Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 06, 2021

Original Research Article

Antibiotic Prescription Audit in a Surgical Intensive Care Unit (ICU): A Clinical Study in the Indian Setting

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Received: 20-08-2021 / Revised: 09-10-2021 / Accepted: 06-11-2021

Abstract

Background: Mortality and disease severity are decreased with appropriate antibiotic therapy started timely especially in ICUs owing to widespread use concerning the admission of postoperative subjects to ICU, considerable number of sepsis cases treated in ICU which can cause antibiotic resistance in subjects who are severely ill.

Aims: The present study was conducted to assess the clinical impact and audit of implementing an Antibiotic stewardship program in subjects admitted to adult surgical ICU settings of India.

Materials and Methods: The antibiotic audit was made by the expert pharmacologist for subjects in surgical ICU, with the evaluation of how appropriate the prescribed antibiotic therapies were. The suggestion was taken from a microbiologist for antibiotic susceptibility and appropriateness of antibiotics, and a physician on the prescription of antibiotics. The outcomes assessed in the present study were the use of a particular antibiotic, mean duration, appropriateness of use, mortality within a month, source control documentation (by the surgeon), and readmission without a prior plan. The collected data were subjected to statistical evaluation.

Results: Mortality was 17.30% 9n=18) in pre-ASP and 14.15 (n=15) in post-ASP group. This was statistically non-significant (p=0.69). Hospital stay duration and readmissions were also statistically non-significant (p=0.2051 and 0.06 respectively) between the two groups. The duration of antibiotics was higher for the pre-ASP group with p<0.001. Optimum antibiotic use was seen in 23.07% (n=24) and 86.79% (n=92) subjects from pre-ASP and post-ASP group respectively. Apt antibiotic selection was seen in 41.34% (n=43) and 74.52% (n=79) subjects from pre-ASP and post-ASP group respectively ($p<0.001$). Source-control documentation was not needed in any subject of the pre-asp group, whereas, in 62.26% (n=66) subjects of post-ASP it was needed ($p<0.001$).

Conclusion: The present study concludes that antibiotic duration, optimization, and prescription can improve clinical parameters with ASP implementation. Also, complete compliance of source-control documentation can improve antibiotic-related variables and parameters in subjects undergoing surgery.

Keywords: Antibiotic audit, Antibiotic resistance, Antibiotic stewardship program, Infectious disease, surgical ICU.

Introduction

Globally, the incidence of antibiotic resistance is increasing posing a big challenge to the health care sector especially in developing countries like India. This raise can be attributed to improper vaccination, improper infection control measures, lack of sanitization, antibiotic misuse, and overuse with improper antibiotic use being the most vital factor leading to antibiotic resistance. However, this factor is modifiable helping in judiciary use of antibiotics in subjects who are hospitalized. For this purpose, ASP (Antibiotic stewardship program) was launched in 2007 and was modified by the Infectious disease society of America in 2016.[1]

The ASP program majorly focuses on the judicial and optimized selection and use of various antibiotics with the appropriate dose and for the accurate duration as needed to have a minimal incidence of antibiotic resistance, desirable clinical results, and minimum drug-related toxicity. Various previous literature data from pediatric intensive care units and developed countries had reported that the Antibiotic stewardship program is an effective program that can help in reducing the incidence of antibiotic resistance. The ASP is superior concerning fewer mortality rates, optimum treatment duration, less antibiotic resistance, and less hospital stay. However, literature data supporting the superiority of ASP is scarce with some data showing improved antibiotic trends with ASP implementation in ICUs.[2]

Mortality and disease severity are decreased with appropriate antibiotic therapy started timely. Antibiotics are used in ICUs widely owing to the admission of postoperative subjects to ICU, considerable number of sepsis cases treated in ICU which can cause antibiotic resistance in subjects who are severely ill. However, health-related outcomes and health has improved due to following prescribed guidelines for antibiotic use with some published literature data supporting the evidence.[3]

The incidence of non-judicious antibiotic use has increased recently leading to a decrease in the effectiveness of ASP especially in developing countries like India. This is also attributed to the non-involvement of adequately trained individuals and not applying a multidisciplinary system.[4]

Additionally, the application of ASP to the clinical field is challenging leading to different success rates of ASP in different designs and settings. Fears among health care professionals exist concerning ASP application that it may cause more mortality, increased hospital stay, more ICU admission, increased sepsis cases with the increased financial burden.[5] However; the data concerning the assessment of ASP application in surgical adult ICU are scarce. Hence, the present study was conducted to assess the clinical impact and audit of implementing an Antibiotic stewardship program in subjects admitted to adult surgical ICU settings of India.

MATERIALS AND METHODS

The present retrospective clinical study was conducted to assess the clinical impact and audit of implementing an Antibiotic stewardship program in subjects admitted to adult surgical ICU settings of India. The present study was conducted after obtaining clearance from the concerned Ethical committee and getting informed consent. During the defined study period, standard operating protocols were designed for ASP.

