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Studies on Antimicrobial Consumption in a Tertiary Care Private Hospital, India

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ABSTRACT

The main aim of this observational study was to study the pattern of usage of antibiotics in a tertiary care hospital as their rampant use is recognised as one of the main reasons of antibiotic resistance. The quantum of use is best described by defined daily dose. Defined daily doses (DDDs) of antimicrobials prescribed per 100 bed days are a good measure of antimicrobial consumption. The DDD methodology converts and standardises readily available product quantity data into crude estimates of clinical exposure to medicines. The DDD is the assumed average maintenance dose for the medication's main indication. The study shows a consistently very high increase in the consumption of Meropenem and Ceftriaxone while there is no significant change in the consumption of Metronidazole, Tobramycin, and Vancomycin. The increase in expenditure due to antibiotic usage from 2011 to 2012 was 23% while the increase from 2012 to 2013 was 17%**.** It has also identified drugs like Meropenem and Piperacillin/Tazobactam which require further investigation to assess their appropriateness in different clinical settings. This needs to be correlated with the hospital's isolated infective organisms' sensitivity reports.

INTRODUCTION

Drug use studies using aggregate data indicate that there is over or under consumption of medicines. The data on utilization may provide useful information for promoting appropriate use of medicines.[1] Antimicrobial agents are among the most frequently prescribed drugs. Inappropriate use of these agents is associated with allergic reactions, toxicity, superinfection, and more importantly the development of antimicrobial resistance.[2,3] In addition, the excessive and inappropriate use of antimicrobials can cause an unnecessary economic burden to health care system and the patients as well.[4] Antimicrobial resistance is more prevalent in hospital settings than in the community.[5] Studies have shown that patients with drug-resistant organisms require longer hospitalization and have increased risk of mortality.[4]

A few hospitals and city based studies of antimicrobial use suggest that drugs are often prescribed in irrational or inappropriate ways. Irrational prescriptions are defined as those that are prescribed at an incorrect dose, frequency or duration that is abundant. [7] The National Policy for Containment of Antimicrobial Resistance issued by Government of India advocates the surveillance of antimicrobial use in the community and hospitals. To begin with the Government proposed the drug utilization studies of antimicrobials in central government hospitals. In addition,, it suggests that the data on consumption trends can be used for intervention studies to promote rational use of these medicines. [7]

Defined daily doses (DDDs) of antimicrobials prescribed per 100 bed days are a good measure of antimicrobial consumption. There are very few studies in India that have published DDDs on antimicrobial consumption. [8] DDD methodology converts and standardizes readily available product quantity data into estimates of clinical exposure to medicines. The DDD is the assumed average maintenance dose for the medication's main indication. [9]With this background in mind, the present study attempted to document the use of antimicrobials and the cost associated with their use in a private tertiary care hospital which would be a source for comparison and attempting interventional studies in relation to resistant pattern.

MATERIALS AND METHODS

The data were obtained from hospital pharmacy records and included for three years duration from January 2011 to December 2013. The total use of antimicrobials of the whole hospital was calculated as a number of units for each antimicrobial. Then the consumption was expressed in terms of internationally recognised units. DDDs per 100 bed – days using the following formula. [10]

$$\text{DDDs /100 bed – days} = \frac{\text{Number of units administered in a given period (mg)} \times 100 \text{ beds}}{\text{DDD (mg)} \times \text{Number of Days in t□e period} \times \text{Number of beds} \times \text{Hospital occupancy index}}$$

Number of units administered = Strength in mg $\times$ $Number of counts$

The Anatomical Therapeutic Chemical (ATC) classification system and defined daily dose (DDD) were used to classify the prescribed antibiotic [15]. The ATC system divides the active substances into groups and subgroups and the DDD is the assumed average maintenance dose per day for a drug when used for its main indication in adults. The DDD provides a fixed unit of measurement, independent from e.g. strength and price, which enable research on patterns in the prescribing of drugs. For this study, the total DDD and DDD/100 bed days were used to present the prescribing of antibiotics.

