



A Review on Antimicrobial Stewardship Programs in Multiple Care Settings

Aiswarya Rajesh¹, Haritha Mohanan¹ and Rajeev P. Thomas^{1*}

¹*Department of Pharmacy Practice, National College of Pharmacy, Manassery, Mukkam Post, Kozhikode, Kerala-673602, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i42B32445

Editor(s):

(1) Dr. Ana Cláudia Coelho, University of Trás-os-Montes and Alto Douro, Portugal.

Reviewers:

(1) Alaa Fadhel Hassan, Iraq.

(2) Maria do Socorro Costa, Universidade Estadual do Ceará, Brazil.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/73285>

Review Article

Received 22 June 2021
Accepted 28 August 2021
Published 02 September 2021

ABSTRACT

Antimicrobial resistance is a global problem that is regarded as one of the most important threats to human health. Misuse of antibiotics leads to an increase in antibiotic resistance as well as higher healthcare costs. Antimicrobial stewardship is a coordinated, multidisciplinary program aimed at improving antimicrobial prescribing to enhance treatment outcomes while reducing unpredictable consequences of antimicrobial use, such as toxicity, pathogenic organism selection, and resistance emergence. Each hospital has its own antimicrobial stewardship program, which requires the enthusiastic participation of both administration and medical staff. The key components are audits and feedbacks, antibiotic pre-authorization, the use of guidelines or written material, and healthcare professional education. These strategies allow for a reduction in total antibiotic exposure while still providing the best care and avoiding the overuse of broad-spectrum antibiotics. Prospective audits can reveal ineffective interventions and suggest changes. The goal of this review is to gain a better understanding of Antimicrobial Stewardship programs so that antibiotic prescribing, dispensing, and administration can be improved in multiple care settings.

Keywords: *Antimicrobial resistance; antimicrobial stewardship program; antibiotics; cost; audit and feedback.*

1. INTRODUCTION

Antimicrobial resistance (AMR) is a global issue that is regarded as one of the most serious threats to human health. It is primarily due to excessive antibiotic use, which is largely caused by incorrect dosing and excessively long treatment durations [1]. Misuse of antibiotic leads to an increase in antibiotic resistance as well as increased healthcare costs. Unfortunately, with the apparent decrease in the number of antibiotics discovered and accepted per year, we see a drastic rise in bacterial resistance. The primary mechanisms of antimicrobial resistance are enzyme breakdown of antimicrobial drugs, changing of antimicrobial target bacterial proteins, and changes in antimicrobial membrane permeability. As a result, the antimicrobial stewardship program (ASP) was created to ensure proper antibiotic use, reduce antimicrobial overuse, and prevent the spread of resistance [2]. It includes encouraging activities that uplift a balance between the individuals desire for appropriate care and the longer-term social need for continued access to effective therapy [3]. Stewardship is generally described as the responsible and careful management of anything allocated to ones care in its broadest sense [4]. In USA, John E. McGowan Jr and Dale N. Gerding came up with the concept of antimicrobial stewardship [3]. Every individual who prescribes, dispenses, or administers antibiotics needs to be held responsible for antimicrobial stewardship [5]. This reviews goal is to gain a better understanding of Antimicrobial Stewardship programs so that antibiotic prescribing, dispensing, and administration can be improved in multiple care settings.

2. A CRITICAL SETTING FOR ANTIMICROBIAL STEWARDSHIP IN EMERGENCY DEPARTMENTS

Annual Emergency Department (ED) visits are increasing, according to data from the National Hospital Surveys. For effective antimicrobial prescribing, there are five Ds: drug, dosage, duration, de-escalation, and the fifth D of stewardship is the diagnosis, which is perhaps most important in the sense of emergency treatment. Antimicrobial stewardship interventions can be divided into two categories: both at the system and provider levels. The efforts should be multidisciplinary, inclusive, patient-centred, and backed up by hospital executives. To promote intervention adoption

and bidirectional input, an ED physician champion will act as a liaison between the stewardship program leadership and front-line clinicians. Culture follow-up services, formulary controls, pharmacist campaigns, and antibiograms are all examples of system-level interventions. Aside from basic education-based approaches, research from behavioural economics and the psychology decision-making literature indicates that audit and feedback, academic detailing, behavioural nudges, and peer comparisons may all help to increase prescribing results. Most common infection types (respiratory, urinary, skin, and soft tissue) have the aspect of antibiotic prescribing that could be dramatically improved. And recommend that these are good places to start for anyone looking to start ED-based stewardship quality assurance initiatives. If a patient is receiving ineffective antimicrobial therapy, a nurse or pharmacist usually consults with the emergency physician and adjusts the regimen. The most successful antibiotic stewardship initiatives combine various programs and techniques at the provider level to achieve long-term changes in responsible antibiotic prescribing [6].

