A Comparative Study on Efficacy of Selected Antibiotics Prescribed in the Treatment of Bacterial Infections in Paediatric and Neonatal Intensive Care Unit of Tertiary Care Teaching Hospital

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Abstract:

Background: The introduction of antibiotics once reduced human morbidity and mortality caused by these bacterial infections dramatically. A sensitivity analysis is a test that determines the "sensitivity" of bacteria to an antibiotic. It also determines the ability of the drug to kill the bacteria. Cephalosporins and Penicillin are a large group of bactericidal antimicrobials that work via their beta-lactam rings. The beta-lactam rings bind to the penicillin-binding protein and inhibit its activity to synthesize a cell wall, the bacteria die.

Objective: To compare the therapeutic efficacy of the prescribed antibiotics such as Cephalosporins and Penicillin class antibiotics in the treatment of bacterial infections in Pediatric and Neonatal Intensive Care Unit patients.

Methods: This study is a prospective observational study for about 6 months in Pediatric and Neonatal Intensive Care Unit in the Department of Pediatrics. The sample recruitment is done based on the inclusion and exclusion criteria of which a total of 83 samples included.

Result: Among 87 patients, results indicate that penicillin remains effective, cephalosporin therapy produced significantly greater improvements in patient outcomes.

Conclusion: Penicillin therapy was effective with a moderate impact on outcomes, cephalosporin therapy resulted in a substantially greater improvement, as evidenced by larger effect sizes in both parametric and non-parametric analyses. This suggests that cephalosporins were more effective than penicillin in improving patient recovery.

Key Words: Cephalosporins, Penicillin, length of stay, WBC.

1. INTRODUCTION:

The introduction of antibiotics once reduced human morbidity and mortality caused by these bacterial infections dramatically. A bacterium is a single, but complex, cell. It can survive on its own, inside or outside the body. Most bacteria aren't harmful. Bacteria in our intestines (gut) help us to digest our food. But some bacteria can cause infections [2].

A sensitivity analysis is a test that determines the "sensitivity" of bacteria to an antibiotic. It also determines the ability of the drug to kill the bacteria. The results from the test can help to determine which drugs are likely to be most effective in treating your infection. Many bacteria are resistant to common antibiotics. The results of such analysis provide the interpretation as **Susceptible** means the antibiotic is effective against the bacteria, **Resistant** means that it is an ineffective antibiotic and **Intermediate** means a higher dose of the antibiotic is needed to prevent growth. Bacteria synthesize a cell wall that is strengthened by cross-linking peptidoglycan units via penicillin-binding proteins (PBP, peptidoglycan transpeptidase). Cephalosporins and Penicillin are a large group of bactericidal antimicrobials that work via their beta-lactam rings. The beta-lactam rings bind to the penicillin-binding protein and inhibit its activity to synthesize a cell wall, the bacteria die [1].

2. MATERIALS AND METHODS:

This study is a prospective observational study for about 6 months in Pediatric and Neonatal Intensive Care Unit in the Department of Pediatrics at Government Cuddalore Medical College and Hospital. The sample recruitment is done based on the inclusion and exclusion criteria of which a total of 83 samples included. The inclusion criteria of the study are those pediatric patients infected with any of the bacterial infections, the patients with axillary temperature ≥ 98.6º F or history of fever during 24 hours before admission and asymptomatic patients with bacterial growth confirmed in microbial culture sensitivity testing. The excluded population are the patients presented with any general danger signs and symptoms in children, any mixed or mono infection with another causative microorganism, with severe malnutrition, and with history of hypersensitivity reactions or contraindications to any of the medicines being tested or used as alternative treatment. The data collection is carried out by proforma. The analysis of the acquired data are done with the help of tools like Microsoft Excel and JSAP Software. The results are drawn and correlated with the published articles.

3. RESULTS:

a. Culture Sensitivity:

Ampicillin shows highest resistance for about 44 patients and Gentamicin shows highest sensitive for about 39 patients.