RESULTS AND DISCUSSION

The antimicrobials used during this period are identified and grouped as Aminoglycosides – Tobramycin, Netilmicin; Beta-Lactams Penicillins – Ampicillin alone as well as in combination with Cloxacillin, Amoxicillin in combination with Clavulanic acid, Piperacillin; Beta-lactamase inhibitors – Tazobactam; Beta-lactamase resistant pencillins: Cloxacillin; Carbapenems – Meropenem, Imepenam in combination with Cilastatin, Doripenem; Cephalosporins - Cefipime, Cefoperazone, Cefotaxime, Ceftriaxone; Glycopeptides – Vancomycin, Teicoplanin; Glycylcyclines – Tigecycline; Imidazole – Metronidazole; Lincosamide – Clindamycin; Macrolides – Azithromycin and Clarithromycin; Quinolones – Ciprofloxacin, Ofloxacin, Levofloxacin, Moxifloxacin; and – Linezolid.

Table 1: The calculated defined daily dose (DDD) for antimicrobials

Class of antibiotics	Antimicrobial	Defined Daily Dose*	2011	2012	2013
Beta Lactam	Amoxicillin	DDDs	11,201.25	11,045.1	9,658.2
		DDD / 100 bed – days	5387.80	4668.06	3910.20
	Ampicillin	DDDs	146.75	96.31	243.12
		DDD / 100 bed – days	70.58	40.70	98.42
Macrolides	Azithromycin	DDDs	3, 30,000	2, 26,666.66	3, 00,000
		DDD / 100 bed – days	1,58,730.15	95,797.58	1214.57
	Clarithromycin	DDDs	24.75	33.75	27.25
		DDD / 100 bed – days	11.90	14.26	11.03
Cephalosporins	Cefoperazone	DDDs	565.25	514.75	424
		DDD / 100 bed – days	271.88	217.55	171.65
	Cefotaxim	DDDs	832.09	1053.87	1020.78
		DDD / 100 bed – days	400.23	445.40	413.27
	Ceftriaxone	DDDs	772.12	3663.5	5080.87
		DDD / 100 bed – days	371.38	1548.32	2057.03
Quinolones	Ciprofloxacin	DDDs	308	429.5	351.5
		DDD / 100 bed – days	148.14	181.52	142.30

	Levofloxacin	DDDs	75	60.25	77.12
		DDD / 100 bed – days	36.07	25.46	31.22
	Moxifloxacin	DDDs	265	107	161
		DDD / 100 bed – days	127.46	45.22	65.18
	Ofloxacin	DDDs	557	2.5	75.5
		DDD / 100 bed – days	267.91	1.056	30.56
Aminoglycoside	Tobramycin	DDDs	560.71	538.57	563.21
		DDD / 100 bed – days	269.70	227.61	228.02
	Netilmicin	DDDs	470	487.14	236.29
		DDD / 100 bed - days	226.07	205.88	95.66
Glycopeptides	Teicoplanin	DDDs	1080.5	1175	966.5
		DDD / 100 bed – days	47.13	496.59	391.29
	Vancomycin	DDDs	209	205.75	194.75
		DDD / 100 bed – days	100.52	86.95	78.84
		DDD / 100 bed – days	66.61	8.24	41.63
Miscellaneous	Doripenem	DDDs	----------	3.66	8
		DDD / 100 bed – days	----------	1.54	3.23
	Linezolid	DDDs	21.75	34	18
		DDD / 100	10.46	14.36	7.28

		bed – days			
	Meropenem	DDDs	1386.6	2047.06	2167.31
		DDD / 100 bed – days	666.95	865.16	877.45
	Metronidazole	DDDs	64.03	69.28	72.81
		DDD / 100 bed – days	30.79	29.25	29.477
	Teigecycline	DDDs	98	182.5	89.5
		DDD / 100 bed – days	47.13	77.13	36.23

