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Clinical Audit on Management of Community-Acquired Pneumonia in Pediatric Intensive Care Unit

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Abstract

Introduction: Paediatric respiratory disease is an important cause of morbidity in both the developing as well as the developed world. Community acquired pneumonia (CAP) means that an infection of the lung caused by multiple microorganisms acquired outside the hospital setting, leading to inflammation of the lung tissue. It is typically associated with fever and respiratory symptoms such as cough and tachypnea, but symptoms may be non-specific in young children. Radiographic changes may be useful to confirm the diagnosis. It remains an important cause of death in children throughout the world, especially in developing countries.

Patients and methods Clinical audit on management of Community Acquired Pneumonia (CAP) among children admitted in the pediatric intensive care unit (PICU) in the period from 1st of January to 31st of December 2016. According to the guidelines of Community Acquired Pneumonia (CAP) in infants and children recommended by the Pediatric Infectious Disease Society and the Infectious Diseases Society of America, August 2011.

Results: Our study was done on children with Community Acquired Pneumonia and was admitted to the pediatric intensive care unit (PICU), Assuit University Children Hospital in in the period from 1st of January to 31st of December 2016. Our study included sixty cases of them were 36 cases (60%) and 24 cases (40%). Their ages ranging from 3 months up to 17 years. Fifty five out of sixty cases (91.7%) were presented with history of fever while forty five cases (75%) were presented with history of cough. According to WHO guidelines for criteria of respiratory distress in children with pneumonia the most common sign of respiratory distress was pulse oximetry measurement <90% on room air as it was in fifty-two cases (86.7%), followed by tachypnea was in forty four cases (73.3%), altered mental status in thirty-five cases (58.3%) and chest retraction in twenty-five cases (41.7%), grunting was in twenty-three cases (38.3%), dyspnea in eighteen cases (30%). Apnea was in fifteen cases (25%) while there was no case presented with nasal flaring.

Keywords: Community acquired pneumonia; Pediatric intensive care unit

Abbreviations: CAP: Community Acquired Pneumonia; PICU: Pediatric Intensive Care; WHO: World Health Organization

Introduction

CAP defined clinically by the presence of signs and symptoms of pneumonia in a child who was completely healthy before the onset of the disease due to an acute infection (less than 14 days duration) of the lower respiratory system .CAP usually occurs below terminal bronchioles leading to cough or difficult breathing, tachypnea and or lower chest wall in drawing [1]. A more practical term - acute lower respiratory infection (ALRI) - is preferred, reflecting the difficulties in obtaining a chest radiograph, especially in rural areas [2].

Pneumonia is the most cause of death worldwide of children under age of five years (Figures 1-4). The application of safe, effective and affordable interventions has reduced pneumonia mortality to one million in 2013 after it was 4 million in 1981 [3].

The aim of the study is to evaluate the following using the 2011 pediatric CAP guidelines in children admitted in the pediatric intensive care unit (PICU) in the period from 1st January to 31st December 2016 as the reference standard where applicable.

Inclusion criteria:

- Age older than 3 months.
- Not Hospitalized.

Exclusion criteria:

- Immune deficiency.
- Chronic lung disease (e.g. cystic fibrosis).

The guideline includes: Indication of Admission at pediatric Intensive Care Unit (ICU) or a Unit with Continuous Cardio-respiratory Monitoring:

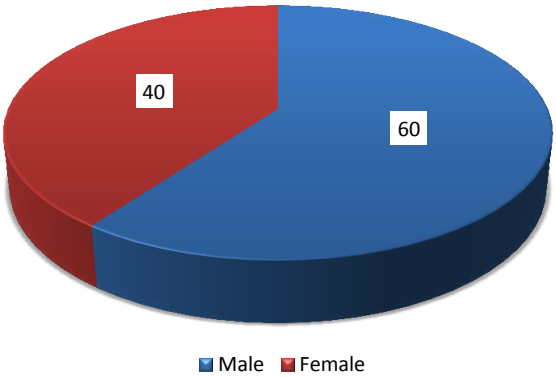

Figure 1: Sex of studied cases.