Table 1. Distribution of patients based on culture sensitivity results

S. No	Drug	Sensitive	Resistance
1	Erythromycin	3	21

2	Tetracycline	33	23
3	Oxacillin	0	35
4	Ampicillin	1	44
5	Amikacin	36	24
6	Linezolid	17	5
7	Gentamicin	39	8
8	Efeperazone	1	9
9	Piperacillin	1	3
10	Piperacillin Tazobactam	29	21
11	Nitrofurantoin	15	6
12	Norfloxacin	9	10
13	Ciprofloxacin	28	6
14	Cefotaxime	1	0
15	Ceftazidime	0	6
16	Ceftriaxone	8	30
17	Cundamycin	13	6
18	Tobramycin	3	3
19	Chloramphenicol	20	13
20	Co-trimoxazole	24	35
21	Amoxicillin	0	4
22	Amoxicillin Clavulanate	0	2
23	Polymixin B	5	0

3.2 Bacteria Identified:

MRSA is most infected Gram- Positive Bacteria i.e 58% and E. coli is the most infected Gram- Negative Bacteria i.e 13%.

S. No	Organism	No. of Patients	Percentage
1	*Klebsiella*	8	10%
2	*E. coli*	11	13%
3	*Pseudomonas*	5	6%
4	*Acinetobacter*	2	3%
5	*Aeromonas*	2	3%
6	*Staphylococcus*	1	1%
7	*Enterobacter cloacae*	1	1%
8	*Citrobacter*	2	2%
9	*Klebsiella oxytoca*	1	1%
10	*Enterobacter aerogens*	1	1%

11	*Proteus mirabilis*	1	1%
12	*MRSA*	48	58%
Grand Total		83	100%

Table 2. Distribution of patients based on bacteria identified

Figure 1: *MRSA* Antibiogram

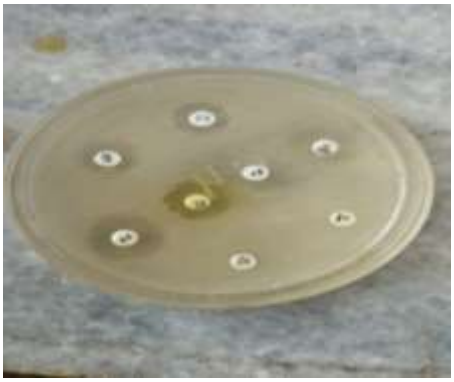

Figure 2: *E. Coli* Antibiogram

3.3 Correlation

Table 3. Pearson's Correlations

Variable Pair	Group	Pearson's *r*	*p*
Age – Day 1 WBC	PAP	–0.494	< .001
Age – Length of Stay	PAP	–0.505	< .001
Age – Day 1 WBC	CAP	–0.534	.001
Age – Length of Stay	CAP	–0.570	< .001
Day 1 WBC – Length of Stay	PAP	0.649	< .001
Day 1 WBC – Length of Stay	CAP	0.797	< .001

