International Journal of Pharmacy and Pharmaceutical Sciences

Print ISSN: 2656-0097 | Online ISSN: 0975-1491 Vol 13, Issue 3, 2021

Original Article

A PROSPECTIVE STUDY OF THE IMPACT OF MICROBIOLOGICAL CULTURES ON ANTIBIOTIC PRESCRIBING PATTERN IN A TERTIARY CARE HOSPITAL

PARTH VACHHANI[1], ANIL SINGH[2]

[1]Team Manager–Global Pharmacovigilance, Cognizant Technology Solutions, Mindspace SEZ, Airoli, Navi Mumbai, Maharashtra, 400708,
[2]Professor and Head, Department of Pharmacology, P. D. U. Government Medical College, Rajkot, Gujarat, 360001
Email: parth1vachhani@gmail.com

Received: 22 Nov 2020, Revised and Accepted: 02 Jan 2021

ABSTRACT

Objective: Antibiotics are frequently prescribed because of clinical suspicion of infection, while the results of the microbiological analysis are still awaited. This study was undertaken to assess the impact of microbiological culture results on the antibiotic prescribing pattern.

Methods: This prospective observational study was conducted on 400 patients of either sex and any age with positive microbiological culture results. Empirical antibiotic therapy details were recorded and change in empirical antibiotic therapy after positive culture results was also recorded. Assessment of sensitivity resistance pattern of microorganisms was also performed.

Results: In the study, male: female ratio was 1.01:1. The majority of patients i.e. 94 (24.50%) were in the 46 y to 60 y of age group. Definitive antibiotic therapy was initiated in 103 patients (25.75%) out of 400 patients. The highest number of changes in antibiotic therapy was done in urinary tract infections (63.95%) and septicemia (32.61%) cases. *Klebsiella* (34.25%), *E. coli* (32%) and *Staphylococcus aureus* (14.75%) were commonly isolated microorganisms. Cephalosporins (77.75%) and aminoglycosides (47%) were commonly used in empirical antibiotic therapy, while nitrofurantoin (47.57%) and penicillins (22.33%) were commonly used in definitive antibiotic therapy. Definitive antibiotic therapy was associated with a reduced duration of hospital stay as compared to empirical antibiotic therapy ($p<0.0001$).

Conclusion: Antibiotic prescribing is infrequently influenced by microbiological culture results. Adjustment of the antimicrobial therapy according to microbiological culture results can decrease the duration of hospital stay as well as can decrease the spread of antimicrobial resistance.

Keywords: Microbiological cultures, Antibiotic therapy, Prescribing pattern, Sensitivity resistance pattern

DOI: https://dx.doi.org/10.22159/ijpps.2021v13i3.40341. Journal homepage: https://innovareacademics.in/journals/index.php/ijpps.

INTRODUCTION

The appropriate use of antibiotics is an important aspect of the treatment of infections. Antibiotics are frequently prescribed because of clinical suspicion of infection while the results of the microbiological analysis are still awaited [1].

Early clinical recognition of infection, rapid laboratory detection of the causative organisms and prompt initiation of appropriate antimicrobial therapy are all essential aspects of the management of severe infections. When the pathogens and their susceptibilities are determined, streamlining and adapting antimicrobial regimens are important to ensure optimal treatment and to limit the untoward consequences of the misuse of antimicrobial agents, particularly the selection of resistant microorganisms and excessive cost of treatment [2].

Several strategies have been suggested to improve antibiotic prescribing such as surveillance of antibiotic resistance, monitoring and auditing of antibiotics use, the use of consensus guidelines or computer decision support and improving multidisciplinary co-operation [3].

Empirical antibiotic therapy may be influenced by microbiological culture results either by broadening or narrowing of the spectrum of antibiotics or by discontinuation of therapy in case of negative cultures. To limit the emergence and spread of resistance, antibiotic therapy should be adjusted according to the results of the microbiological culture [4].

The results of microbiological cultures are often ignored because the patients are doing well on empirical therapy. Although microbiological studies form the basis of effective treatment, clinicians and hospital services show varying degrees of interest in microbiological analysis to decide the appropriate treatment [5-7].

