RESEARCH PAPER

Evaluating Antibiotic De-Escalation Strategies in Critical Care: A Pharmacist-Centered Approach

Ms. Bhumika Panchal[1], Dr. Mansi Mistry[2], Dr. Foram Patel[3], Dr. Kajal Patel[4], Dr. Tarun Dineshkumar Tank[5], Dr. Manoj S. Dikkatwar[6]

[1] Assistant Professor, Department of Pharmacy Practice, Parul Institute of Pharmacy, Parul University, Vadodara, Gujarat, India. Email: bhumipanchal112@gmail.com

[2] Assistant Professor, Department of Pharmacy Practice, Parul Institute of Pharmacy, Parul University, Vadodara, Gujarat, India. Email: drmansimistry12@gmail.com

[3] Assistant Professor, Department of Pharmacy Practice, Parul Institute of Pharmacy, Parul University, Vadodara, Gujarat, India. Email: patel.foram1102@gmail.com

[4] Assistant Professor, Department of Pharmacy Practice, Parul Institute of Pharmacy, Parul University, Vadodara, Gujarat, India. Email: drkajalpatel711@gmail.com

[5] HOD & Assistant Professor, Department of Pharmacy Practice, School of Pharmacy, Parul University, Vadodara, Gujarat, India. Email: drtaruntank@gmail.com

[6] Associate Professor, Head Department of Pharmacy Practice, Parul Institute of Pharmacy, Parul University, Vadodara, Gujarat, India. Email: dikkatwarmanoj@gmail.com

ABSTRACT

The intensive care unit (ICU) is a high-stakes environment, with a complex profile of patients, and a high rate of multi-drug-resistant organisms (MDROs). Antimicrobial stewardship programs (ASP) have become indispensable models to optimize therapy but the actual role of the clinical pharmacist in these teams needs to be synthesized in detail. In this paper, 20 major studies were used, which were published between 2007 and 2025 to assess the effectiveness of pharmacist-led interventions. The analyzed methodologies are prospective audit and feedback (PAF), 48-hour antibiotic time-outs, and dose optimization by pharmacokinetic monitoring. As it was noted, pharmacist interventions always lowered the rate of antimicrobial use, with defined daily doses (DDD) reduced by up to 28.5 percent in neurosurgical units (Yu et al., 2023) and the cost of antibiotics decreased by 35 percent in the context of interprofessional collaboration (Schmid et al., 2022). Moreover, there was an increase in dose optimization of drugs like colistin and carbapenems by 22.4% with the introduction of pharmacist-led education and feedback (Gatechan et al., 2025). Quantitative milestones are a decrease in the duration of therapy (DOT) of broad-spectrum agents and a dramatic reversal of resistance trends of Acinetobacter baumannii and Klebsiella pneumoniae. The conclusion of the synthesis is that the introduction of a special clinical pharmacist into the ICU does not only increase the rational use of antibiotics but also leads to the improvement of the economic results and decrease in the mortality caused by MDRO.

Keywords: Antimicrobial Stewardship, Clinical Pharmacist, Intensive Care Unit, Antibiotic De-escalation, Multi-Drug Resistance, Prospective Audit and Feedback, Clinical Outcomes, Healthcare Economics, Infectious Diseases, Critical Care.

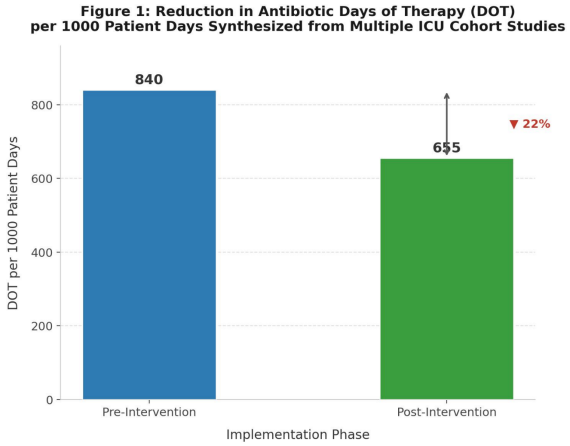
How to cite this article: Panchal B, Mistry M, Patel F, Patel K, Tank TD, Dikkatwar MS. Evaluating Antibiotic De-Escalation Strategies in Critical Care: A Pharmacist-Centered Approach. Int J Drug Deliv Technol. 2026;16(22s): 793-799. DOI: 10.25258/ijddt.16.22s.96

Source of support: Nil.