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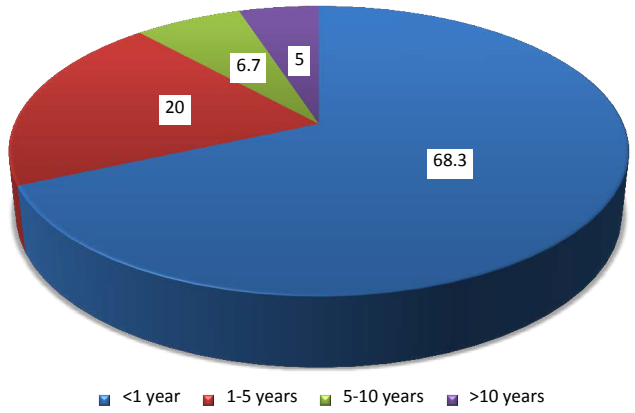

Figure 2: Age of studied cases.

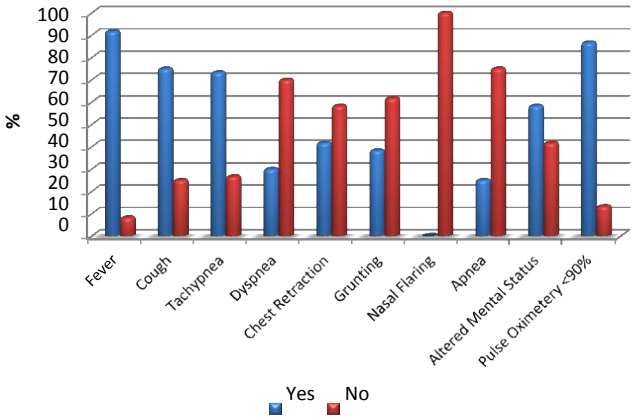

Figure 3: Percentage frequency of significant items of history and examination among studied cases.

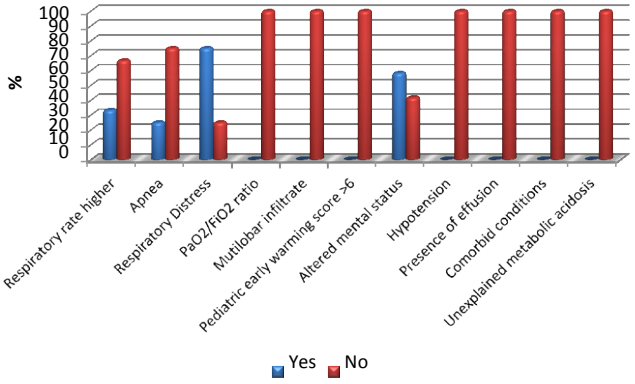

Figure 4: Minor criteria for admission at pediatric intensive care unit.

Major criteria:

- Need to invasive mechanical ventilation.
- Fluid refractory shock.
- Acute need for Nasal intermittent positive pressure ventilation (*NIPPV*).
- Hypoxemia requiring Fraction of Inspired Oxygen more than inspired concentration or flow feasible in general care area.

Minor criteria:

- Respiratory rate higher than WHO classification for age.
- Apnea.
- Signs of respiratory distress (e.g. retractions, dyspnea, nasal flaring, grunting).
- PaO_2/FiO_2 ratio below 250.
- Multilobar infiltrates.
- Pediatric Early Warning score (PEWS) more than 6.
- Altered mental status.
- Hypotension.
- Presence of effusion.
- Unexplained metabolic acidosis [4].

Diagnostic Testing for Pediatric Cap

Pulse oximetry

- All children presented with signs and symptoms pneumonia and suspected hypoxemia.
- Hypoxemia (SpO_2<92% with inspired oxygen of >0.50) [4].

Chest radiography

Initial Chest Radiographs: All patients need hospital admission with pneumonia; to record presence, size and character of infiltrates and document the presence of complications that may need further interventions.

Follow-up Chest Radiograph:

- For poor clinical response, clinical deterioration within 48–72 hours after receiving antibiotics.
- In presence of complicated pneumonia which accompanied with severe respiratory distress or poor general condition [4].

Blood cultures

Requiring hospitalization for moderate and severe bacterial CAP [4].

Testing for atypical bacteria

Mycoplasma pneumonia: in the presence of signs/symptoms consistent with but not classic for Mycoplasma; can help guide antibiotic selection [4].

Sputum gram stain and culture

In hospitalized children who can produce sputum used for culture and gram stain [4].

Tracheal aspirates

In children with respiratory distress and need to mechanical ventilation; at the time of initial endotracheal tube insertion tracheal aspirates should be taken [4].

Bronchoscopic or blind protected specimen brush sampling, bronchoalveolar lavage (BAL), percutaneous lung aspiration, or open lung biopsy

For the immunocompromised children with symptoms and signs

of severe pneumonia if initial investigations are negative [4].