Scatter plots

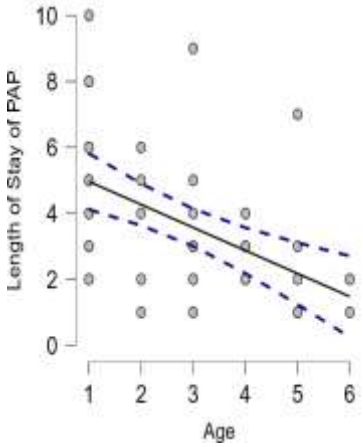

Figure 3: Age-Length of stay of PAP

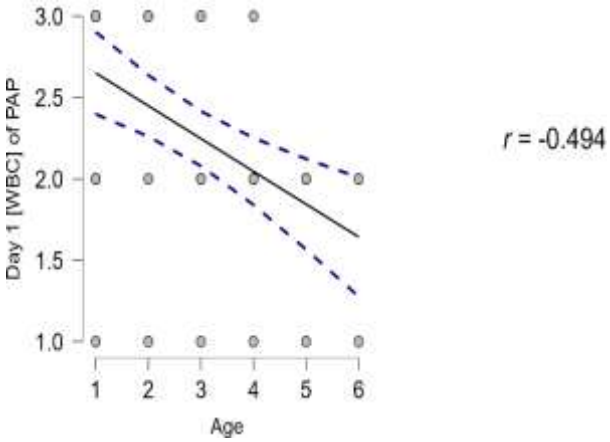

Figure 4: Age-Day 1 [WBC] of PAP

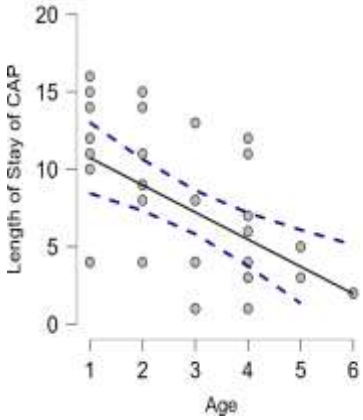

Figure 5: Age-Length of stay of CAP

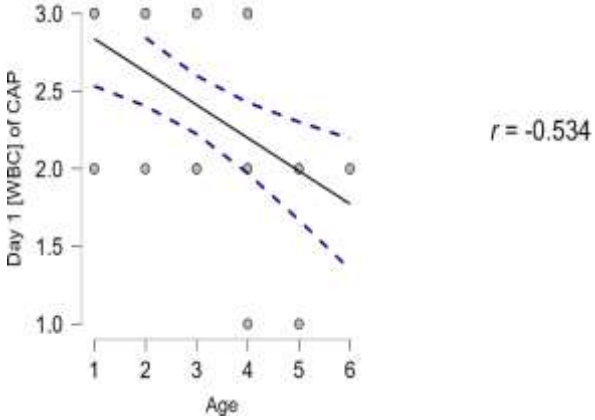

Figure 6: Age-Day 1 [WBC] of CAP

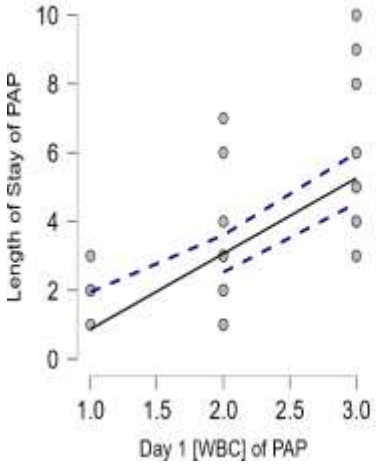

Figure 7: Length of Stay of PAP-Day 1 [WBC] of PAP

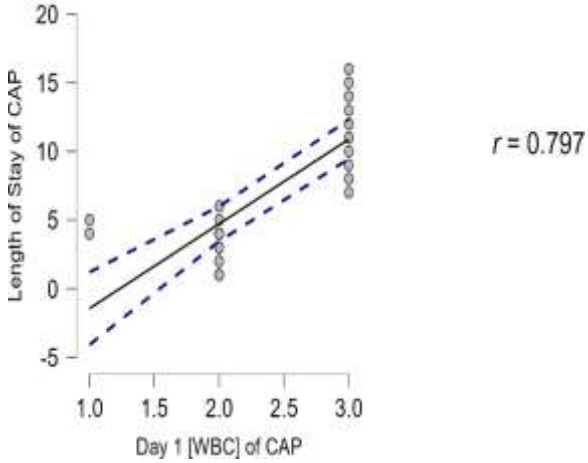

Figure 8: Day 1 [WBC] of CAP-Length of Stay of CAP

3.3.1 Age and Clinical Variables

For **Penicillin Acquiring Patients (PAP)**, there was a significant negative correlation between age and Day 1 white blood cell count (WBC), $r = –.494$, $p < .001$, and between age and length of hospital stay, $r = –.505$, $p < .001$. These results indicate that **younger patients tended to have higher WBC levels at admission and longer hospital stays**, while older patients had lower WBC counts and shorter stays.

Similarly, for **Cephalosporin Acquiring Patients (CAP)**, age was significantly negatively correlated with Day 1 WBC, $r = –.534$, $p = .001$, and with length of hospital stay, $r = –.570$, $p < .001$. This pattern mirrors that of PAP patients, again suggesting that **younger patients experienced more severe infections (higher WBC) and required longer hospitalization compared to older patients**.

