales mejoran la prescripción de antimicrobianos mediante el liderazgo en la optimización de dosis, la optimización de dosis guiada por farmacocinética/farmacodinámica, la optimización diagnóstica rápida, los programas de cambio de vía intravenosa a oral y la resolución de problemas relacionados con los medicamentos. La gestión colaborativa de la farmacoterapia dentro de los programas de optimización del uso de antimicrobianos puede reducir el gasto en antimicrobianos en aproximadamente un 34,0 %. Sin embargo, la evidencia disponible sigue siendo heterogénea y en gran medida observacional, y la mayoría de los datos provienen de países de altos ingresos, lo que limita la generalización. A pesar de la creciente evidencia de sus beneficios, los servicios de farmacia clínica siguen infrautilizados en algunos países de ingresos bajos y medios debido a limitaciones estructurales, escasas oportunidades de capacitación y escasez de personal. Para optimizar el uso de antimicrobianos y los resultados en los pacientes, los sistemas de salud deben integrar mejor a los farmacéuticos clínicos especializados en enfermedades infecciosas en equipos multidisciplinarios, fortalecer la capacidad diagnóstica e integrar los principios de optimización del uso de antimicrobianos en la formación farmacéutica. Los farmacéuticos clínicos se han convertido en colaboradores clínicos esenciales en el manejo y la prevención de infecciones, con el potencial de mejorar los resultados individuales de los pacientes y contribuir a una mayor mitigación de la resistencia a los antimicrobianos. Mejorar su función representa una prioridad estratégica para preservar la eficacia de los antimicrobianos y mejorar la seguridad del paciente.

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1. INTRODUCTION

Clinical pharmacy has evolved from a product-focused practice to a patient-centered discipline aimed at optimizing medication therapy, improving clinical outcomes, and advancing public health. The American College of Clinical Pharmacy defines clinical pharmacy as the provision of direct patient care that optimizes medication therapy and promotes health and disease prevention [1]. Within infectious diseases (IDs), clinical pharmacist is recognized as antimicrobial pharmacotherapy expert and integral member of multidisciplinary team [2]. Clinical pharmacist supports antimicrobial prescribing through individualized dosing, therapeutic drug monitoring (TDM), and rapid diagnostic stewardship, alongside antimicrobial stewardship programs (ASPs)-evidence-based frameworks developed to optimize antimicrobials selection, dosage, and duration-which ultimately reduce inappropriate antimicrobial use, improve patient outcomes, curb antimicrobial resistance (AMR), and minimize drug toxicity [3-5]. Globally, AMR, rising rates of multidrug-resistant tuberculosis and persistent gaps in treatment access threaten health systems, particularly in low- and middle-income countries (LMICs) [6], where antimicrobial shortages and delayed diagnosis are common [7]. The COVID-19 pandemic has further exacerbated antibiotic misuse and accelerated the emergence of pathogen resistance [8]. Clinical pharmacy services can improve outcomes by reducing medication errors in hospital settings [9], and generate cost savings through shorter hospital stays, antimicrobial de-escalation, and intravenous-to-oral (IV-to-oral) step-down therapy [10]. Nevertheless, their integration into IDs services and ASPs remains partial in some regions. Challenges such as workforce shortages, lack of formal stewardship structures, and insufficient training opportunities, continue to hinder full implementation [11]. Previous reviews have described the contributions of clinical pharmacists to antimicrobial stewardship (AMS), but no recent publication has synthesized research from January 2021 to October 2025 that simultaneously considers clinical outcomes, diagnostic stewardship, economic value, and workforce integration. Therefore, this narrative review provides the clinical, economic, and operational impact of infectious diseases clinical pharmacist (ID-CP) and highlights his role in connecting AMR prevention with optimized patient care.

2. METHODS

This narrative review was conducted according to the Scale for the Assessment of Narrative Review Articles (SANRA) guidelines, recommended for non-systematic reviews synthesizing heterogeneous evidence and contextual insights rather than perform quantitative pooling [12, 13]. A narrative approach was selected to integrate of clinical, economic, operational, and workforce-related evidence across diverse healthcare settings.