3. PROGRAMS FOR ANTIMICROBIAL STEWARDSHIP IN CHILDREN

Infectious diseases continue to be the major cause of hospitalization in paediatric wards and paediatric intensive care units (PICUs) [7]. ASPs must define critical targets, process metrics, and treatment outcome based on different local variables and effectively adapt appropriate strategies to achieve stewardship goals. Some of the possible targets include promoting antimicrobial dose adjustment and tracking, improving proper shifts from intravenous to oral antibiotics, and maximizing total lengths of medications. Days of therapy (DOTs) are the preferred metric for antibiotic use. DOTs refer to the single antibiotic delivered to a single patient on a calendar day, regardless of the number of doses given that day. Analysis of outcome metrics, including process metrics, must always be done on a regular basis to ensure continued treatment effectiveness and recognise possible areas of change [5].

In critical care units like the PICU, where broad-spectrum antibiotics are commonly used, the presence of multidrug-resistant (MDR) bacteria and healthcare-associated infections (HAI), proper antibiotic monitoring and rational antibiotic

use are essential. Prospective audit, Antibiotic pre-authorisation, use of guidelines or written information, and training of healthcare professionals are the core components. These techniques allow for a reduction in overall antibiotic exposure as well as preventing the overuse of broad-spectrum antibiotics while still offering the best possible treatment [7].

4. PROGRAMS FOR ANTIMICROBIAL STEWARDSHIP IN ORGAN TRANSPLANT PATIENTS

While national and international transplant societies are working to better define and enforce stewardship principles in Solid-organ Transplant (SOT), the presence of transplant infectious disease (TID) specialists in SOT patient care is linked to more stewardship-concordant prescribing and better patient outcomes [8]. Communication, preparation, education, as well as monitoring and assessment were all essential for a successful implementation. Understanding institutional prescribing settings in the sense of transplantation is at the core of these initiatives. The ASPs microbiology laboratory is its foundation, and dedicated laboratory space and staff to handle transplant-specific tests may be needed. Successful programs include personnel with experience in bacteriology and mycobacteriology, virology, mycology, parasitology, and serologic testing. The participation of pharmacy management is required to properly handle critical drug and vaccine supply issues affecting this community [9]. ASP plays a crucial role in anti-infective formulary decision-making through presence of hospitals pharmacy and therapeutics committee. Formulary decisions must strike a balance between quick access to critical therapeutics for immunocompromised patients and a range of coverage that represents local epidemiology and therapeutic effectiveness, all while minimizing adverse reactions and costs [10]. Due to the rising prevalence of infections caused by antimicrobial-resistant organisms in SOT and hematopoietic stem cell transplant (HSCT) patients, applying Antimicrobial Stewardship concepts to these patient populations is essential. Stewardship, in combination with infection control, may have a long-term positive effect on immunocompromised patients and is the logical next step in antimicrobial treatment for immunocompromised patients [10].

5. PROGRAMS FOR ANTIMICROBIAL STEWARDSHIP IN VETERINARY PRACTICE

Antimicrobial resistance is one of the most important concerns in animal veterinary medicine today. On a global scale, numerous multidrug-resistant bacteria (MDR) have appeared and distributed among animals. All of these MDR bacteria are prone to existing antibiotics approved for use in animals, creating a major threat to animal wellbeing and increasing the chances of treatment failure and euthanasia [11]. In middle-income regions, where extensive farming is being replaced by huge industrial supply chain that continually use large volumes of antimicrobials, often with little veterinarian involvement, the use of antimicrobials in agriculture and veterinary science is a big factor of resistance in bacteria.

In February 2016, the World Health Organization, the Food and Agriculture Organization (FAO), and the World Organization for Animal Health collaborated to release a guideline and toolbox for implementing national action plans. The FAO plan is divided into four sections: (i) antimicrobial resistance and associated threats recognition, (ii) antimicrobial resistance and antibiotic use surveillance and monitoring, (iii) enhancing governance associated to antimicrobial use and antimicrobial resistance, along with application of global antimicrobial resistance guidelines/standards such as the Codex Alimentarius, and (iv) promoting good training in farming and feed systems, as well as careful antimicrobial use, at the national level, including the power to enforce global guidelines and standards on antimicrobial resistance and use, and trying to take antimicrobial resistance issues into account in the development of voluntary guidelines for organic farming production [12].