3.3.2 Day 1 WBC and Length of Stay

Within both groups, there was a strong positive correlation between Day 1 WBC and length of hospital stay. For PAP patients, $r = .649$, $p < .001$, and for CAP patients, $r = .797$, $p < .001$. These findings demonstrate that **higher infection severity at admission (as reflected by elevated WBC counts) was strongly associated with longer hospitalization duration**. The relationship was especially strong in the CAP group.

Younger patients tended to present with higher infection severity (WBC) and required longer hospitalization in both PAP and CAP groups. Higher Day 1 WBC was strongly correlated with longer hospital stays, particularly in CAP patients ($r = .797$, very strong effect). While the direction of correlations was consistent across groups, the relationships were somewhat stronger in the **CAP group**, indicating that in cephalosporin patients, infection severity (WBC) was a particularly strong predictor of hospital stay length.

Table 4. Paired Students T Test with Wilcoxon Signed-Rank Test

Time Points	Test	Statistic	z	df	p	*Effect Size	*SE Effect Size
Before & After Treatment of PAP	Student	3.18		49	.003	0.45	0.217
	Wilcoxon	297.000	2.60		.004	0.57	0.217
Before & After Treatment of CAP	Student	4.92		32	< .001	0.86	0.225
	Wilcoxon	161.500	3.31		< .001	0.89	0.262

*Effect sizes for the Students *t*-test are reported as Cohen's *d*. Effect sizes for the Wilcoxon signed-rank test are reported as matched rank biserial correlation (*r*). SE = Standard Error of the effect size.

3.3.3 Paired-Samples Analysis of PAP (Penicillin Acquiring Patients)

A paired-samples *t*-test was conducted to evaluate the effect of penicillin-based treatment on clinical outcomes. Results indicated that the values after treatment was

significantly higher than before treatment $t(49) = 3.18$, $p = .003$, Cohen's $d = 0.45$. This represents a **moderate effect size**, suggesting that penicillin treatment produced measurable improvements in patient outcomes.

The non-parametric Wilcoxon signed-rank test confirmed these findings, $z = 2.60$, $p = .004$, with a matched rank biserial correlation of $r = 0.57$ (moderate effect). Together, these results provide consistent evidence that penicillin therapy led to a moderate but significant clinical improvement.

3.3.4 Paired-Samples Analysis of CAP (Cephalosporin Acquiring Patients)

A paired-samples *t*-test was conducted to examine the effect of cephalosporin-based treatment. Results showed a significant increase in values after treatment compared to before treatment $t(32) = 4.92$, $p < .001$, Cohen's $d = 0.86$. This indicates a **large effect size**, suggesting that cephalosporin therapy was highly effective in improving clinical outcomes.

Similarly, the Wilcoxon signed-rank test yielded a significant result, $z = 3.31$, $p < .001$, with a matched rank biserial correlation of $r = 0.89$, also reflecting a **large effect size**. Thus, cephalosporin treatment demonstrated robust improvements.

3.3.5 Comparison of PAP vs. CAP Outcomes

Although both groups exhibited statistically significant improvements, the **CAP group (cephalosporin patients)** showed a **larger effect size** (Cohen's $d = 0.86$; $r = 0.89$) compared to the **PAP group (penicillin patients)** (Cohen's $d = 0.45$; $r = 0.57$). This indicates that while both penicillin and cephalosporin treatments were effective, **cephalosporin therapy resulted in greater overall improvement** than penicillin therapy.

4. DISCUSSION:

The present study aimed to evaluate and compare the clinical effectiveness of penicillin-based and cephalosporin-based therapies in treating patients with bacterial infections, with a focus on changes in infection severity and hospitalization outcomes. Our findings provide compelling evidence that both treatment approaches led to significant clinical improvement; however, cephalosporin therapy demonstrated a notably greater effect [8,9].