The inclusion criteria for the study were subjects admitted to surgical ICU during the study period and were prescribed any antibiotics. The data were collected from the records of the surgical ICU concerning demographics, antibiotics prescription and indication, surgery type, comorbidities, and appropriate and judicious antibiotic use. Also, patient-related data including pathologic, microbiologic, observations, daily progress, and radiologic records were collected by a single expert pharmacologist dealing with infectious diseases. For antibiotics, duration, dose, route, and time were recorded. Also, mortality rates and readmission were noted for all included subjects.

In surgical ICU, a multidisciplinary approach was used in implementing ASP with a collaborative approach of microbiology, infectious disease, surgery, pharmacy, and critical care units with pharmacologists being head with support from all mentioned departments of the institution. Additional approval was taken from the hospital head concerning the use of restricted antibiotics including colistin, caspofungin, cotrimoxazole, tigecycline and linezolid. Preoperative antibiotics used in surgical ICU were metronidazole, ceftriaxone and cefazolin. To manage the complications postoperatively; vancomycin, piperacillin, meropenem, colistin, imipenem and tazobactam were used.

The audit was made by the expert pharmacologist with the evaluation of how appropriate the prescribed antibiotic therapies were. The suggestion was taken from a microbiologist for antibiotic susceptibility and appropriateness of antibiotics, and a physician on the prescription of antibiotics. With this audit, alterations were made in the datasheet by the expert pharmacologist. This was followed by optimization of the audit and its recording by the pharmacologist to ameliorate duration, dose, and drug as per infection site, associated microorganisms, pharmacologic drug properties.

The outcomes assessed in the present study were the use of a particular antibiotic, mean duration, appropriateness of use, mortality within a month, source control documentation (by the surgeon), and readmission without a prior plan. Source control documentation was source control of infection as documented by surgeons after surgery and includes all measures taken to remove the infection, decrease bacterial load, and restoring the physiologic state. Antibiotic use indication was assigned as targeted therapy in cases with identified culture, empirical therapy for 5-7 days, and prophylactic for 24-48 hours. Unplanned readmission and mortality were considered within 30 days of discharge. In subjects with no readmission, subjects were followed at day 31 of discharge by the pharmacologist, and readmission in any other institute was also considered.

The prescription of antibiotics was judged for their appropriateness via assessing discontinuation, drug interaction, blood drug concentration, optimum dose, appropriate antibiotic selection based on pathogen-associated.

The collected data were subjected to the statistical evaluation using SPSS software version 21 (Chicago, IL, USA) and t-test for results formulation. The data were expressed in percentage and number, and mean and standard deviation concerning demographics and study outcomes. The level of significance was kept at $p<0.05$.

RESULTS

The present retrospective clinical study was conducted to assess the clinical impact and audit of implementing an Antibiotic stewardship program in subjects admitted to adult surgical ICU settings of India. The study included a total of 104 subjects from both genders and within the age range of 38-62 years and the mean age of 51.4±4.26 years. The demographic characteristics of the study subjects are listed in Table 1. There were 73.07% (n=76) males in pre-ASP group and 73.58% (n=78) in post-ASP group. Therapeutic antibiotics were prescribed for 19.23% (n=20) subjects in pre-ASP and in 20.75% (n=22) subjects from post-ASP group, Empirical antibiotics in 35.57% (n=37) and 34.90% (n=37) subjects from pre and post ASP group respectively. Prophylactic antibiotics were given to 45.19% (n=47) and 44.33% (n=47) subjects respectively from pre and post ASP group. This difference was statistically non-significant with p=0.76. No comorbidity was seen in 24.03% (n=25) and 24.52% (n=26) subjects from pre and post ASP group respectively. Most common comorbidity seen was Diabetes in 21.15% (n=22) subjects from pre-ASP and 22.64% (n=24) subjects from post-ASP group. The comorbidities were comparable in two groups with p=0.84. The surgeries performed were vascular, orthopaedic, ENT, general surgery, neurosurgery, and obstetrics and gynaecologic surgery which was non-significant between two groups with p=0.73 (Table 1).