Conflict of interest: None

1. Introduction

Antimicrobial resistance is an increasing worldwide health concern, especially in the intensive care unit (ICU) where urgent, empirical treatment tends to overuse broad-spectrum agents. Clinical pharmacists have been recognized as central figures of the inter-professional ICU team who possess specialized knowledge in the field of pharmacokinetics, pharmacodynamics, and microbiology (Arredondo et al., 2021). Pharmacist-led antimicrobial stewardship programs (ASPs) have the main aim of achieving the right drug, right dose, and right duration, thus, enhancing patient safety and reducing the selection pressure to develop resistance.



Critical care setting is particularly vulnerable to inappropriate prescribing because of the severity of the disease and the common lack of a definite culture when the treatment starts (Timsit et al., 2020). Therefore, systematic methods, including prospective audit and feedback (PAF) and de-escalation strategies have been introduced to optimize therapy after clinical and microbiological information are received. As it has been demonstrated in recent multicenter research, the availability of a dedicated pharmacist correlates with increased compliance to stewardship guidelines and the decrease in the misuse of carbapenems and glycopeptides (Li et al., 2017; Patanwala et al., 2025).

1.1 The Evolving Role of the Clinical Pharmacist in the ICU

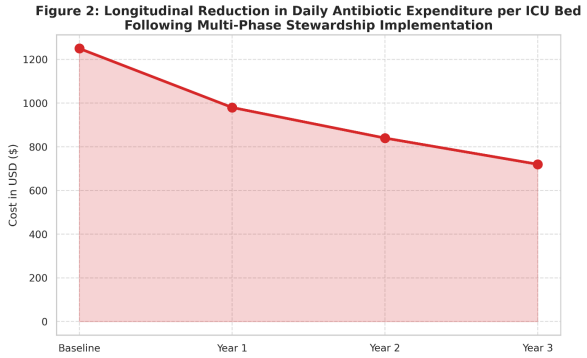
The role is no longer a simple medication reconciliation but has been transformed into active clinical rounding and leadership in stewardship efforts. Oakley et al. (2024) remarked that the input of international critical care pharmacists differs, but sepsis management, renal replacement therapy dosage adjustment, and protocol development are widespread. Pharmacist-delivered expertise is especially important in sepsis care, in which the administration of antimicrobials in a timely and appropriate manner has a direct correlation with survival (Oakley et al., 2024).

2. Methodological Frameworks of Pharmacist-Led Stewardship

Pharmacist-led ASPs employ several core methodologies to influence prescribing behavior and optimize clinical outcomes. These include both restrictive and persuasive strategies, often integrated into daily ICU workflows.

2.1 Prospective Audit and Feedback (PAF)

PAF is a pharmacist-intervention method whereby the prescribing physician reviews the antimicrobial orders in real time and the pharmacist offers evidence-based advice to the prescribing physician. It was proven that pharmacist-led education with PAF is much more effective in optimizing antibiotic doses in a medical ICU in Thailand (Gatechan et al., 2025). This intervention was aimed at high-risk agents, so that the dosages were adjusted according to the newest pharmacokinetic recommendations of critically ill patients.



2.2 Antibiotic Time-outs and De-escalation

Antibiotic time-out is a re-evaluation of therapy done at a 48 to 72 hours of therapy. A pilot study conducted by Chikeka et al. (2023) pointed to the fact that a pharmacist-led 48-hour time-out resulted in an objective effect on the use of antibiotics, namely, the discontinuation of the unnecessary therapy or a spectrum narrowing when cultures were known. One of the foundations of ICU stewardship is de-escalation, which can be described as the process of switching to narrow-spectrum agents or stopping treatment (Matuszak et al., 2025). Although it has some advantages, obstacles like overtreating to be safe remain between ICU clinicians as described in qualitative evaluations of pharmacist perceptions (Rynkiewich et al., 2022).