Although the appropriateness of antibiotic prescribing has been investigated frequently, the impact of microbiological culture results on antibiotic prescribing has not been analyzed frequently; therefore, this study was designed to analyze how the results of microbiological cultures influence antibiotic use in the treatment of infection. The assessment of the sensitivity resistance pattern of microorganisms was considered a secondary objective of the study.

MATERIALS AND METHODS

This study was a prospective observational study which was conducted at P. D. U. Government Medical College and Hospital, Rajkot, Gujarat, from March-2014 to February-2015 after permission of the Institutional Ethics Committee [PDUMCR/IEC/9067/2014].

A total of 400 patients of either sex and of all age who were admitted in the hospital, given empirical antibiotic therapy and tested positive on microbiological culture followed by sensitivity testing were included in the study. The patients having malaria, tuberculosis and human immunodeficiency virus infection were excluded from the study because of specific antimicrobial therapy for these diseases. Pregnant women, immunocompromised and cancer patients were also excluded from the study.

The patients with positive microbiological culture sensitivity testing were enrolled in the study after their informed written consent. Patient details like age, sex, diagnosis, type of specimen collected, isolated microorganisms and their sensitivity/resistance pattern was recorded from the laboratory reports. In these patients, empirical antibiotic therapy details like an antimicrobial drug; its dose, route of administration, frequency and duration of treatment before culture sensitivity testing were noted from their respective case notes and treatment charts. Change in empirical therapy after culture sensitivity reports were also recorded. Assessment of sensitivity and resistance pattern of isolated microorganisms at the hospital was considered as a secondary objective of the study. The recorded data were analyzed by Microsoft Office Excel 2013 and using descriptive statistics.

RESULTS

In this study, out of 400 patients, 201 (50.75%) were males and 199 (49.25%) were females with a male: female ratio of 1.01:1. The mean age of the patients was 32.61±22.74 y with a range of 1 d to 95 y. The highest number of patients i.e. 94 (24.50%) were in the 46 y to 60 y of age group.

Out of 400 patients, definitive antibiotic therapy was initiated in 103 (25.75%) patients after culture sensitivity testing. Table 1 shows the isolated microorganisms during the study and the number of patients receiving definitive antibiotic therapy according to isolated microorganisms.

Table 1: Number of patients receiving definitive antibiotic therapy according to isolated microorganisms

S. No.	Isolated microorganism	Total No. of patients (N=400)	No. patients receiving definitive antibiotic therapy (N=103)
1	*Klebsiella*	137	33
2	*E. coli*	128	43
3	*Staphylococcus aureus*	59	7
4	*Pseudomonas*	44	9
5	*Proteus mirabilis*	10	3
6	*Acinetobacter*	7	3
7	*Providencia rettgeri*	4	1

Isolated microorganisms like *Providencia Stuartii*, *Enterobacter*, *Streptococcus* and *Salmonella Paratyphi-B* were less than 2 in number and Isolated like *Proteus Vulgaris* and *Morgenella,* where no change in therapy was done, are not mentioned in the table 1.

The patients with 45 different conditions were enrolled in the study out of which urinary tract infection (UTI) was the most common clinical diagnosis. Table 2 shows the number of patients receiving definitive antibiotic therapy according to the first 10 most common diagnoses.

Table-2: Number of patients receiving definitive antibiotic therapy according to the first 10 most common diagnoses

S. No.	Diagnosis	Total No. of patients (N=225)	No. patients receiving definitive antibiotic therapy (%) (N=85)
1	UTI	86	55 (63.95)
2	Septicemia	46	15 (32.61)
3	Burns	25	5 (20)
4	Pemphigus vulgaris	23	3 (13.04)
5	Pneumonitis	21	3 (14.29)
6	Diarrhoea	21	0
7	Cellulitis	16	0
8	Diabetic foot	15	0
9	Acute osteomyelitis	15	1 (6.67)
10	Chronic suppurative otitis media	12	3 (25)