2.1. LITERATURE SEARCH STRATEGY

A comprehensive literature search identified relevant publications from January 2021- October 2025 using PubMed/MEDLINE and ScienceDirect. Guidelines, position statements, and policy documents from recognized organizations were also included when directly relevant. Full-text articles were retrieved via institutional subscriptions or author contact as needed.
Search terms combined keywords and Boolean operators: “clinical pharmacist” AND (“infectious diseases” OR “antimicrobial stewardship” OR “antimicrobial resistance”) AND (“cost-effectiveness” OR “health system”). Medical Subject Headings (MeSH) terms and database-specific indexing enhanced retrieval sensitivity where applicable.

2.2. ELEGIBILITY CRITERIA

Inclusion criteria:

- **Study design:** Randomized controlled trials, cohort studies, quasi-experimental studies, implementation studies, economic evaluations, and narrative/systematic reviews.
- **Setting:** Hospital/institutional infectious diseases services involving clinical pharmacists.
- **Outcomes:** Clinical (treatment success, length of stay), economic (cost savings), and operational (recommendations acceptance).
- **Language**: English.
- **Period**: January 2021- October 2025.

Exclusion criteria:

- Editorials, opinion pieces, commentaries, or letters without primary data.
- Conference abstracts/posters without full-text.
- Non-infectious diseases practice settings (oncology-only or community pharmacy).

2.3. QUALITY CONSIDERATIONS AND BIAS MITIGATION

Consistent with narrative review methodology, a formal meta-analysis and structured risk-of-bias assessment were not performed. However, to reduce selection and interpretation bias, the synthesis prioritized:

- Studies with defined interventions/outcomes.
- Consistency findings across multiple settings.
- Transparency reporting relevant to infectious diseases clinical pharmacy.

2.4. STUDY SELECTION AND SYNTHESIS

Two reviewers conducted a two-stage screening process (title and abstract followed by full-text review) independently. The principal investigator resolved discrepancies in the abstraction/interpretation of the data. From an initial 312 records, 126 full-text articles were assessed for eligibility, of which 50 were retained for the final synthesis. Flow diagram is provided to enhance transparency (Figure 1).

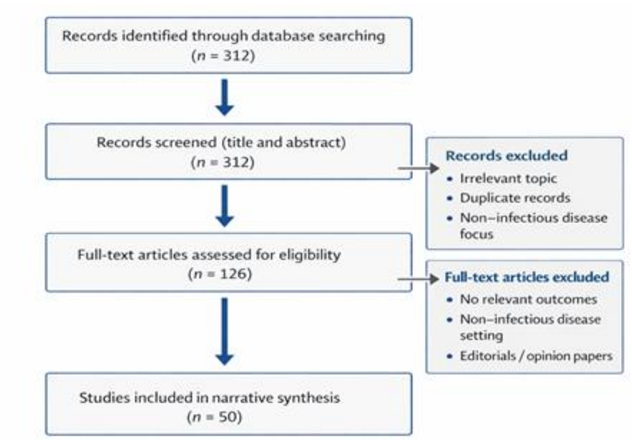

Figure 1: *Flow diagram of review.*

3. CORE ROLES AND RESPONSABILITIES OF INFECTIOUS DISEASES CLINICAL PHARMACIST

3.1. LEADERSHIP IN AMS

Infectious diseases specialized clinical pharmacists are core ASPs members who drive safe, appropriate, and evidence-based antimicrobial prescribing by:

- Selecting appropriate empiric/targeted therapies based on clinical presentation, and local antibiograms.
- Optimizing dosing using pharmacokinetic/pharmacodynamic (PK/PD) principles.
- Performing daily therapy reviews to identify opportunities for de-escalation.
- Managing IV-to-oral switch programs.

Pharmacist-led ASPs reduce antimicrobial consumption, increase guideline adherence, and lower resistance risk, including hospital-acquired *Clostridium difficile* infections [14-16]. Outpatient parenteral antimicrobial therapy programs exemplify these benefits [17].

3.2. DIAGNOSTIC STEWARDSHIP AND RAPID RESULTS INTERPRETATION

Traditional diagnostics are accurate but often slow or inaccessible, particularly in LMICs. ID-CP helps bridge this gap by:

- Interpreting rapid diagnostic tests such as PCR, and MALDI-TOF.
- Facilitating earlier initiation of targeted therapy.
- Preventing unnecessary broad-spectrum antibiotic use.

Engagement in diagnostic stewardship significantly reduce the time to optimal therapy [18, 19]. This highlighting the need for further advancements in this area.