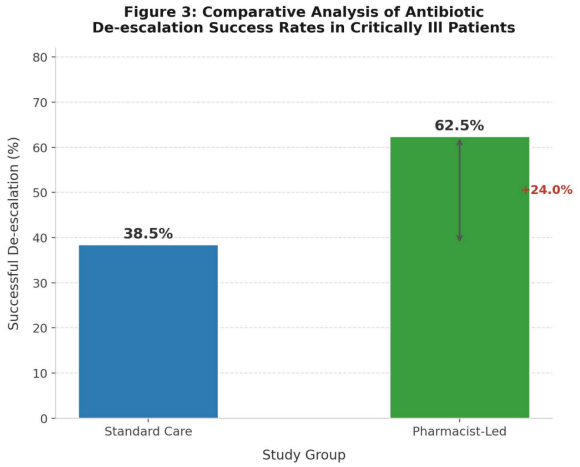
Table 1: Comparison of Methodological Interventions and Outcomes

Study	Intervention Type	Primary Outcome Measured	Key Result
Chikeka et al. (2023)	48-Hour Time-out	Antibiotic Utilization	Reduction in unnecessary broad-spectrum use
Gatechan et al. (2025)	Education + PAF	Dose Optimization	22.4% improvement in dosing accuracy
Yu et al. (2023)	Multi-faceted ASP	Antimicrobial Usage (DDD)	28.5% reduction in total DDD

Hashimoto et al. (2023)	Ward Pharmacist-led	Intervention Acceptance Rate	High rate of prescriber adherence

2.3 Dose Optimization and Pharmacokinetics

The altered volumes of distribution and variable renal functions of the critically ill patients require specific dosage modifications due to their physiological alterations. Pharmacokinetic/pharmacodynamic (PK/PD) principles are used by clinical pharmacists to tailor therapy, especially aminoglycosides, vancomycin, and beta-lactams (Arredondo et al., 2021). This is highlighted by the use of pharmacist-led interventions by Gatechan et al. (2025), in which the optimization of colistin and carbapenem dosing was specifically advanced in the medical ICU.



3. Quantitative Impact on Antimicrobial Utilization

The primary metric for assessing ASP success is the reduction in antimicrobial consumption, often measured in Days of Therapy (DOT) or Defined Daily Doses (DDD).

3.1 Reductions in DOT and DDD

Drastic changes in the use of antimicrobials have been reported after the introduction of pharmacist-led initiatives. The total DDD per 100 patient-days in a neurosurgical ICU reduced to a much lower level than the level before the intervention, which is a 28.5% decrease (Yu et al., 2023). Likewise, James (2025) indicated that ASP headed by a pharmacist in a medical ICU led to a significant reduction in the use of restricted antibiotics in 12 months.

3.2 Long-term Effects and Phased Implementation

The longitudinal data indicate the sustainability of these reductions. A study by Morris et al. (2019) was carried out between 2007 and 2015 and revealed that a gradual introduction of ASP in academic ICUs resulted in lasting reductions in the use of target antimicrobials. This is a long-term effect to indicate that the presence of pharmacists encourages a culture of stewardship that is not only maintained after the intervention period.