Testing for Viral Pathogens

Influenza

If influenza test is positive, it may be useful in limitation of the need for more investigations and antimicrobial use and guiding to use of antiviral agents in admitted chidren [4].

Complete blood count

A complete blood count should be done for all (Figure 5) patients admitted with severe pneumonia, for clinical correlation between the clinical examination and other laboratory and imaging investigations [4].

Acute phase reactant

In patients with severe CAP which need to hospital admission or those with complications, acute-phase reactants may be useful in conjunction with clinical findings to assess the response to treatment [4].

Antimicrobial therapy for specific pathogens

1. In child who is fully immunized or in regions that do not show high level pneumococcal penicillin resistance:

2. **Ampicillin or Penicillin G** are first-line.

a. **Azithromycin** for suspected atypical pneumonia.

b. **Vancomycin or clindamycin** should be added when *S. aureus* is suspected by labs, clinical findings or imaging.

3. **Ceftriaxone or cefotaxime** are alternatives [4].

4. In child who is not fully immunized or in regions that show high-level pneumococcal penicillin resistance:

5. **Ceftriaxone or cefotaxime** also useful for life-threatening infections and empyema [4].

6. **Pneumococcal Penicillin resistance:** According to **Minimum Inhibitory** Concentration Report (MIC): *Streptococcus pneumoniae* with MICs for penicillin <2.0 µg/mL:

Ampicillin (150-200 mg/kg/day every 6 h) or **penicillin** (200000-250 000 U/kg/day every 4-6 h) are preferred.

Cefotaxime (150 mg/kg/day every 8 h), **clindamycin** (40 mg/kg/day every 6-8 h) or **vancomycin** (40-60 mg/kg/day every 6-8 h) are alternatives [4].

7. ***S. pneumoniae* resistant to penicillin, with MICs >4.0 µg/ml: Ceftriaxone** (100 mg/kg/day every 12-24 h) is preferred; **Ampicillin** (300-400 mg/kg/day every 6 h), **levofloxacin** (Figures 6-8) (16-20 mg/kg/day every 12 h for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5-16 years old; maximum daily dose, 750 mg) or **linezolid** (30 mg/kg/day every 8 h for children <12 years old and 20 mg/kg/day every 12 h for children >12 years old); may also be effective: **clindamycin** (40 mg/kg/day every 6-8 h) or **vancomycin** (40-60 mg/kg/day every 6-8 h) [4].

8. **Specific treatment for CAP**

a ***Haemophilus influenza*: Ampicillin** (150-200 mg/kg/day every 6 h) if b-lactamase negative, **ceftriaxone** (50-100 mg/kg/day every 12-24 h) if b-lactamase producing or **cefotaxime** (150 mg/kg/day every 8 h) are preferred; **Ciprofloxacin** (30 mg/kg/day every 12 h) or **levofloxacin** (16-20 mg/kg/day every 12 h for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5 to 16 years old; maximum daily dose, 750 mg) may be used [4].

b ***Mycoplasma pneumoniae*: Azithromycin** (10 mg/kg intervenously on days 1 and 2 of therapy; then oral therapy if possible) is recommended;

Erythromycin lactobionate (20 mg/kg/day every 6 h) or **levofloxacin** (16-20 mg/kg/day every 12 h; maximum daily dose, 750 mg) may be used [4].

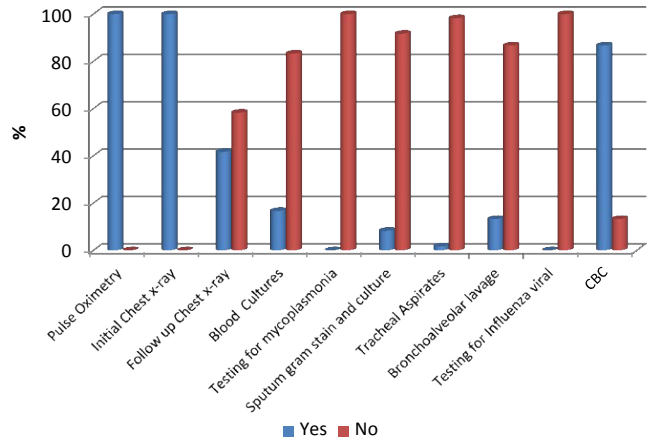

Figure 6: Diagnostic testing for pediatric CAP.