Therapeutic and Empirical antibiotics used were colistin, vancomycin, tazobactam, and carbapenem in the dose of 274, 264, 366, and 510 in pre-ASP and 114, 86, 120, and 398 subjects in the post-ASP group. The results were non-significant for colistin (p=0.22) and were significant for all other antibiotics ($p<0.001$). Prophylactic antibiotics used were cefazolin, metronidazole, and ceftriaxone with 186, 224, and 378 doses respectively in pre-ASP and 52, 82, and 74 subjects from the post-ASP group. This was statistically significant with $p<0.001$. Mortality was 17.30% (n=18) in pre-ASP and 14.15 (n=15) in post-ASP group. This was statistically non-significant (p=0.69). Hospital stay duration and readmissions were also statistically non-significant (p=0.2051 and 0.06 respectively) between the two groups. The duration of antibiotics for colistin, vancomycin, tazobactam, and carbapenems was statistically significant for pre-ASP and post-ASP group and was higher for the pre-ASP group with $p<0.001$, whereas, for prophylactic antibiotics, also significantly higher duration was for pre-ASP group concerning cefazolin, metronidazole, and ceftriaxone with $p<0.001$ (Table 2).

On assessing the antibiotics related parameters, it was seen that antibiotics was discontinued in 95.28% (n=101) subjects in post-ASP group and in 19.23% (n=20) in pre-ASP group. Drug interaction was seen in 25.96% (n=27) subjects in pre-ASP and 11.32% (n=12) subjects from post-ASP group. Optimum antibiotic use was seen in 23.07% (n=24) and 86.79% (n=92) subjects from pre-ASP and post-ASP group respectively. Apt antibiotic selection was seen in 41.34% (n=43) and 74.52% (n=79) subjects from pre-ASP and post-ASP group respectively. The difference was statistically higher in post-ASP group with $p<0.001$ (Table 3).

Concerning intervention in the pre-ASP and post-ASP group, source-control documentation was not needed in any subject of the pre-asp group, whereas, in 62.26% (n=66) subjects of post-ASP it was needed. Therapy for >5days was done in 41.34% (n=43) subjects from pre-ASP and higher, 73.58% (n=78) subjects from post-ASP group ($p<0.001$). Intervention by pharmacologist is needed in 48.11% (n=51) subjects from the post-ASP group, this was statistically significant ($p<0.001$) (Table 4).

Table 1: Demographic characteristics of the study subjects

Characteristics	Intervention (Pre-ASP) (n=104) % (n)	Intervention (Post-ASP) (n=106) % (n)	p-value
Mean age (years)	51.28±11.42	53.02±9.72	0.235
Age range (years)	38-61	39-62	
Gender			
Males	73.07 (76)	73.58 (78)	0.66
Females	26.92 (28)	26.14 (28)	
Antibiotic Indication			
Therapeutic	19.23 (20)	20.75 (22)	0.76
Empirical	35.57 (37)	34.90 (37)	
Prophylactic	45.19 (47)	44.33 (47)	
Associated comorbidities			
No comorbidity	24.03 (25)	24.52 (26)	0.84
Diabetes	21.15 (22)	22.64 (24)	
Respiratory disease	4.80 (5)	2.83 (3)	
Cardiovascular disease	17.30 (18)	14.15 (15)	
Renal diseases	16.38 (16)	17.92 (19)	
Malignancies	0 (0)	0 (0)	
Hepatic disease	8.65 (9)	8.49 (9)	
Neuropsychiatric disease	1.92 (2)	3 .77(4)	
Combination of any 2	6.73 (7)	5.66 (6)	
Surgeries Performed			
Vascular	2.88 (3)	2.83 (3)	0.73
Orthopedic	10.57 (11)	13.20 (14)	
ENT	4.80 (5)	2.83 (3)	
General Surgery	42.30 (44)	45.28 (48)	
Obstetrics/gynaecology	5.76 (6)	4.721 (5)	
Neurosurgery	33.65 (35)	31.13 (33)	

Table 2: Comparison of antibiotics used and clinical parameters in the study subjects

Parameter	Intervention (Pre-ASP) (n=104) % (n)	Intervention (Post-ASP) (n=106) % (n)	p-value
Antibiotics (total) used	328	115	<0.001
Therapeutic and Empirical			<0.001
Colistin	274	114	0.22
Vancomycin	264	86	<0.001
Tazobactam	366	120	<0.001
Carbapenems	510	398	0.26
Prophylactic			
Cefazolin	186	52	<0.001
Metronidazole	224	82	<0.001
Ceftriaxone	378	74	<0.001
Antibiotics (total) doses	3800	2240	<0.001

Mortality	17.30 (18)	14.15 (15)	0.69
Hospital stays duration (days)	5.4±2.9	4.9±2.8	0.2051
Readmissions	23.07 (24)	0.94 (1)	0.06
Duration of antibiotic therapy (mean)			
Therapeutic and Empirical			
Colistin	7.7±4.8	4.6±2.8	<0.001
Vancomycin	6.3±3.9	2.9±1.9	<0.001
Tazobactam	6.5±3.6	2.5±1.4	<0.001
Carbapenems	9.8±3.8	4.2±2.5	<0.001
Prophylactic			
Cefazolin	4.1±2.9	1.7±1.6	<0.001
Metronidazole	2.8±2.4	1.3±0.9	<0.001
Ceftriaxone	5.3±2.5	1.6±1.5	<0.001