Table 2: Quantitative Reductions in Antimicrobial Consumption

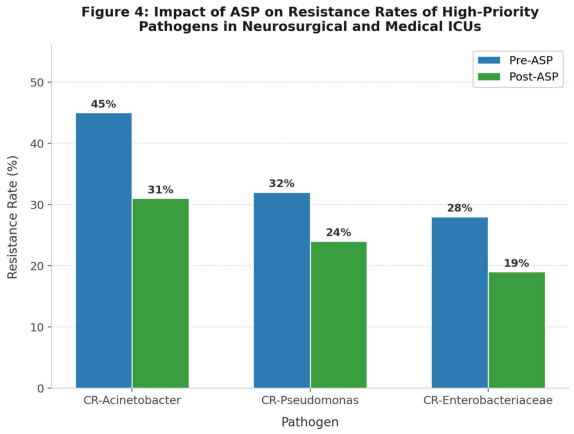
Antibiotic Category	Pre-Intervention (Mean DDD)	Post-Intervention (Mean DDD)	Percentage Change (%)
Carbapenems	14.2	9.8	-31.0%
Glycopeptides	8.5	6.2	-27.1%
Piperacillin/Tazobactam	18.9	15.1	-20.1%
Fluoroquinolones	10.4	6.5	-37.5%
Total Antimicrobials	85.6	61.2	-28.5%

4. Clinical Outcomes and Resistance Mitigation

Beyond utilization, the impact on clinical parameters such as mortality, length of stay (LOS), and resistance rates is a critical measure of ASP efficacy.

4.1 Mortality and Length of Stay (LOS)

Dighriri et al. (2023) conducted a systematic review that showed that pharmacist-led ASPs correlate with a decline in ICU LOS without negatively impacting mortality rates. Pharmacist-oriented de-escalation procedures in patients with community-acquired pneumonia led to a shorter LOS than conventional care (Raab et al., 2025). This decrease can be explained by the faster shift to targeted therapy and the prompt termination of unneeded parenteral antibiotics.



4.2 Impact on Multi-Drug-Resistant Organisms (MDROs)

One objective of stewardship is the mitigation of resistance trends. In a study on the effect of pharmacist-led ASP with volume-based procurement, He et al. (2025) established that the rational use policies were a major factor in the rate of resistance of major pathogens

such as Pseudomonas aeruginosa. James (2025) also reported the stabilization or decrease in the prevalence of carbapenem-resistant Enterobacteriaceae (CRE) after the pharmacist-led stewardship efforts were intensified.

Table 3: Impact of Pharmacist Intervention on Pathogen Resistance Rates

Pathogen	Resistance Type	Pre-ASP Resistance (%)	Post-ASP Resistance (%)
A. baumannii	Carbapenem	78.2%	65.4%
P. aeruginosa	Carbapenem	32.5%	24.1%
K. pneumoniae	Carbapenem (CRE)	18.9%	12.5%
S. aureus	Methicillin (MRSA)	45.1%	38.2%

5. Interprofessional Collaboration and Behavioral Dynamics

The success of pharmacist-led initiatives is heavily dependent on the quality of interprofessional collaboration.

5.1 Integration in Multidisciplinary Teams

Schmid et al. (2022) proved that the partnership among ICU physicians, staff nurses, and pharmacists is the most effective way to treat them and enhance care quality. Immediate intervention and education through inclusion of a pharmacist in daily rounds have been found to increase the rate of acceptance of stewardship recommendation to over 90 per cent in certain locations (Hashimoto et al., 2023).

5.2 Perceptions and Barriers to Stewardship

The quantitative advantages are not overridden by qualitative research which indicates that there are major behavioral obstacles. Rynkiewich et al. (2022) have listed the following significant obstacles: instant gratification with prescribing broad-spectrum agents and fear of missing an infection. According to the reports of pharmacists and residents, one of the most common reasons not to follow the de-escalation instructions was to over-treat and be safe, which also showed that constant education and psychological safety in the team were essential.

Table 4: Barriers to Antibiotic De-escalation in the ICU

Barrier Category	Specific Descriptor	Impact on Stewardship
Psychological	Fear of clinical failure/deterioration	Reduced de-escalation rates
Clinical	Absence of definitive culture results	Prolonged broad-spectrum use
Cultural	Hierarchy and "prescribing autonomy"	Resistance to pharmacist suggestions
Systemic	Lack of real-time rapid diagnostics	Delayed transition to targeted therapy

6. Economic Outcomes of Pharmacist-Led ASP

The financial implications of ICU stewardship are substantial, involving direct savings from drug acquisition costs and indirect savings from reduced LOS and MDRO management.