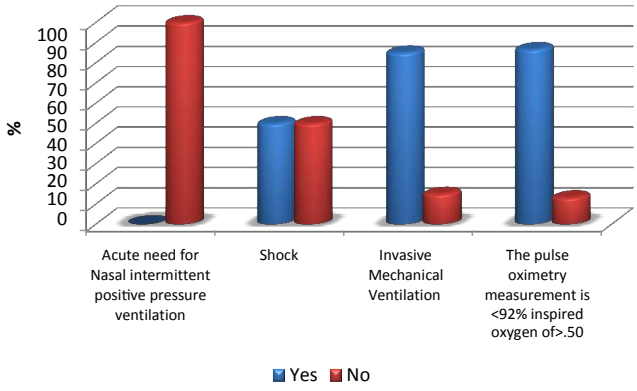

Figure 5: Major criteria for admission at pediatric intensive care unit.

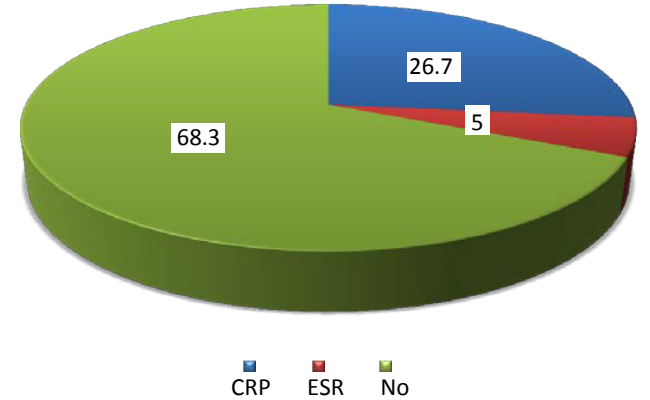

Figure 7: Acute phase reactant.

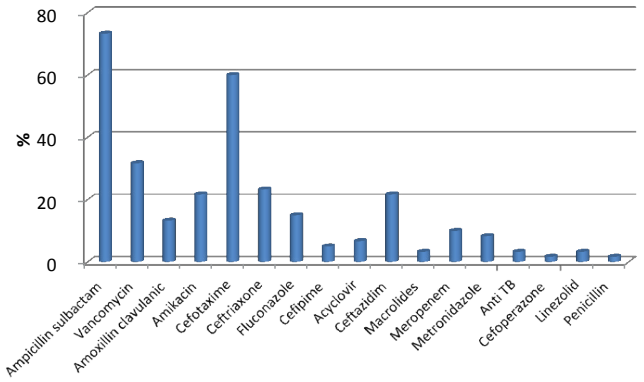

Figure 8: Antimicrobial therapy.

c ***Chlamydia trachomatis*: Azithromycin** (10 mg/kg intervenously on days 1 and 2 of therapy; then oral therapy if possible) is recommended;

Erythromycin lactobionate (20 mg/kg/ day every 6 h intervenously) or **levofloxacin** (16-20 mg/kg/day in 2 doses for children 6 months to 5 years old and 8-10 mg/kg/day once daily for children 5 to 16 years old; maximum daily dose,750 mg)may be used [4].

d **Group A Streptococcus: Penicillin** (100 000-250 000 U/kg/ day every 4-6 h) or **ampicillin** (200 mg/kg/day every 6 h) are preferred;

Ceftriaxone (50-100 mg/kg/day every 12-24 h) or **cefotaxime** (150 mg/kg/day every 8 h); (Tables 1-4) may also be effective: **clindamycin**, if susceptible (40 mg/kg/day every 6-8 h) or **vancomycin** b (40-60 mg/ kg/day every 6-8 h) may be used [4].

e. ***Stapyhylococcus aureus*, methicillin susceptible: Cefazolin** (150 mg/kg/day every 8 h) or **Oxacillin** (150-200 mg/kg/day every 6-8 h) are recommeded;

Clindamycin (40 mg/kg/day every 6-8 h) or **vancomycin** (40-60 mg/kg/day every 6-8 h) may be used [4].

f. ***S. aureus*, methicillin resistant, susceptible to clindamycin: Vancomycin** (40-60 mg/kg/day every 6-8 h) or **clindamycin** (40 mg/ kg/day every 6-8 h) are recommeded;

Linezolid (30 mg/kg/day every 8 h for children <12 years old and 20 mg/kg/day every12 h for children >12 years old) may be used [4].

g. ***S. aureus*, methicillin resistant, resistant to clindamycin:**

Vancomycin (40-60 mg/kg/day every 6-8 h) is recommeded; **Linezolid** (30 mg/kg/day every 8 h for children <12 years old and 20 mg/kg/day every 12 h for children >12 years old) may be used.