Among 400 patients who received empirical antibiotic therapy, cephalosporin [n=311 (77.75%)] was the most commonly prescribed group of antimicrobials in which ceftriaxone was the most common drug. After cephalosporin, aminoglycosides [n=188 (47%)] were commonly used in which amikacin was the most common drug. Other antimicrobials which were used as an empirical antibiotic therapy included: fluoroquinolones [n=118 (29.5%)], nitroimidazoles [n=106 (26.5%)], penicillins [n=58 (14.5%)], macrolides [n=8 (2%)], tetracyclines [n=2 (0.5%)] and glycopeptides [n=1, (0.25%)]. Out of 400 patients, 291 patients received two antimicrobials and 50 patients received three antimicrobials as empirical antibiotic therapy.

Among 103 patients who received definitive antibiotic therapy, urinary antiseptic [n=49 (47.57%)] like nitrofurantoin was the most commonly used drug followed by penicillin group [n=22 (21.35%)] of drug which included piperacillin. Other antimicrobials which were used as definitive antibiotic therapy included: fluoroquinolones [n=16 (15.53%)], cephalosporins [n=15 (14.56%)], aminoglycosides [n=13 (12.62%)], glycopeptides [n=3 (2.91%)], macrolides [n=3 (2.91%)], tetracyclines [n=2 (1.94%) and nitroimidazoles [n=1, (0.97%)]. Out of 103 patients who received definitive antibiotic therapy, 19 patients received two antimicrobials and 1 patient received three antimicrobials.

Mean duration of stay in empirical and definitive antibiotic therapy was 3.90±1.43 d and 2.72±0.56 d, respectively, which showed that there was a decreased duration of hospital stay in definitive antibiotic therapy as compared to empirical antibiotic therapy having p-value<0.0001 by Mann-Whitney test calculated in GraphPad Prism software (version 6.07). Table 3 shows the difference between the mean duration of stay in empirical and definitive antibiotic therapy according to the first 10 most common diagnoses.

Table 3: Mean duration of stay in empirical and definitive therapy according to the first 10 most common diagnoses

S. No.	Diagnosis	Mean duration of stay (days) in empirical antibiotic therapy	Mean duration of stay (days) in definitive antibiotic therapy
1	UTI	3.27	2.94
2	Septicemia	5.77	2.23
3	Burns	3.96	2.40
4	Pemphigus vulgaris	3.61	3
5	Pneumonitis	3.52	3
6	Diarrhoea	2.35	0
7	Cellulitis	4.33	0
8	Diabetic foot	3.18	0
9	Acute osteomyelitis	3.76	2
10	Chronic suppurative otitis media	2.78	1.66

During the study, the most commonly isolated microorganisms were from *Enterobacteriaceae* group [n=288 (72%)] followed by other gram-negative bacteria [n=51 (12.75%)] and gram-positive organisms [n=61 (15.25%)]. Table 4 shows the culture sensitivity testing results of all isolated microorganisms during the study.

Table 4: Culture sensitivity testing results

S. No.	Antimicrobial group/Drug	*Enterobacteriaceae*[1]		Other Gram-negative[2]		Gram-positive[3]	
		No. of different agent tested	Sensitive (%)	No. of different agent tested	Sensitive (%)	No. of different agent tested	Sensitive (%)
1	Cephalosporins	688	247 (35.90)	62	41 (66.13)	61	44 (72.31)
2	Penicillins	433	212 (48.96)	50	38 (76)	83	9 (10.84)
3	Aminoglycoside	297	149 (50.17)	54	26 (48.15)	17	3 (17.65)
4	Fluoroquinolone	292	168 (57.53)	35	24 (68.57)	36	28 (77.78)
5	Co-trimoxazole	180	63 (35)	4	1 (25)	32	21 (65.63)
6	Nitrofurantoin	95	79 (83.16)	4	0	-	-
7	Meropenem	82	81 (98.78)	12	12 (100)	-	-
8	Tetracyclines	65	11 (16.92)	1	0	19	15 (78.95)
9	Aztreonam	48	30 (62.50)	14	11 (78.57)	1	1 (100)
10	Glycopeptides	9	7 (77.78)	1	0	96	96 (100)
11	Linezolid	7	2 (28.57)	1	0	59	59 (100)
12	Macrolides	5	4 (80)	1	0	62	28 (45.16)
13	Others	76	33 (43.42)	44	44 (100)	99	81 (81.82)