In human and veterinary medicine, the philosophy and practice of Antimicrobial stewardship are still evolving. However, it is a progressive, dynamic method of ongoing improvement encapsulated in the Good Stewardship Practice (GSP) concept. Only a GSP mentality will guarantee Antimicrobial drugs long-term viability. Antimicrobial stewardship and GSP refer to a set of coordinated methods and strategies aimed at promoting, improving, monitoring, and evaluating the wise use of Antimicrobial to maintain their efficacy in the future while also promoting and protecting human and animal health [13]. Efficient

antimicrobial stewardship strategies are now a must if we are to maintain the effectiveness of our current drugs and ensure the long-term viability of any new agents that are created [12]. In human medicine, ASPs are initiated and sustained by a dedicated interdisciplinary group comprised of an infectious disease clinician and a clinical pharmacist [11].

6. PROGRAMS FOR ANTIMICROBIAL STEWARDSHIP IN ORTHOPAEDIC SURGERY

Surgical site infections (SSIs) continue to be a significant cause of morbidity, mortality, and hospital costs due to the widespread use of prophylactic antibiotics in orthopaedic surgery. SSIs are the second leading cause of nosocomial infections, occurring in 2% to 5% of patients who receive uncontaminated additional operations. This is partly due to the rising prevalence of antibiotic-resistant bacteria [14]. The application of medical experience and skill to obtain the best outcomes for patients with infectious diseases is aided by the laboratory's accurate and timely microbiology, especially in the period of rising antibiotic resistance [15].

Antimicrobial stewardship standards are an essential aspect of providing high-quality orthopaedic surgical treatment. These principles include determining appropriate antibiotic indications, selecting the appropriate antibiotic based on known or expected pathogens, determining the correct dose, and determining the appropriate treatment period. In terms of improving patient care and lowering costs, ASPs can be a valuable resource for both orthopaedic surgeons and healthcare facilities [14].

7. PROGRAMS FOR ANTIMICROBIAL STEWARDSHIP IN ICU

Antimicrobial stewardship is very important in Intensive Care Units (ICU). Many ICUs have become Multidrug-resistant (MDR) pathogen traps, accumulating patients who have failed to respond to antibiotic treatment due to resistance. Long-term mechanical ventilation often increases the risk of repeated ventilator-associated pneumonia (VAPs), with each pathogen being more resistant than the previous one. As a result, intensivists are often exposed to the side effects of excessive antibiotic therapy [16]. With the help of their institutions, neonatal intensive care units can form interdisciplinary antimicrobial stewardship teams [17].

Prescriber audit and feedback, as well as preauthorization, formulary restriction of some antibiotics, and antibiotic time-outs, are all successful components of an ASP in the ICU. As rapid diagnostics become more common in the ICU, performance evaluation and its impact on outcomes will become increasingly important [16,17]. Education and computerized decision support are examples of additional strategies. Measurements of patient safety and efficiency, such as rates of adverse drug events and adequate dosing and timing of perioperative prophylaxis, should be included in metrics to assess antimicrobial stewardship programs [17]. Infectious Disease (ID) pharmacist and an ID physician are usually in charge of the overall ASP; collaboration with ICU leadership is essential for progress [16].

8. PHARMACISTS AND THEIR ROLE IN ANTIMICROBIAL STEWARDSHIP PROGRAMS

Pharmacists' contributions to AMS are not confined to hospitalisation, and their expertise is useful in meeting the aims of ambulatory care and long-term treatment ASPs. To provide drug management services, pharmacists had also established a presence in health clinics and long-term treatment facilities. If given additional AMS training, these pharmacists may take on the position of ASP champions. Antimicrobial selection, dose, and duration can all be controlled by pharmacists. Pharmacists also have the expertise to monitor and report AMS metrics, as well as ensure that all regulatory standards. As part of a prospective audit with treatment and feedback, pharmacists should look for patients who might benefit from infectious disease consultation. Discussions for infectious diseases was shown to reduce the morbidity and mortality in many infectious diseases [4]. Leadership support is essential for the growth and survival of an ASP, regardless of the size of the hospital. The role of ASP in optimizing patient outcomes, reducing antimicrobial resistance, and meeting regulatory requirements must be understood by leadership [18]. With the regulatory environment changing, small hospitals will need to customise ASPs to their resources, necessitates, and workforce structure [19].