Duration of antimicrobial therapy for CAP: The recommended duration is 10 days.

Discussion

The main purpose of these guidelines is to decrease morbidity and mortality rates for CAP in children by presenting recommendations for clinical management that can be applied in patients if deemed appropriate by the treating stuff.

Objectives

To evaluate the following using the 2011 pediatric CAP guidelines in children admitted in the pediatric intensive care unit (PICU) in the period from 1st January to 31st December 2016 as the reference standard where applicable.

	No.	%
Age	60	100
<1 year	41	68.3
1-5 years	12	20
5-10 years	4	6.7
>10 years	3	5
Range in months	3-204	
Mean ± SD	2.1 ± 3.5	
Sex		
Male	36	60
Female	24	40

Table 1: Demographic data of the studied group (Mean ± SD).

	No.	%
Fever		
Yes	55	91.7
No	5	8.3
Cough		
Yes	45	75
No	15	25
Tachypnea		
Yes	44	73.3
No	16	26.7
Dyspnea		
Yes	18	30
No	42	70
Chest Retraction		
Yes	25	41.7
No	35	58.3
Grunting		
Yes	23	38.3
No	37	61.7
Nasal Flaring		
Yes	0	0
No	60	100
Apnea		
Yes	15	25
No	45	75
Altered Mental Status		
Yes	35	58.3
No	25	41.7
Pulse Oximetery <90% on room air		
Yes	52	86.7
No	8	13.3

Table 2: Percentage frequency of significant items of history and Examination among studied cases:

Demographic data

Our study was done on children with Community Acquired Pneumonia and was admitted to the pediatric intensive care unit (PICU), Assuit University Children Hospital in in the period from 1st January to 31st December 2016.

Our study included sixty cases of them were 36 cases (60%) and 24 cases (40%). Their ages ranging from 3 months up to 17 years.

	No.	%
Respiratory rate higher WHO classification for age		
Yes	20	33.3
No	40	66.7
Apnea		
Yes	15	25
No	45	75
Respiratory Distress		
Yes	45	75
No	15	25
PaO_2/FiO_2 ratio below 250		
Yes	0	0
No	60	100
Mutilobar infiltrate		
Yes	0	0
No	60	100
Pediatric early warming score >6		
Yes	0	0
No	60	100
Altered mental status		
Yes	35	58.3
No	25	41.7
Hypotension		
Yes	0	0
No	60	100
Presence of effusion		
Yes	0	0
No	60	100
Comorbid conditions		
Yes	0	0
No	60	100
Unexplained metabolic acidosis		
Yes	0	0
No	60	100

Table 3: Minor criteria for admission at pediatric intensive care unit.

According to history and examination

Fifty five out of sixty cases (91.7%) were presented with history of fever while forty-five cases (75%) were presented with history of cough.

According to WHO guidelines for criteria of respiratory distress in children with pneumonia the most common sign of respiratory distress was pulse oximetry measurement <90% on room air as it was in fifty-two cases (86.7%), followed by tachypnea was in forty-four cases (73.3%), altered mental status in thirty-five cases (58.3%) and chest retraction in twenty-five cases (41.7%), grunting was in twenty-three cases (38.3%), dyspnea in eighteen cases (30%). Apnea was in fifteen cases (25%) while there was no case presented with nasal flaring.

According to indication of admission at pediatric intensive care unit

Minor criteria: Respiratory distress was present in forty-five cases (75%), altered mental status in thirty-five cases (58.3%), Respiratory rate greater than WHO classification for age was in twenty cases (33.3%) and apnea was in fifteen cases (25%).

There was no case with paO_2/FiO_2 ratio below 250 nor multilobar infiltrates nor Pediatric Early Warning score (PEWS) more than 6 nor presence of effusion nor comorbid conditions nor unexplained metabolic acidosis.

Major criteria: The pulse oximetry measurement is <92% inspired oxygen of >0.50 was the most common indication of admission to the pediatric intensive care unit (PICU) as it was present in fifty-two cases (86.7%) while fifty-one cases (85%) required invasive ventilation via a nonpermanent artificial airway (e.g. endotracheal tube). Shock was present in thirty cases (50%) but there was no case needed for nasal intermittent positive pressure ventilation.