3.3. DIRECT PATIENT CARE AND THERAPEUTIC OPTIMIZATION

Bedside ID-CP interventions include:

- Dose adjustment for patients with renal/hepatic impairment.
- Monitoring narrow-index drugs (vancomycin and aminoglycosides).
- Identifying/resolving drug-related problems (DRPs).
- Providing patient counseling.

These interventions associated with shorter length of hospital stays, better outcomes, and fewer medication errors [9, 20, 21].

3.4. ACCEPTANCE OF RECOMMENDATIONS

Physician acceptance rate of stewardship pharmacists' recommendations varies but generally is high, with reported rates of 90.8% in a Turkish intensive care unit [21] and 92.0% in a 5-year multihospital study [22]. Success factors include ward round presence, close IDs physician collaboration, and electronic documentation. Resource-constrained settings face barriers:

- Funding shortages.
- Stewardship pharmacist scarcity.
- Inadequate ASPs.
- Limited IDs training.
- Absent national AMS policies [23].

However, countries with formal IDs pharmacy specialist's program demonstrate substantial antimicrobial consumption and cost reductions [24-28].

4. ECONOMIC IMPACT AND ROLES IN HEALTH SYSTEM EFFICIENCY

Stewardship pharmacist represents a strategic financial investment, generating economic value through several key mechanisms:

4.1. COST CONTAINMENT AND EXPENDITURE REDUCTION

Cost containment strategies reduce healthcare spending driven by prolonged hospitalization, extended treatment, comprehensive workups, disability management, and end-of-life care by deprescribing unnecessary broad-spectrum

Table 1: Economic impact of hospital-based antimicrobial stewardship programs	
Economic metric improved	**Demonstrated impact**
Hospital length of stay	Reduced across multiple infectious syndromes, with ~9% reduction in length of stay [10, 14]
Antimicrobial expenditure	Reductions of ~34% in overall antimicrobial costs after implementation of ASPs [10, 26]
Adverse drug event-related costs	Positive ROI 171% achieved through prevention [29]
Cost avoidance	Substantial increase demonstrated in single- and multicenter studies, average ROI 760% [32]

ASPs: antimicrobial stewardship programs; ROI: return on investment.

antibiotics, and recommending cost-effective alternatives such as biosimilars, or formulary-preferred products. Pharmacist-led medication reviews demonstrate a positive return on investment by reducing in-hospital adverse drug events [29].

4.2. EFFICIENCY THROUGH IV-TO-ORAL SWITCH THERAPY

Sequential therapy programs reduce:

- Drug acquisition costs.
- Nursing administration time.
- Hospital length of stay.

Multicenter studies confirm that these interventions result in total antimicrobial cost reductions [10, 30].

4.3. PHARNACOKINETIC/PHARMACODYNAMIC OPTIMIZATION

Therapeutic drug monitoring-guided dosing adjusted for renal function and infection severity prevents treatment failure and toxicity, avoids the high costs associated with managing drug-related harm and complications. This is associated with improved clinical cure rates [31].

4.4. PREVENTION AND RESOLUTION OF DRPS

A six-year multicenter analysis showed stewardship pharmacist interventions yielded significant cost savings by preventing adverse drug events [32]. Furthermore, ASPs led by these specialists in primary healthcare centers reduced antimicrobial intake and pharmacy expenditures over five years [33].

4.5. BUDGET ALLOCATION AND WORKFORCE EFFICIENCY

Where physicians face time pressure or staffing shortages, ID-CP leads ASPs rounds autonomously, reviewing microbiology results and addressing antimicrobial-related issues. This prevents budget leakage from inappropriate antimicrobial use. Economic impact of ASPs, and stewardship interventions summarized in Table 1 [10, 14, 26, 29, 32]. Evidence indicates that, even without IDs physicians, pharmacist led-stewardship remains effective [24, 25, 34].

5. BRIDGING AMR AND OPTIMIZED PATIENT OUTCOMES

Antimicrobal resistance threatens current treatment effectiveness, exacerbating morbidity, mortality, and healthcare allocations. ID-CP is uniquely positioned to combat AMR at individual patient level via optimizing therapy and public health levels, through prevention, surveillance, and education.