1=Klebsiella, E. coli, Proteus mirabilis, Proteus vulgaris, Providencia rettgeri, Providencia stuartii, Morgenella and Enterobacter; 2=Pseudomonas and Acinetobacter; 3=Staphylococcus aureus and Streptococci

DISCUSSION

Much concern has been voiced in the last two decades about the widespread use of antimicrobial agents, including broad-spectrum antibiotics, leading to the emergence of multiple drug-resistant microorganisms.

This study assessed the impact of microbiological culture results on antibiotic prescribing pattern. Among positive culture sensitivity testing, antibiotic prescribing was influenced only in 25.75% of patients which is consistent with the study done by Maraha *et al.* in which it was 32% of all enrolled patients [8]. A similar study was performed by Gyssens *et al.* which showed approximately 50% change in empirical antibiotic therapy after culture sensitivity testing which is higher than our study [9]. Another study was conducted in a British district general hospital where microbiological culture sensitivity testing resulted in modification of therapy in 67% of the cases [10].

UTI patients' isolates showed *E. coli* and *Klebsiella* in their cultures and were given ceftriaxone and norfloxacin as empirical antibiotic therapy but these isolates were resistant to these drugs. This may be suggestive of the highest use of drugs like nitrofurantoin and levofloxacin in definitive antibiotic therapy as changes in the empirical antibiotic therapy in these cases were according to the sensitivity pattern of isolated microorganisms. This sensitivity pattern was consistent with the study done by Shalini *et al.* in which *Klebsiella* had 75.86% and 72.41% sensitivity to nitrofurantoin and levofloxacin, respectively and *E. coli* had 93.86% and 75% sensitivity to nitrofurantoin and levofloxacin, respectively [11].

Septicemia cases showed *Klebsiella*, *Pseudomonas* and *Providencia rettgeri* in their culture isolates. These patients were given either ampicillin and gentamicin or cefotaxime and amikacin as empirical antibiotic therapy. As some of these isolates were resistant to ampicillin and gentamicin, such patients were given cefotaxime and amikacin as definitive antibiotic therapy. Those patients who were also resistant to cefotaxime and amikacin; and who showed *pseudomonas* in culture isolates were given piperacillin as definitive antibiotic therapy. In our study, piperacillin was 100% sensitive to *pseudomonas* and 98.53% to *enterobacteriaceae* isolates which is suggestive of the use of this drug as definitive antibiotic therapy in septicemia cases.

Staphylococcus aureus was the most commonly isolated gram-positive microorganism. The highest number of changes in empirical antibiotic therapy was done in pemphigus vulgaris cases among *Staphylococcus aureus* isolates and these patients were given vancomycin as definitive antibiotic therapy because it was 100% sensitive. The study performed by Duran *et al.* also showed a similar sensitivity pattern to *Staphylococcus aureus* [12].

Enterobacteriaceae group of microorganisms like *Klebsiella, Proteus, E. coli* and *Enterobacter* and other gram-negative organisms like *pseudomonas* constitute the highest number of the isolated microorganisms in our study and they are the commonest cause of hospital-acquired infections. These microorganisms are more resistant to the commonly used antimicrobial drugs of empirical antibiotic therapy. To prevent the development of such nosocomial infection, guidelines provided by the World Health Organization (WHO) on prevention of nosocomial infection should be followed such as reducing person-to-person transmission and preventing transmission from the environment [13].