9. NURSES ROLE IN ANTIMICROBIAL STEWARDSHIP PROGRAMS

Nurses are involved in every aspect of patient care, including monitoring, detection, prescribing,

and designing patient-specific treatment plans [20]. In ASPs, the nurses job is to keep track of how well antibiotics are being used. The nurses responsibility has been identified as assisting in the proper use of antimicrobial by questioning the prescriber as required. Even though nurses do not prescribe drugs, they are in a unique position to challenge antimicrobial choices [21]. Formal recognition of the nurse role, education tailored to represent nurses learning needs and behaviour, partnering with nurses in organizing and implementing local stewardship programs, and ensuring the engagement of nursing and clinical leaders are all potential ways to improve nurses participation and commitment to stewardship [22].

10. ANTIMICROBIAL STEWARDSHIP AND ACADEMICS

It is self-evident that any teaching activities regarding AMR and AMS programs will fail unless health care members knowledge, attitude, and perceptions regarding antimicrobials are understood [23]. It has been shown that today's medical students lack adequate basic and clinical knowledge of infectious disease issues. These knowledge gaps may arise as a result of ineffective medical school curricula that do not properly address the basics of antibiotic usage, management, and treatment length however; the situation differs by country [24]. It is suggested that the appropriate regulatory and standards authorities undertake coordinated efforts and treatments to review curricula regularly to assure the delivery of focused formative and normative training, enhanced lectures on antibiotic usage and stewardship to improve future prescribers knowledge and practices [25]. By this the future doctors and medical students can make a positive moral perspective on this problem [24].

11. COST ANALYSIS

Choosing an antibiotic with the right spectrum for the infection site and a high level of activity against the common pathogens at the infection site is the first step in getting the best results. Second, choose an antibiotic with a low risk of resistance and a low risk of side effects. ASP has essential pharmacoeconomic aspects that can save healthcare system resources, which should be used to support ASP employees and support programs. Antibiotic stewardship programs will save a lot of money for institutions [26].

12. CONCLUSION

In health care, quality is determined by the results obtained rather than the number of services provided, resulting in a change in emphasis from volume to value. The process of care used is also not a factor in determining value. ASPs strive to provide high value for patients by implementing various therapies, with a value specified as the health results obtained per money spent. Clinicians must use antimicrobials more effectively, which is why AMS programs are so important. Clinicians should consider spectrum, degree of action against the site, associated pathogen, and resistance potential when choosing an empiric antibiotic for a patient with sepsis. Where possible, choose an antibiotic with a low resistance potential, a broad range, and a high level of activity against the pathogen. Make every effort to maximize dosing based on Pharmacokinetic/ Pharmacodynamic considerations and treat for the shortest time possible to eliminate the infection. Based on the results of prospective audits, the effectiveness of various ASP interventions is evaluated and modified. Prospective audits can spot ineffective interventions and recommend changes or entirely new innovative approaches.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kjærsgaard M, Leth RA, Udipi A, Ank N. Antibiotic stewardship based on education: Minor impact on knowledge, perception and attitude Antibiotic stewardship based on education: Minor impact on knowledge, perception and attitude. *Infect Dis (Auckl)* [Internet]. 2019;0(0):1–11. Available: <https://doi.org/10.1080/23744235.2019.1648856>
2. Momattin H, Al-ali AY, Mohammed K, Al-tawfiq JA. Benchmarking of antibiotic usage: An adjustment to reflect antibiotic. *J Infect Public Health* [Internet]. 2017;8–11. Available: <http://dx.doi.org/10.1016/j.jiph.2017.08.008>