Rationale antimicrobials use, consistently recognized as the most effective AMR mitigation strategy, and facilitated by ID-CP through:

- Ensuring antimicrobials are prescribed only when clinically indicated.
- Differentiating prophylactic, empiric, and targeted therapy.
- Selecting antimicrobials based on pathogen susceptibility and WHO Access–Watch–Reserve (AWaRe) classification [35].

Access antibiotics promotion and Watch/Reserve restriction reduce the selection pressure driving AMR.

5.1. PHARMACISTS AND VACCINATION PROGRAMS

Well-established infection prevention is known to reduce the need for antimicrobials and AMR risk. Pharmacist contributes in prevention by:

- Participating in immunization campaigns.
- Educating patients/healthcare providers on vaccine adherence.
- Interpreting vaccination contraindications.

Pharmacist interventions increase vaccine uptake among high-risk population groups, including pregnant, postpartum women, as well as neonates, and reducing infection-related hospitalizations and mortality, particularly valued in LMICs [36-38].

5.2. SURVEILLANCE AND OUTBREAK CONTAINMENT

Antimicrobial resistance surveillance is essential for detecting emerging resistance patterns and guiding

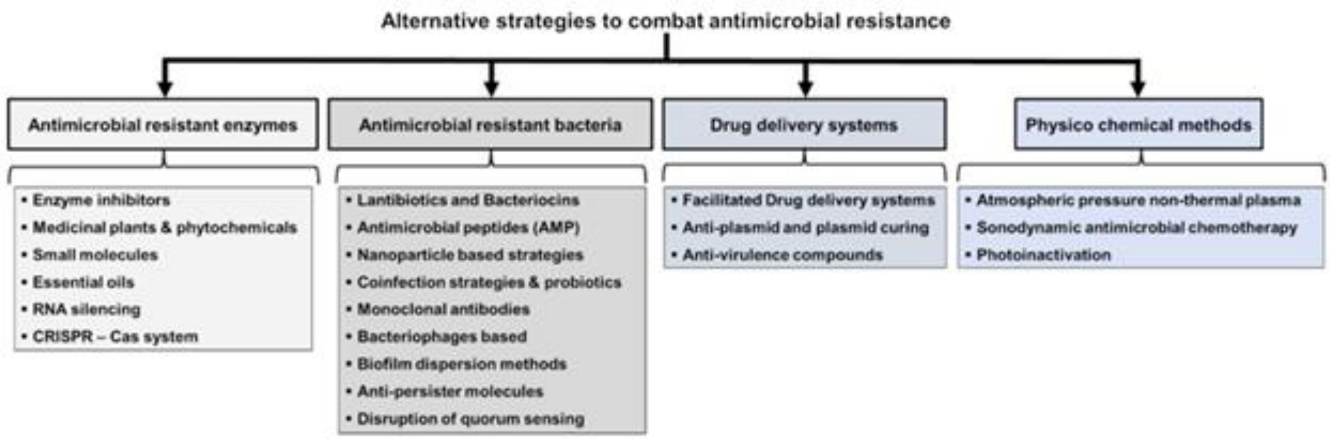

Figure 2: *Major Categories of Alternative Strategies to Combat Antibacterial Resistance.*

empirical therapy. On the other hand, several resource-limited settings lack structured surveillance programs; 23 of 47 African Union member states report AMR data to the WHO through the Global Antimicrobial Resistance and Use Surveillance System (GLASS) [39]. ID-CP strengthen surveillance by:

- Reviewing/interpreting local antibiograms.
- Identifying resistant pathogen clusters.
- Reporting unusual resistance patterns.

By serving as a link between microbiology laboratories and clinicians, ID-CP facilitate timely modification of empirical therapy and rapid responses to outbreaks.

Table 2: Impact areas of ID-CP on AMR outcomes	
Impact area of ID-CP	**Key outcomes related to AMR**
Optimization of antimicrobial prescribing	Reduces workforce pressure and slows AMR development
Vaccination and infection prevention	Decreases infection incidence, thereby reducing overall antimicrobial demand
AMR surveillance and reporting	Facilitates rapid outbreak containment and limits resistant pathogen spread
Patient education and drug disposal	Minimizes environmental antimicrobial contamination through proper disposal practices
Integration of new therapies	Enhances access to effective treatments while preserving existing antimicrobials' effectiveness

AMR: antimicrobial resistance, ID-CP: infectious diseases clinical pharmacist.