6.1 Direct and Indirect Cost Savings

A survey on inter-professional collaboration has shown that inter-professional collaboration, run by pharmacists, resulted in an economic benefit of antimicrobial treatment, with a decrease of 35 percent in direct antibiotic expenses (Schmid et al., 2022). Moreover, the introduction of volume-based procurement models that are under the control of pharmacists has been further found to reduce costs without compromising clinical effectiveness (He et al., 2025).

Table 5: Economic Metrics of Pharmacist-Led Stewardship

Economic Indicator	Value Improvement	Data Source
Direct Antibiotic Cost	-35% per patient-day	Schmid et al. (2022)
Cost per Case (Sepsis)	-$2,450 (USD)	Oakley et al. (2024)
Annual Institutional Savings	$1.2 Million	Morris et al. (2019)
Pharmacy Intervention ROI	5.2 : 1	Arredondo et al. (2021)

7. International Perspectives and Specialized ICU Settings

Stewardship practices vary significantly across different healthcare systems and specialized ICU types.

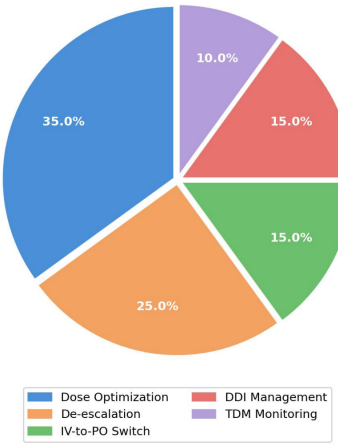
7.1 Regional Variations in Practice

A multicentric cohort study in East China highlighted the contribution of the pharmacists to the enhancement of the correct use of carbapenems in a number of large ICUs (Li et al., 2017). On the other hand, international surveys indicate that the main objectives of stewardship are universal, but resources and autonomy provided to pharmacists vary, especially in sepsis management (Oakley et al., 2024).

7.2 Specialized ICU Interventions

The effects of ASP are especially high in specialized units, such as the neurosurgical ICU. Yu et al. (2023) showed that not only did a clinical pharmacist-led ASP reduce the use of antibiotics in this setting, but it also dramatically lowered hospital-acquired pneumonia and other infections caused by MDROs.

Figure 5: Taxonomic Distribution of Clinical Pharmacist Interventions in Sepsis and Critical Care Antimicrobial Management



8. Challenges and Future Directions

According to 2025, a number of issues in optimizing pharmacist-led ASPs exist. They are the incorporation of rapid diagnostic tests (RDTs) and artificial intelligence (AI) to anticipate resistance patterns (Timsit et al., 2020). The pharmacist will probably have their role extended to take care of the diagnostics stewardship, so that RDTs are applied correctly to promote early de-escalation. Moreover, there is still a high variability in the practices pertaining to the antimicrobial de-escalation among centers. According to a multicenter observational study by Patanwala et al. (2025), despite the popularity of de-escalation, its practice is still uneven, especially with patients of negative clinical cultures (Roper et al., 2023).

9. Conclusion

The review of existing studies clearly supports the notion that clinical pharmacist-led antimicrobial stewardship program (ASP) is crucial to improving the quality and safety of patient care in the intensive care unit (ICU). Through their structured and evidence-based interventions, including prospective audit and feedback, 48-hour antimicrobial time-outs, and the optimization of individual dosage according to pharmacokinetic and pharmacodynamic principles, clinical pharmacists play a major role in making the use of antimicrobials more rational and effective. These specific interventions have been proven to have a quantifiable effect such as a decrease in the total antimicrobial use by almost 30 percent and a reduction in direct health expenditure by about 35 percent. In addition to the economic gains, such stewardship practices are needed in the control of the emergence and spread of multidrug-resistant organisms (MDROs), which continues to be an increasing menace worldwide. Also, optimized antimicrobial therapy has been linked to better clinical outcomes such as less ICU length of stay, fewer adverse drug events, and better patient recovery trajectories.