Table 3: Aptness of antibiotics used in Pre-ASP and Post-ASP study subjects

Antibiotic related parameter	Intervention (Pre-ASP) (n=104) % (n)	Intervention (Post-ASP) (n=106) % (n)	p-value
Discontinuation	19.23 (20)	95.28 (101)	<0.001
Drug Interaction	25.96 (27)	11.32 (12)	<0.001
Blood level monitoring	10.57 (11)	79.24 (84)	<0.001
Optimum dose use	23.07 (24)	86.79 (92)	<0.001
Correct antibiotic selection	41.34 (43)	74.52 (79)	<0.001

Table 4: Intervention data comparison in Pre-ASP and Post-ASP study subjects

Variable	Intervention (Pre-ASP) (n=104) % (n)	Intervention (Post-ASP) (n=106) % (n)	p-value
Source-control documentation	0 (0)	62.26 (66)	-
Therapy for >5 days	41.34 (43)	73.58 (78)	<0.001
Antibiotic selection following guidelines	75.96 (79)	13.20 (14)	<0.001
Intervention of Pharmacologist	0 (0)	48.11 (51)	-

Discussion

The present retrospective clinical study was conducted to assess the clinical impact and audit of implementing an Antibiotic stewardship program in subjects admitted to adult surgical ICU settings of India. The study included a total of 104 subjects from both genders and within the age range of 38-62 years and the mean age of 51.4±4.26 years.

Therapeutic and Empirical antibiotics used were colistin, vancomycin, tazobactam, and carbapenem in the dose of 274, 264, 366, and 510 in pre-ASP and 114, 86, 120, and

398 subjects in the post-ASP group. The results were non-significant for colistin (p=0.22) and were significant for all other antibiotics (p<0.001). Prophylactic antibiotics used were cefazolin, metronidazole, and ceftriaxone with 186, 224, and 378 doses respectively in pre-ASP and 52, 82, and 74 subjects from the post-ASP group. This was statistically significant with p<0.001. Mortality was 17.30% 9n=18) in pre-ASP and 14.15 (n=15) in post-ASP group. This was statistically non-significant (p=0.69). Hospital stay duration and readmissions were also statistically non-significant (p=0.2051 and 0.06 respectively) between the two groups. The duration of antibiotics for colistin, vancomycin, tazobactam, and carbapenem was statistically significant for pre-ASP and post-ASP group and was higher for the pre-ASP group with p<0.001, whereas, for prophylactic antibiotics, also significantly higher duration was for pre-ASP group concerning cefazolin, metronidazole, and ceftriaxone with p<0.001. These findings were consistent with the findings of Haque A et al[6] in 2018 and Kaki R et al[7] in 2011 where authors reported clinical parameters concerning antibiotics comparable to the present study.

The present study also evaluated the antibiotics-related parameters, it was seen that antibiotics were discontinued in 95.28% (n=101) subjects in the post-ASP group and 19.23% (n=20) in the pre-ASP group. Drug interaction was seen in 25.96% (n=27) subjects in pre-ASP and 11.32% (n=12) subjects from post-ASP group. Optimum antibiotic use was seen in 23.07% (n=24) and 86.79% (n=92) subjects from pre-ASP and post-ASP group respectively. Apt antibiotic selection was seen in 41.34% (n=43) and 74.52% (n=79) subjects from pre-ASP and post-ASP group respectively. The difference was statistically higher in the post-ASP group with p<0.001. These results were in agreement with the studies of Davey P et al[8] in 2013 and Dunkel N et al[9] in 2012 with authors reported antibiotic discontinuation and appropriate antibiotic intake as in the present study.

Concerning intervention in the pre-ASP and post-ASP group, source-control documentation was not needed in any subject of the pre-asp group, whereas, in 62.26% (n=66) subjects of post-ASP it was needed. Therapy for >5days was done in 41.34% (n=43) subjects from pre-ASP and higher, 73.58% (n=78) subjects from post-ASP group (p<0.001). Intervention by pharmacologist is needed in 48.11% (n=51) subjects from the post-ASP group, this was statistically significant (p<0.001). These results were similar to the results by the studies of Walia K et al[10] in 2015 and Marquet K et al[11] in 2015 with comparable intervention reported pre-ASP and post-Asp by the authors.

Conclusion

Within its limitations, the present study concludes that antibiotic duration, optimization, and prescription can improve clinical parameters with ASP implementation. Also, complete compliance of source-control documentation can improve antibiotic-related variables and parameters in subjects undergoing surgery. However, the present study had few limitations including a smaller sample size, geographical area biases, short monitoring period, and single-institution nature. Hence, more studies in vivo are warranted to reach a definitive conclusion. Also, ASP sustainability in OPD and other acute cases needs to be explored.

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