5.3. PUBLIC AND COMMUNITY-LEVEL INTERVENTIONS

Beyond the hospital, pharmacist educates the public on self-medication risk, antibiotic sharing, and improper disposal of antibiotics. Establishing drug take-back programs prevent antibiotics entering ecosystems, a recognized resistance driver [40, 41]. To effectively tackling environmental AMR spread, broader strategy must address industrial/agricultural sources: pharmaceutical manufacturing effluent, hospital waste, and livestock runoff.

5.4. NOVEL TECHNOLOGIES AND EMERGING THERAPIES

Infectious diseases clinical pharmacist supports safe and appropriate introduction of innovative therapies for multidrug-resistant infections, including:

- Next-generation antibiotics.
- Monoclonal antibodies.
- Bacteriophage therapy.
- Antimicrobial peptides.
- Gene-based therapies [42].

These modalities represent major categories of alternative strategies to curb AMR. (Figure 2) [43]. ID-CP also evaluate cost-effectiveness to guide formulary decisions. The impact of ID-CP interventions on AMR and patient outcomes is summarized in Table 2.

6. FUTURE DIRECTION: ARTIFICIAL INTELLIGENCE AND EVOLVING ROLES

As AMR continue to rise, ID-CPs' roles is expanding to include:

- Designing/implementing national stewardship frameworks.

- Leading training for medical, pharmacy, and nursing students.
- Embedding stewardship principles in undergraduate/postgraduate curricula.

Future healthcare system will require pharmacist who are system-level leaders in AMR mitigation [44].

6.1. ARTIFICIAL INTELLIGENCE AND CLINICAL AUTOMATION IN IDS PRACTICE

Artificial intelligence (AI) driven systems transform AMS through:

- Machine learning predicting resistant pathogens earlier than routine assessments.
- Enabling earlier targeted therapy and reducing unnecessary broad-spectrum antimicrobial exposure.
- Real-time analysis of laboratory/electronic health record data flagging inappropriate use and suggesting dose adjustments.

These tools function as a decision-support system that enhances efficiency and fast-tracks pharmacist-led intervention.

Automation platforms route rapid microbiology results directly to ID-CP, facilitating timely de-escalation and optimization of therapy [45-48].

6.2. IMPLEMENTATION CHALLENGES IN LMICS

Digital inequities hinder AI implementation:

- Limited digital infrastructure.
- Absent stewardship information systems.
- Professional pharmacist deficits driven by global migration.

Skilled pharmacist frequently relocates to higher-income countries for better training and remuneration, aggravating workforce gaps in resource-constrained settings [49, 50].

6.3. COMPLEMENTARY STRATEGY

Workload-reducing operational tasks now automated and encompass:

- Antibiogram generation.
- Dashboard monitoring.
- Surveillance analytics.

Core clinical cognitive and patient-specific therapeutic decision-making–remain pharmacist expertise-dependent. Strengthening ID-CP workforce pathways alongside AI expansion optimally expands ASP's capacity and reduce the burden of AMR.

7. LIMITATIONS

This review has certain limitations inherent to its narrative design. The absence of quantitative synthesis precludes pooled effect estimates, and the lack of formal risk of bias assessment means that the quality of included studies is likely to be variable. Restriction to the English language publications may have omitted relevant evidence. The evidence base is also skewed towards high-income countries, limiting the generalizability of findings to LMICs settings. Furthermore, many of included studies are observational, complicates causal inference. Ultimately, the deliberate focus on recent literature may have exclude the foundational work, this was considered necessary to capture contemporary practice and recent developments in IDs pharmacy and AMS.

8. CONCLUSIONS

Sustainable success of healthcare systems in managing IDs depends on rational antimicrobial use, evidence-based guideline adherence, promotion of responsible prescribing, and overcoming core AMS barriers. Effective AMR control and reduced infection-related mortality demand strengthened health system infrastructure and robust interprofessional collaboration.

System-wide stewardship strategies are essential to maintain antimicrobial effectiveness for future generations. Prioritize stewardship expertise, fosters judicious use of novel/existing antimicrobials, and leverage appropriate AI tools to enhance decision-making and patient care. The role of clinical pharmacist in IDs departments consistently improve outcomes across healthcare settings.

9. CONFLICT OF INTERESTS

The authors have no conflict of interest to declare. The authors declared that this study has received no financial support.

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