4.1 Age and Clinical Indicators

A significant negative correlation was observed between **age and Day 1 WBC count**, and between **age and length of hospital stay**, in both Penicillin Acquiring Patients (PAP) and Cephalosporin Acquiring Patients (CAP). These results suggest that **younger patients tended to present with more severe infections**—as indicated by elevated WBC counts—and required **longer hospitalization periods**. This pattern was consistent across both treatment groups, reflecting the possibility that younger individuals either mount a stronger inflammatory response or are more frequently hospitalized for more severe infections.

Furthermore, the strength of these correlations was **slightly greater in the CAP group**, indicating that age-related differences in infection severity and treatment response may be more pronounced among patients receiving cephalosporins [7,10].

4.2 Day 1 WBC and Length of Stay

There was a **strong positive correlation** between **Day 1 WBC counts** and **length of hospital stay** in both PAP and CAP groups. Notably, this relationship was **stronger in the CAP group (r = .797)** than in the PAP group (r = .649), indicating that initial infection severity was a particularly strong predictor of clinical course and resource utilization among cephalosporin-treated patients. This finding reinforces the clinical importance of early WBC levels as a marker of disease severity and a potential predictor of hospitalization needs.

4.3 Treatment Effectiveness

Both treatment groups exhibited statistically significant improvements in clinical measures following therapy, as indicated by both **paired-samples t-tests** and **Wilcoxon signed-rank tests**. However, effect sizes clearly favoured cephalosporin therapy:

- **Penicillin Group (PAP)**:
  - Cohen's d = 0.45 (moderate effect)
  - Wilcoxon r = 0.57 (moderate effect)
- **Cephalosporin Group (CAP)**:
  - Cohen's d = 0.86 (large effect)
  - Wilcoxon r = 0.89 (large effect)

These results indicate that while penicillin remains effective, **cephalosporin therapy produced significantly greater improvements** in patient outcomes. This is consistent with prior studies (e.g., Stan et al.,[4] Gooch et al.,[5] Isabelle et al.,[6]) which have demonstrated superior bacteriological and clinical efficacy of cephalosporins compared to penicillin in various infections.

A study by Gerber et al., found that **cefadroxil** was well tolerated and as effective as oral penicillin V [3]. Our study further supports these findings by showing that patients treated with **cephalosporins** performed better than those treated with **penicillin**, based on a **paired sample analysis**. This analysis revealed that patients receiving cephalosporins exhibited a greater **effect size** compared to those receiving penicillin.

5. CONCLUSION:

The present analysis demonstrated that both **Penicillin Acquiring Patients (PAP)** and **Cephalosporin Acquiring Patients (CAP)** showed significant improvement following treatment. While penicillin therapy was effective with a moderate impact on outcomes, cephalosporin therapy resulted in a substantially greater improvement, as evidenced by larger effect sizes in both parametric and non-parametric analyses. This suggests that **cephalosporins were more effective than penicillin in improving patient recovery**. Correlation analyses

further revealed that **younger patients tended to present with higher Day 1 WBC counts and required longer hospital stays**, indicating more severe infection and prolonged recovery compared to older patients. Moreover, Day 1 WBC counts were strongly and positively associated with length of stay in both groups, with this relationship being particularly strong in CAP patients. This highlights the predictive value of baseline WBC in determining recovery time.

6. RECOMMENDATION:

Both treatment groups showed significant improvement. However, the **Cephalosporin Acquiring Patients (CAP)** group exhibited **greater improvement and stronger effect sizes** compared to the **Penicillin Acquiring Patients (PAP)** group, suggesting that cephalosporins were more effective in improving clinical outcomes. Since cephalosporin therapy demonstrated a larger effect size and stronger clinical improvement compared to penicillin, clinicians may consider cephalosporins as a more effective treatment option in similar patient populations, especially in cases presenting with higher infection severity. Younger patients were observed to have higher infection severity and longer hospitalization. This highlights the need for closer monitoring and possibly more aggressive therapeutic strategies for younger populations. Also, individualized treatment plans that combine effective antibiotic selection with early supportive interventions (hydration, nutrition, comorbidity management) may improve recovery outcomes.

Future research should include larger and more diverse patient samples to confirm these findings and enhance generalizability. Tracking patient outcomes beyond discharge would help evaluate long-term recovery differences between penicillin and cephalosporin therapy.

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