3. Dyar OJ, Huttner B, Schouten J, Pulcini C. What is antimicrobial stewardship? *Clin Microbiol Infect* [Internet]. 2017;23(11): 793–8. Available:<http://dx.doi.org/10.1016/j.cmi.2017.08.026>
4. Parente DM, Morton J. Role of the Pharmacist in Antimicrobial Stewardship. *Med Clin North Am* [Internet]. 2018; 102(5):929–36. Available:<https://doi.org/10.1016/j.mcna.2018.05.009>
5. Nichols K, Stoffella S, Meyers R, Giroto J. Pediatric antimicrobial stewardship programs. *J Pediatr Pharmacol Ther.* 2017; 22(1):77–80.
6. Pulia M, Redwood R, May L. Antimicrobial Stewardship in the emergency department. *Emerg Med Clin North Am.* 2018; 36(4):853–72.
7. Ricardo A, Cardoso D, Almeida A De, Marques F, Biscaia C, Murni IK, et al. The role of antimicrobial stewardship programmes in children: A systematic review. *J Hosp Infect* [Internet]; 2017. Available:<http://dx.doi.org/10.1016/j.jhin.2017.08.003>
8. Hand J, Patel G. Antimicrobial stewardship in transplant patients. *Curr Opin Organ Transplant.* 2019;24(4):497–503.
9. Hand J. Strategies for Antimicrobial Stewardship in Solid Organ Transplant Recipients. *Infect Dis Clin North Am* [Internet]. 2018;32(3):535–50. Available:<https://doi.org/10.1016/j.idc.2018.04.003>
10. Robilotti E, Holubar M, Seo SK, Deresinski S. Feasibility and applicability of antimicrobial stewardship in immunocompromised patients. *Curr Opin Infect Dis.* 2017;30(4):346–53.
11. Guardabassi L, Prescott JF. Antimicrobial stewardship in small animal veterinary practice: from theory to practice. *Vet Clin North Am - Small Anim Pract* [Internet]. 2015;45(2):361–76. Available:<http://dx.doi.org/10.1016/j.cvsm.2014.11.005>
12. Lloyd DH, Page SW. Antimicrobial stewardship in veterinary medicine. *Antimicrob Resist Bact from Livest Companion Anim.* 2018;(1):675–97.
13. Prescott JF, Boerlin P. Antimicrobial use in companion animals and Good Stewardship Practice. *Vet Rec.* 2016;179(19):486–8.
14. Campbell KA, Stein S, Looze C, Bosco JA. Antibiotic stewardship in orthopaedic surgery: Principles and practice. *J Am Acad Orthop Surg.* 2014;22(12):772–81.
15. Septimus EJ. Antimicrobial Resistance: An Antimicrobial/Diagnostic Stewardship and Infection Prevention Approach. *Med Clin North Am* [Internet]. 2018;102(5):819–29. Available:<https://doi.org/10.1016/j.mcna.2018.04.005>
16. Pickens CI, Wunderink RG. Principles and practice of antibiotic stewardship in the ICU. *Chest* [Internet]. 2019;156(1):163–71. Available:<https://doi.org/10.1016/j.chest.2019.01.013>
17. Patel SJ, Saiman L. Principles and strategies of antimicrobial stewardship in the neonatal intensive care unit. *Semin Perinatol* [Internet]. 2012;36(6):431–6. Available:<http://dx.doi.org/10.1053/j.semperi.2012.06.005>
18. Buckel WR, Veillette JJ, Vento TJ, Stenehjem E. Antimicrobial stewardship in community hospitals. *Med Clin North Am.* 2018;102(5):913–28.
19. Stew Edward Stenehjem, David Y Hyun, Ed Septimus, Kalvin C Yu, Marc Meyer, Deepa Raj, et al. Antibiotic Stewardship in small hospitals: Barriers and potential solutions. *Infectious Diseases Society of America.* 2017;1–22.
20. Ladenheim D. Role of nurses in supporting antimicrobial stewardship. *Nurs Stand.* 2018;33(6):55–8.
21. Van Huizen P, Kuhn L, Russo PL, Connell CJ. The nurses role in antimicrobial stewardship: A scoping review. *Int J Nurs Stud* [Internet]. 2021;113:103772. Available:<https://doi.org/10.1016/j.ijnurstu.2020.103772>
22. Gotterson F, Buising K, Manias E. Nurse role and contribution to antimicrobial stewardship: An integrative review. *Int J Nurs Stud* [Internet]. 2021;117:103787. Available:<https://doi.org/10.1016/j.ijnurstu.2020.103787>
23. Baraka MA, Alsultan H, Alsalman T, Alaithan H, Islam MA, Alasser AA. Health care providers perceptions regarding antimicrobial stewardship programs (AMS) implementation - Facilitators and challenges: A cross-sectional study in the Eastern province of Saudi Arabia. *Ann Clin Microbiol Antimicrob* [Internet]. 2019;18(1): 1–10. Available:<https://doi.org/10.1186/s12941-019-0325-x>
24. Efthymiou P, Gkentzi D, Dimitriou G. Knowledge, attitudes and perceptions of

- medical students on antimicrobial stewardship. *Antibiotics*. 2020;9(11):1–13.
25. Fasina FO, LeRoux-Pullen L, Smith P, Debusho LK, Shittu A, Jajere SM, et al. Knowledge, Attitudes, and perceptions associated with antimicrobial stewardship among Veterinary Students: A Multi-Country Survey From Nigeria, South Africa, and Sudan. *Front Public Heal*. 2020;8.
26. Cunha CB. The pharmaco-economic aspects of antibiotic stewardship programs. *Med Clin North Am*. 2018; 102(5):937–46.

© 2021 Rajesh et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle4.com/review-history/73285>