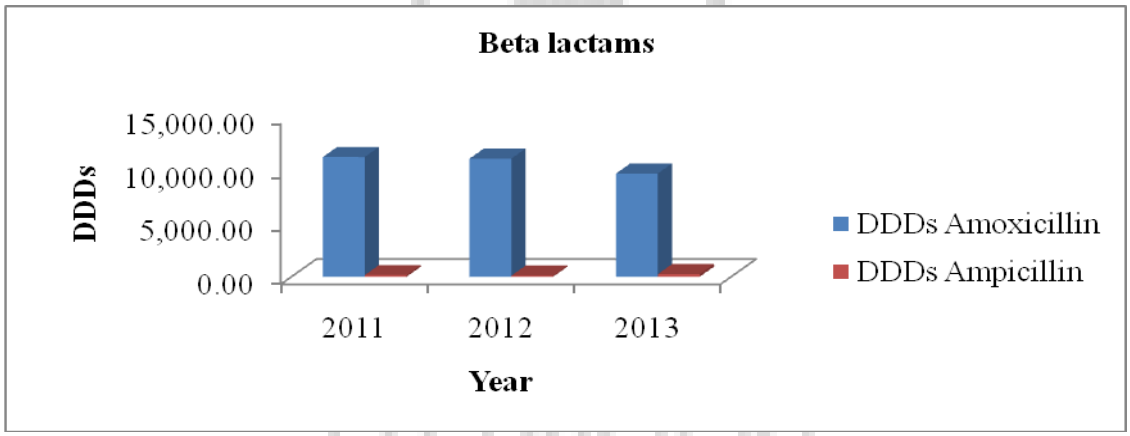

Fig1: Defined daily dose of Beta-lactams

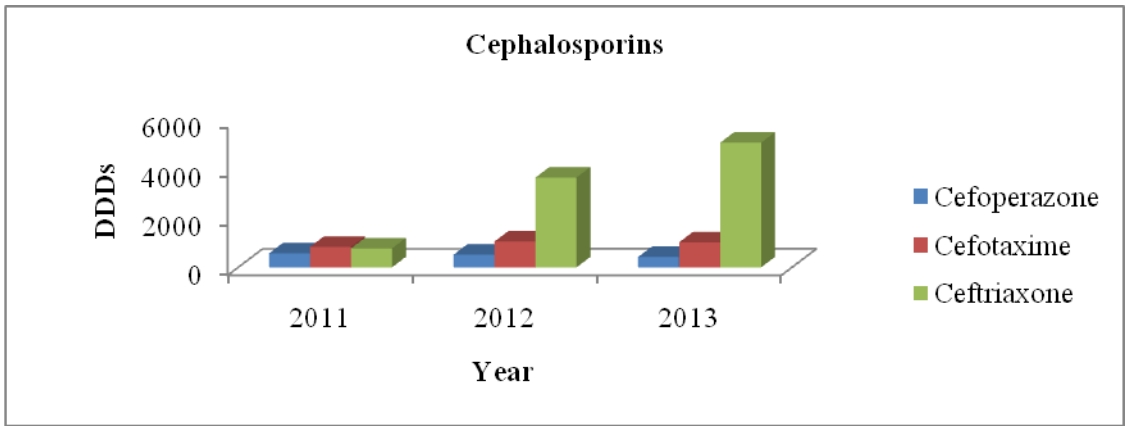

Fig 2: Defined daily dose of Cephalosporins

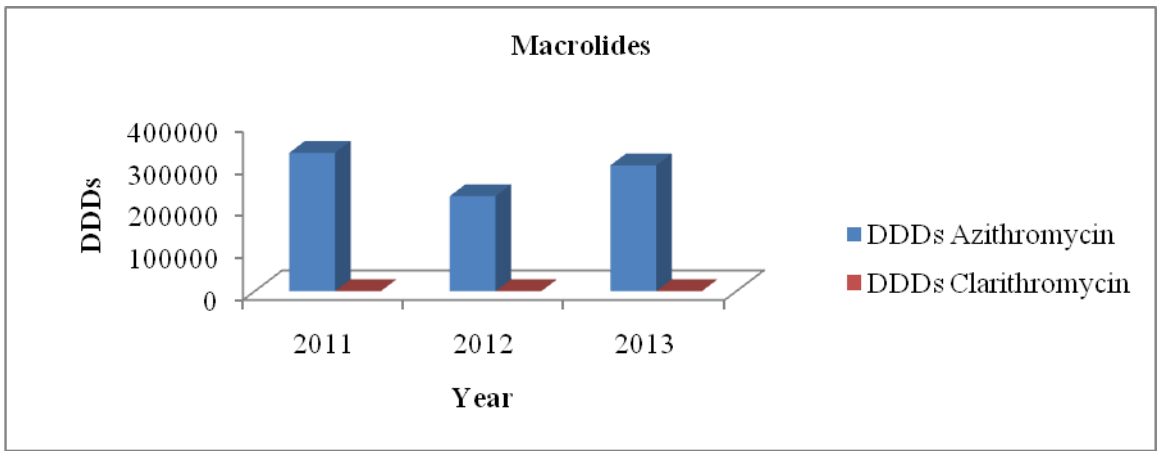

Fig 3: Defined daily dose of Macrolides

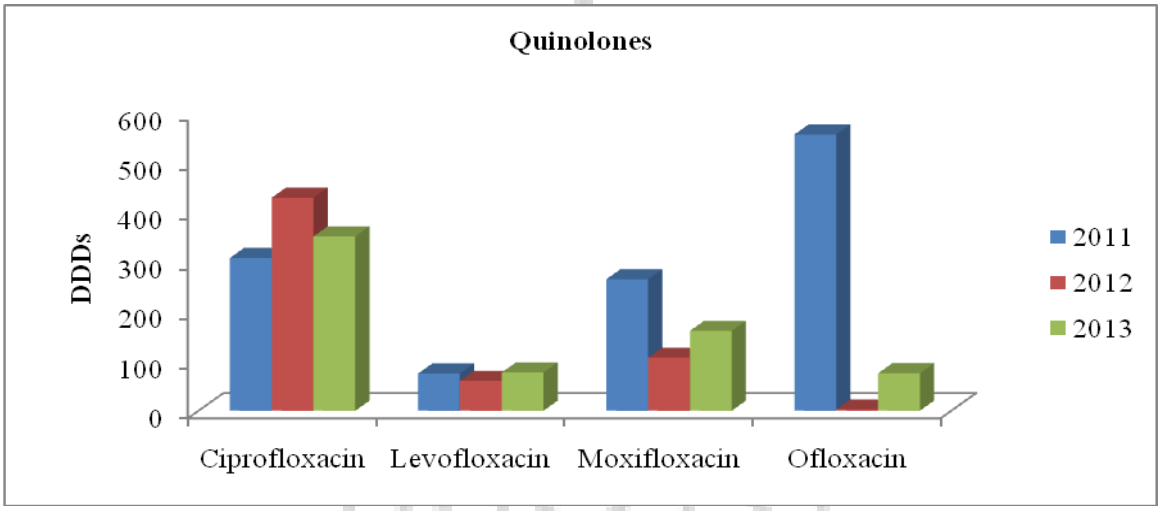

Fig 4: Defined daily dose of Quinolones

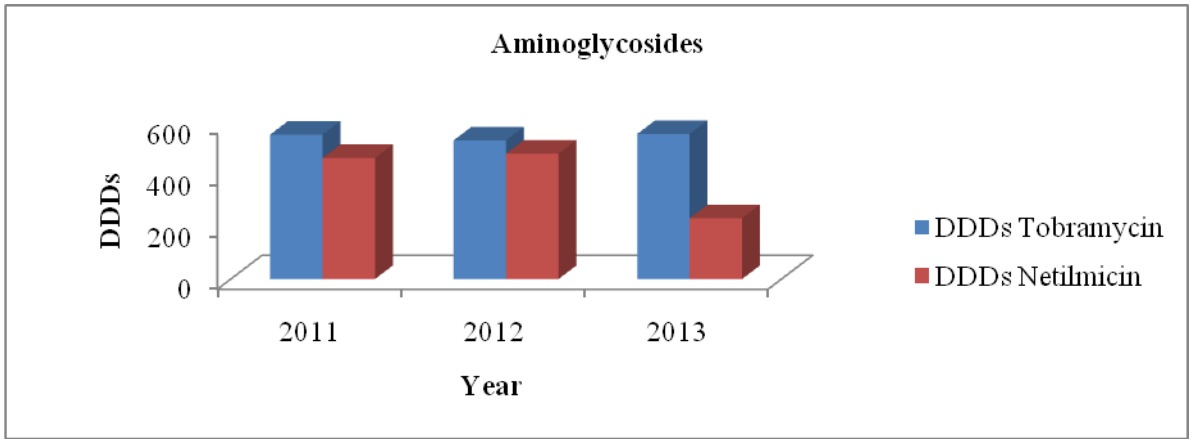

Fig 5: Defined daily dose of Aminoglycosides

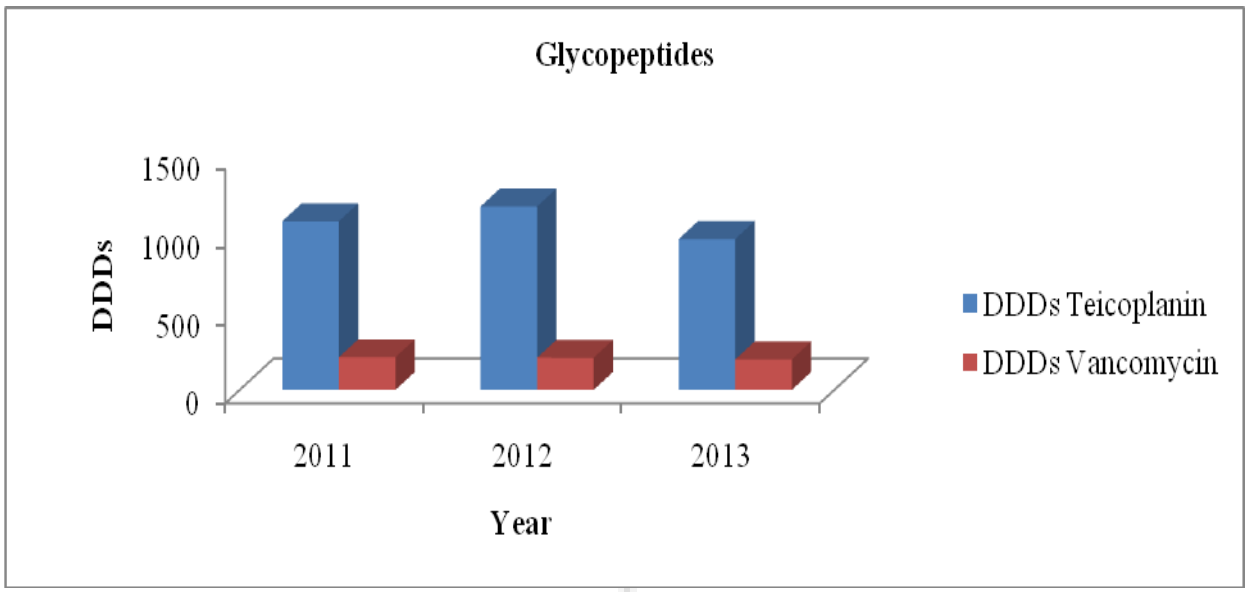

Fig 6: Defined daily dose of Glycopeptides

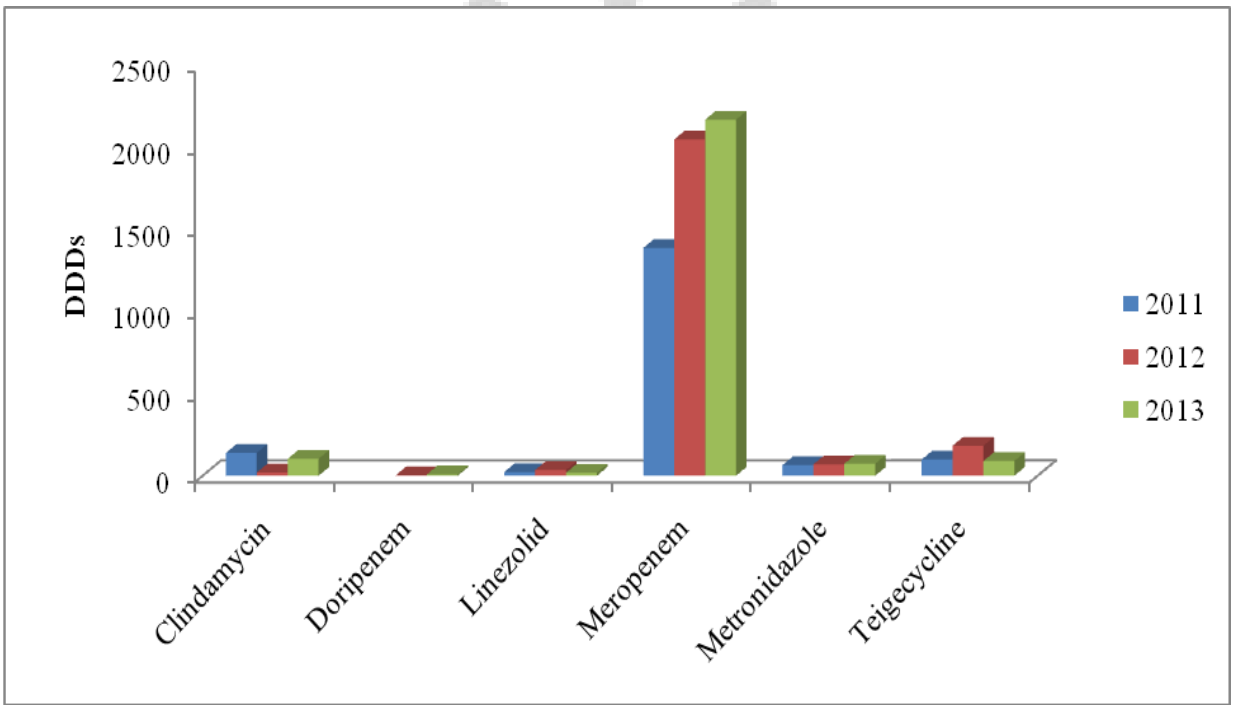

Fig 7: Defined daily dose of Miscellaneous antibiotics

Table 2: The percentage expenditure data of antimicrobials

Sr. no	Antibiotic	Cost (%)		
Year		2011	2012	2013
1	Amoxicillin	11.1	8.9	6.1
2	Ampicillin	0.05	0.03	0.07
3	Azithromycin	0.2	0.12	0.13
4	Cefipime	0.05	0.01	0.1
5	Cefoperazone	2.2	2.1	1.5