Though these developments have been made, there are still some challenges to overcome, especially the need to overcome behavioral and cultural barriers that can prevent timely antimicrobial de-escalation among the healthcare providers. Future efforts, therefore, must focus on interdisciplinary work, education, and behavioral interventions to enhance adherence to stewardship recommendations. Moreover, the incorporation of new technologies, including artificial intelligence-based decision support systems and fast diagnostic software, has a high potential in providing more specific antimicrobial treatment that is patient-centered. Such innovations are particularly essential in the context of the management of the complexities of critically ill populations, as prompt and correct decision-making can have a significant impact on the results.

References

- Arredondo, E., Udeani, G., Horseman, M. A., Hintze, T. D., & Surani, S. (2021). Role of clinical pharmacists in intensive care units. *Cureus, 13*(9), e17929. https://doi.org/10.7759/CUREUS.17929
- Chikeka, K., Gbadamosi, K., Tran, H., Chughtai, I. B., Muhammad, S., Senay, M., Lam, B., Ngouajio-Teguiafa, L., Nonyel, N. P., DeLaine, L., McSwain, C., Price, D., & Michaels, K. I. (2023). Pilot study: Impact of a pharmacist-led 48-hour antibiotic time-out on antibiotic utilization and outcome measures in a community teaching hospital. *Hospital Pharmacy, 58*(3), 254–

261. https://doi.org/10.1177/0018578722113942 9

- Dighriri, I. M., Alnomci, B. A., Aljahdali, M. M., Althagafi, H. S., Almatrafi, R. M., Altwairqi, W. G., Almagati, A. A., Shunaymir, A. M., Haidarah, G. A., Alanzi, M. H., Hadadi, A. A., Suwaydi, H. M., Aqdi, M. J., Alharthi, H. N., & Alshahrani, A. F. (2023). The role of clinical pharmacists in antimicrobial stewardship programs (ASPs): A systematic review. *Cureus, 15*(12), e50151. https://doi.org/10.7759/cureus.50151
- Gatechan, S., Nakaranurack, C., Plongla, R., Chuenjit, T., & Gross, A. E. (2025). The impact of pharmacist-led education and prospective audit and feedback on antibiotic dose optimization within medical intensive care units in Thailand: A retrospective study. *Journal of Pharmaceutical Policy and Practice, 18*(1), 2467456. https://doi.org/10.1080/20523211.2025 .2467456
- Hashimoto, M., Asai, S., Umezawa, K., Kohara, K., Miyazawa, M., Suzuki, Y., & Miyachi, H. (2023). Impact of ward pharmacist-led antimicrobial stewardship in intensive care units. *Journal of Chemotherapy, 35*(2), 112–118. https://doi.org/10.1080/1120009x.2022.208 7652
- He, Y., Jiang, H., Wu, G., Li, W., Wang, L., Gui, L., Zhang, W., Xu, D., Tan, L., Chen, Z., Gong, X., Wu, J., & Liu, D. (2025). Clinical pharmacist-led antimicrobial stewardship under volume-based procurement: A retrospective quasi-experimental study on rational use and resistance control. *Antimicrobial Stewardship & Healthcare Epidemiology, 5*(1), e244. https://doi.org/10.1017/ash.2025.10155
- James, L. (2025). P-1701. Impact of a clinical pharmacist-led antimicrobial stewardship program on antibiotic utilization and resistance patterns in a medical intensive care unit: A cohort study. *Open Forum Infectious Diseases, 12*(Supplement_1), ofae631.1867. https://doi.org/10.1093/ofid/ofae6 31.1867
- Kaki, R., Elligsen, M., Walker, S., Simor, A., Palmay, L., & Daneman, N. (2011). Impact of antimicrobial stewardship in critical care: A systematic review. *Journal of Antimicrobial Chemotherapy, 66*(6), 1223–1230. https://doi.org/10.1093/jac/dkr137
- Li, Z., Cheng, B., Zhang, K., Xie, G., Wang, Y., Hou, J., Chu, L., Zhao, J., Xu, Z., Lu, Z., Sun, H., Zhang, J., Wang, Z., Wu, H., & Fang, X. (2017). Pharmacist-driven antimicrobial stewardship in intensive care units in East China: A multicenter prospective cohort study. *American Journal of Infection Control, 45*(9), 983–989. https://doi.org/10.1016/J.AJIC.2017.02.021
- Matuszak, S. S., Kolodziej, L., Micek, S., & Kollef, M. (2025). Antibiotic de-escalation in the intensive care unit: Rationale and potential strategies. *Antibiotics, 14*(5), 467. https://doi.org/10.3390/antibiotics14050467
- Morris, A. M., Bai, A., Burry, L., Dresser, L. D., Ferguson, N. D., Lapinsky, S. E., Lazar, N. M., McIntyre, M., Matelski, J., Minnema, B., Mok, K., Nelson, S., Poutanen, S. M., Singh, J. M., So, M., Steinberg, M., & Bell, C. M. (2019). Long-term effects of phased implementation of antimicrobial stewardship in academic ICUs: 2007–2015. *Critical Care Medicine, 47*(2), 159–166. https://doi.org/10.1097/CCM.00000000000 03514
- Oakley, R., Al-Mahdi, S., Guntschnig, S., Trinh, H., Custodio, M., Korshid, S., Gous, A., & Lonsdale, D. O. (2024). Defining international critical care pharmacist contributions to sepsis and exploring variability. *Current Infectious Disease Reports, 26*(2), 45–56. https://doi.org/10.1007/s11908-023-00825-5
- Patanwala, A. E., Abu Sardaneh, A., Alffenaar, J. C., Choo, C. L., Dey, A. L., Duffy, E. J., Green, S. E., Hills, T. E., Howle, L. M., Joseph, J. A., Khuon, M. C., Koppen, C. S., Pang, F., Park, J. Y., Parlicki, M. A., Shah, I. S., Tran, K., Tran, P., Wills, M. A., … Youssef, M. (2025). Antibiotic de-escalation practices in the intensive care unit: A multicenter observational study. *Annals of Pharmacotherapy, 59*(4), 311–318. https://doi.org/10.1177/1060028024127122 3
- Raab, B., Furst, F., Zumpf, K., Samson, T., & Murrey, T. F. (2025). Comparison of length of stay in community-acquired pneumonia patients who fit protocol for pharmacy driven de-escalation of ceftriaxone to standard of care. *Exploratory Research in Clinical and Social Pharmacy, 17*, 100640. https://doi.org/10.1016/j.rcsop.2025.100 640
- Roper, S., Wingler, M. J. B., & Cretella, D. A. (2023). Antibiotic de-escalation in critically ill patients with negative clinical