According to diagnosis testing for pediatric CAP

Pulse Oximetry and Initial Chest Radiographs were done for sixty cases (100%) while Follow-up Chest Radiographs was done for twenty-five cases (41.7%).

Complete Blood Count (CBC) was the commonest laboratory test as it was done for fifty-two cases (86.7), other laboratory tests were used as CRP was done for sixteen cases (26.7%) while ESR was done for three cases (5%) and Blood cultures were done for ten cases (16.7%).

Bronchoalveolar lavage (BAL) was done for eight cases (13.3%) while Sputum gram stain and culture was done for five cases (8.3%) but Tracheal Aspirates was done for only one case (1.7%).

Testing for mycoplasma and Testing for Influenza viral were not done for any case.

According to antimicrobial therapy

All cases received combined empiric antimicrobial therapy. Ampicillin sulbactam was the commonest empiric antimicrobial therapy as forty four cases (73.3%) received it followed by cefotaxime in thirty (Tables 5 and 6) sex (60%), nineteen cases received vancomycin (31.7%), fourteen cases (23%) received ceftriaxone.

Thirteen cases (21.7%) received amikacin, also ceftazidim was received in thirteen cases (21.7%).

Nine cases (15%) received Fluconazole, eight cases (13.3%) received Amoxicillin Clavulanic, six cases (10%) received Meropenem, five cases (8.3%) received Metronidazole, four cases (6.7%) received Acyclovir while three cases (5%) received Cefipime.

Two cases (3.3%) received Macrolides, also Anti TB and linezolid received in two cases.

	No.	%
Acute need for Nasal intermittent positive pressure ventilation		
Yes	0	0
No	60	100
Shock		
Yes	30	50
No	30	50
Invasive Mechanical Ventilation		
Yes	51	85
No	9	15
The pulse oximetry measurement is <92% inspired oxygen of >0.50		
Yes	52	86.7
No	8	13.3

Table 4: Major criteria for admission at pediatric intensive care unit.

	No.	%
Pulse Oximetry		
Yes	60	100
No	0	0
Initial Chest x-ray		
Yes	60	100
No	0	0
Follow up Chest x-ray		
Yes	25	41.7
No	35	58.3
Blood Cultures		
Yes	10	16.7
No	50	83.3
Testing for mycoplasmonia		
Yes	0	0
No	60	100
Sputum gram stain and culture		
Yes	5	8.3
No	55	91.7
Tracheal Aspirates		
Yes	1	1.7
No	59	98.3
Bronchoalveolar lavage		
Yes	8	13.3
No	52	86.7
Testing for Influenza viral		
Yes	0	0
No	60	100
CBC		
Yes	52	86.7
No	8	13.3
Acute Phase Reactant		
CRP	16	26.7
ESR	3	5
No	41	68.3

Table 5: Diagnostic testing for pediatric CAP:

	No.	%
Ampicillin sulbactam	44	73.3
Vancomycin	19	31.7
Amoxillin clavulanic	8	13.3
Amikacin	13	21.7
Cefotaxime	36	60
Ceftriaxone	14	23.3
Fluconazole	9	15
Cefipime	3	5
Acyclovir	4	6.7
Ceftazidim	13	21.7
Macrolides	2	3.3
Meropenem	6	10
Metronidazole	5	8.3
Anti TB	2	3.3
Cefoperazone	1	1.7
Linezolid	2	3.3
Penicillin	1	1.7

Table 6: Antimicrobial therapy.

Only one case (1.7%) received Cefoperazone and one received penicillin.

Conclusion

An accurate and rapid diagnosis of the pathogen responsible for CAP provides for informed decision making, resulting in improved care with focused antimicrobial therapy, fewer unnecessary tests and procedures and, for those who are hospitalized, potentially shorter inpatient stays. Unfortunately, in the diagnosis of CAP, particularly bacterial CAP, there are no single diagnostic tests that can be considered the reference standard.

We decide to understand this clinical audit to evaluate how the guidelines will have been followed in the acute management of children with Community Acquired Pneumonia at pediatric intensive care. After studying patients admitted at PICU for CAP we found that many points in the 2011 pediatric CAP guidelines are neglected and not followed the most common point is Tracheal Aspirates was done for only one case (1.7%) while many other points are followed strongly as Pulse Oximetry and Initial Chest Radiographs were done for (100%) of case.

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