6	Cefotaxime	0.5	0.5	0.6
7	Ceftriaxone	0.7	2.4	2.5
8	Ciprofloxacin	0.1	0.2	0.1
9	Clarithromycin	0.4	0.5	0.4
10	Clindamycin	1.1	1	1
11	Doripenem		0.1	0.26
12	Imipenam/ cilastatin	1.2	0.2	0.3
13	Levofloxacin IV 500mg	0.3	0.2	0.2
14	Linezolid	0.1	0.1	0.1
15	Meropenem	28.5	32.5	43.2
16	Metronidazole	1.3	1.1	1
17	Moxifloxacin	0.3	0.1	0.1
18	Netilmicin	1.3	1.1	0.5
19	Ofloxacin	0.3	0.01	0.05
20	Piperacillin / Tazobactum	35	33.4	32
21	Teicoplanin	10	9.3	7.1
22	Tigecyclin	2.5	4.3	1.6
23	Tobramycin	0.3	0.2	0.2
24	Vancomycin	1.9	1.7	1.1

DISCUSSION

There has been a consistent very high increase in the consumption of Meropenem and Ceftriaxone while there is no significant change in the consumption of Metronidazole, Tobramycin, and Vancomycin. Similarly, there has been a consistent decrease in the overall use of Moxifloxacin, Netilmicin, and Ofloxacin. Other antimicrobials