As the 3rd generation cephalosporins and aminoglycosides are commonly used as empirical antibiotic therapy in gram-negative microorganism infected cases, these microorganisms show increased resistance to these drugs in our hospital which is a growing concern for the treatment of such infections. For the prevention of development of resistance, antimicrobial stewardship programme should be initiated in the hospital along with the formation of guidelines for effective use of antimicrobials at the hospital. Antimicrobial stewardship programmes have been shown to reduce inappropriate antimicrobial use, reductions in antimicrobial resistance and improved clinical outcomes for patients [14].

Older drugs like co-trimoxazole showed more sensitivity (65.53%) to gram-positive organisms as compared to macrolides (45.16%) and penicillins (10.84%). Therefore, these drugs can be used as empirical antibiotic therapy in gram-positive infected patients.

Antibiotic therapy should be changed according to microbiological culture sensitivity testing results as there is a statistically significant difference ($p<0.0001$) in the duration of hospital stay in definitive and empirical antibiotic therapy. This practice can reduce the spread of antimicrobial resistance as well as can decrease the cost of the therapy [15].

Sensitivity resistance pattern of the microorganism at a local level of the hospital can be formed for the rational use of the antibiotics and to prevent the development of resistance. The development of effective control programs through the adoption of measures that restrict the use of specific antimicrobials, the establishment of therapeutic guidelines, the constant monitoring of the resistance pattern of the common pathogenic organisms in the hospital are recommended to improve the usage of antibiotics [16].

Infectious disease specialists can play a significant role in the management of infections. They can improve the appropriateness of the antimicrobial treatment at no extra cost [17]. Study performed by Byl *et al.* emphasizes the importance of close coordination among the clinical laboratory, the infectious disease specialists and physicians in ensuring optimal care for severely infected patients. They also underscore the need to foster the education of physicians in the field of antimicrobial therapy for the management of infections [18].

The future of antibiotics and the survival of every human being that acquires a bacterial infection will depend on the serious commitment of many stakeholders including government authorities, policymakers, health-care workers, pharmaceutical companies and consumers. Solutions for antimicrobial resistance will not be easy and paradoxically increasing the price of antibiotics might restrict their use but a delicate balance between overuse and lack of access is to be maintained. There is a room for innovative ideas in quality assurance, health financing and social marketing [19].

There is a need to formulate antibiotic policies in every hospital because the resistance of pathogenic microorganisms to antimicrobial agents is increasing and it is difficult to keep pace with the development of resistance. Similar studies should be done on a larger scale and at regular intervals which can reflect the change in the sensitivity resistance pattern of microorganisms towards the antimicrobial agents. There is a need to develop new antimicrobial agents which are becoming an "endangered species" owing to loss of interest by pharmaceutical companies in developing newer drugs on one end and development of resistance on the other end. Appropriate and cautious use of antimicrobials has become a necessity for us to continue the use of these "wonder drugs".

There were certain limitations of this study. The first limitation was that culture sensitivity testing for all the antimicrobial drugs was not performed throughout the study due to availability of culture sensitivity testing kits. The second limitation was that the specimens which did not show any culture isolates were not included in the study (only 8-10 samples show positive culture isolates out of daily average of 40 samples). This was a one-time study, continuous review of sensitivity profile of various microorganisms should be performed regularly.

CONCLUSION

In conclusion, our data show that antibiotic prescribing is infrequently influenced by microbiological culture results. However, this does not imply that microbiological investigations are not essential in the diagnostic process when the infection is suspected. A review of the microbiological results of patients receiving antibiotics may be an effective approach to integrate microbiological results into medical practices and to improve antibiotic prescribing. Adjustment of the antimicrobial therapy according to microbiological culture results can decrease the duration of hospital stay and the spread of antimicrobial resistance.

ACKNOWLEDGEMENT

The authors would like to acknowledge the staff of Microbiology Department, P. D. U. Government Medical College, Rajkot, Gujarat for support and co-operation during the study.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

Parth Vachhani: Preparation of study documents; data collection, data entry and evaluation in MS Excel; preparation of research article.

Anil Singh: Designed and framed the study, suggested different ways of data evaluation, final review and update of research article.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest concerning the content of this work.