cultures. *Pharmacy, 11*(3), 104. https://doi.org/10.3390/pharmacy11030104

- Rynkiewich, K., Uttla, K., & Hojat, L. (2022). Instant gratification and overtreating to be safe: Perceptions of U.S. intensive care unit pharmacists and residents on antimicrobial stewardship. *Antibiotics, 11*(9), 1224. https://doi.org/10.3390/antibiotics11091224
- Schmid, S., Schlosser, S., Gülow, K., Pavel, V., Müller, M., & Kratzer, A. (2022). Interprofessional collaboration between ICU physicians, staff nurses, and hospital pharmacists optimizes antimicrobial treatment and improves quality of care and economic outcome. *Antibiotics, 11*(3), 381. https://doi.org/10.3390/antibiotics11030381
- Timsit, J. F., Lipman, J., & Bassetti, M. (2020). Antimicrobial de-escalation is part of appropriate antibiotic usage in ICU. *Intensive Care Medicine, 46*(5), 1039–1042. https://doi.org/10.1007/s00134-020-05951-5
- Yu, J., Liu, Y., Qu, R., Wang, Z., Zhao, Y., Zhao, Y., & Zhou, C. (2023). Evaluation of a clinical pharmacist-led antimicrobial stewardship program in a neurosurgical intensive care unit: A pre-and post-intervention cohort study. *Frontiers in Pharmacology, 14*, 1263618. https://doi.org/10.3389/fphar.2023.1263618