have increased consumption in 2012 and then decreased in 2013. Expenditure on antimicrobials though increased because of the cost of high-end antimicrobials, it may be observed that the extent of increase has decreased. (Table 1)

The increase in expenditure from 2011 to 2012 was 23% while the increase from 2012 to 2013 was 17%. The four antimicrobials attributed to the maximum costs. The average percentage contributions to the expenditure are: Meropenem (35%), Piperacillin / Tazobactam (33.3%), Teicoplanin (11.5%) and Amoxicillin (8.7%). The Piperacillin / Tazobactam, Teicoplanin, and Amoxicillin have declined trends in terms of contribution to the total antimicrobial costs but there has been increasing expenditure on account of Meropenem. (Table 2)

The various studies reported on antimicrobial use are from teaching hospitals and the comparison cannot be made. However, further progressive studies made in this hospital later or any other similar hospitals can utilize these data as a reference. The lower figures would indicate at least better health standards if not better prescribing practices.[11]

CONCLUSION

This is first of its kind of study in this private hospital after framing of Antimicrobial Policy at country level, looking into the consumption data of antimicrobials. The study provides the baseline data for comparison later, in order to assess the trend in their use. It has also identified drugs like Meropenem and Piperacillin/Tazobactam which requires further investigation to assess their appropriateness in different clinical settings. This need to be correlated with the hospital's isolated infective organisms' sensitivity reports.

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