REFERENCES

1. Goldman DA, Weinstein RA, Wenzel RP. Strategies to prevent and control the emergence and spread of antimicrobial-resistant microorganisms in hospitals. JAMA 1996;275:234–40.
2. Gross PA, Barrett TL, Patchen DE. Quality standard for the treatment of bacteremia. Clin Infect Dis 1994;18:428–30.
3. Evans RS, Classen DC, Pestontik SL, Lundsgaarde HP, Burke JP. Improving empiric antibiotic selection using computer decision support. Arch Intern Med 1994;154:878–84.
4. John JF Jr, Fishman NO. Programmatic role of the infectious diseases physician in controlling antimicrobial costs in the hospital. Clin Infect Dis 1997;24:471–85.
5. Chiu J, Thompson GW, Austin TW, Hussain Z, John M, Bombassaro AM, *et al.* Antibiotic prescribing practices for catheter urine culture results. Can J Hosp Pharm 2013;66:13-20.
6. Berild D, Ringertz SH, Lelek M. Appropriate antibiotic use according to diagnoses and bacteriological findings: report of 12 point-prevalence studies on antibiotic use in a university hospital. Scand J Infect Dis 2002;34:56-60.
7. Arbo MDJ, Snydman DR. Influence of blood culture results on antibiotic choice in the treatment of bacteremia. Arch Intern Med 1994;154:2641–5.
8. Maraha B, Bonten M, Fiolet H, Stobberingh E. The impact of microbiological cultures on antibiotic prescribing in general internal medicine wards: microbiological evaluation and antibiotic use. Clin Microbiol Infect 2000:6:99-102.
9. Gyssens IC. Optimizing antimicrobial drug utilization. Studies and interventions in a University hospital. Ph. D. Thesis, the Netherlands: Catholic University of Nijmegen; 1996. p. 127–65.
10. Moss F, McNicol MW, McSwiggan DA, Miller DL. Survey of antibiotic prescribing in a district general hospital. I Pattern of use. Lancet 1981;ii:349–52.
11. Shalini D, Joshi MC, Rashid MK, Joshi HS. Study of antibiotic sensitivity pattern in urinary tract infection at a tertiary hospital. Natl J Integr Res Med 2011;2:43-6.
12. Duran N, Ozer B, Duran G, Onlen Y, Demir C. Antibiotic resistance genes and susceptibility patterns in *staphylococci*. Indian J Med Res 2012;135:389-96.
13. World health organization. Prevention of hospital acquired infections. Available from: http://www.who.int/csr/ resources/ publications/whocdscsreph200212.pdf [Last accessed on 06 Aug 2015].
14. SARI. A strategy for the control of antimicrobial resistance in Ireland. Available from: https://www.hpsc.ie/A-Z/MicrobiologyAntimicrobialResistance/InfectionControlandHAI/Guidelines/File,4116,en.pdf [Last accessed on 06 Aug 2015]
15. Berlid D, Mohseni A, Diep ML, Jensenius M, Ringertz SH. Adjustment of antibiotic treatment according to results of blood culture leads to decrease antibiotic use and costs. J Antimicrob Chemother 2006;57:326-30.
16. Mistry VR, Pandya AS, Chaudhari JS, Sondarva DB, Pillai A, Hotchandani SC. Use of antimicrobial prophylaxis in clean elective orthopedic surgical procedures and identifying common infective organisms. Int J Med Sci Public Health 2013;2:994-1000.
17. Nathwani D, Davey P, France AJ, Phillips G, Orange G, Parratt D. Impact of an infection consultation service for bacteraemia on clinical management and use of resources. Q J Med 1996;89:789–97.
18. Byl B, Clevenbergh P, Jacobs F, Struelens MJ, Zech F, Kentos A, *et al.* Impact of infectious disease specialists and microbiological data on the appropriateness of antimicrobial therapy for bacteremia. Clin Infect Dis 1999;29:60-6.
19. Laxminarayan R, Duse A, Wattal C, Zaidi AKM, Wertheim HFL, Sumpradit N, *et al.* Antibiotic resistance-the need for global solutions. Lancet Infect Dis 2013;13:1057-98.