Antimicrobial drug prescribing patterns for community-acquired pneumonia in hospitalized patients: A retrospective pilot study from New Delhi, India

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ABSTRACT

Objective: The objective of this study was to determine patterns and frequency of antimicrobial drug use among hospitalized patients with community-acquired pneumonia (CAP).

Methodology: A retrospective 5 years (April 2007–March 2012) detailed medical record review of patients diagnosed with CAP and discharged to home from Non-Intensive Care Unit respiratory medicine wards of two public hospitals in Delhi.

Results: A total of 261 medical records were analyzed. Over the 5 years, 82.0% (2007–08), 78.6% (2008–09), 59.5% (2009–10), 64.7% (2010–11), and 67.8% (2011–12) patients were prescribed two antimicrobials. In the last two study years, the proportion of patients receiving three antimicrobials increased (from 2.0% to 26.5% and 28.8%), while the proportion receiving monotherapy decreased (from 16.0% to 8.8% and 3.4%). In accordance with guidelines, beta-lactams and macrolides were the two most frequently prescribed antimicrobials (34.1%). However, newer generation beta-lactams were prescribed. A total of 37 patients were prescribed beta-lactam-tazobactam combination preparations. Overall, beta-lactams constituted more than 40% of prescriptions while macrolides were the second most prescribed class. Cephalosporin prescriptions significantly increased (\(P < 0.01\)) and penicillin prescriptions significantly decreased over study periods. The prescription of fluoroquinolones also decreased (21.5–6.0%, \(P < 0.01\)) and aminoglycoside prescription ranged from 9.7% to 16.4%, over 5 years. Reasons for prescribing three antimicrobials, use of aminoglycosides, or higher-end/reserve antibiotics were not mentioned in the medical records. There were no hospital-specific guidelines for doctors to follow in the treatment of CAP.

Conclusions: These findings suggest the need for implementing antimicrobial treatment guidelines. Adequate documentation and monitoring of antibiotic use for feedback are also lacking. An antimicrobial stewardship program may offer the most comprehensive solution for appropriate use of antimicrobials.

KEY WORDS: Antibiotics, antimicrobial resistance, antimicrobial stewardship, pneumonia, prescription audit, treatment guidelines

Introduction

Community-acquired pneumonia (CAP) is an acute symptomatic infection of the lower respiratory tract, which develops outside a hospital or nursing home. Antibiotic therapy

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is the mainstay for treatment of CAP.[11–21] Experts advocate a judicious approach to antibiotic therapy in light of increasing antimicrobial resistance (AMR), which is a serious public health problem.[13] A number of prospective and retrospective studies in Europe and USA helped to define the pattern of CAP and provided information for rational antibiotic therapy.[14–16] However, surveillance of antibiotic use in a specific disease is not routinely done in India, and little data were available on the pattern of antibiotic use in the community or in the hospital for CAP from India. Effective surveillance is central to control AMR, and is needed to promote rational use of antibiotics[22] as shown by various extensive programs such as European Surveillance on Antibiotic Consumption and Swedish Strategic Programme against Antibiotic Resistance from the developed world.[23–26] In the absence of a systematic surveillance system in place for resource-poor settings, WHO recommends use of simple indicators to follow trends in antibiotic use that provide guidance to local agencies in the identification of deficiencies and priority areas for intervention.[27,28] Implementing the standard treatment guidelines (STGs) is one of the important tools to promote rational use of antibiotics.[13] Delhi Society for the promotion of Rational Use of Drugs (DSPRUD) has taken the initiative and prepared STGs (2002) covering treatment for priority health problems.[14,29] These guidelines recommend treatment of CAP for young/middle-aged patients as injection penicillin G/CAP amoxicillin/CAP erythromycin/Injection erythromycin/if staph infection suspected, injection cefotaxime; for elderly (immune-competent): Injection cefotaxime/injection ceftazidime; for elderly (immune-suppressed): Same as for immune-competent and in addition injection gentamicin/injection amikacin. These guidelines do not deal with the treatment of hospitalized patients in detail. At the time of this study, well-recognized national official guidelines for the treatment of CAP were not available. The most widely referred international guidelines for the management of patients with CAP have been those published by the American Thoracic Society (ATS)[31] and the Infectious Diseases Society of America (IDSA).[32] Both IDSA and the ATS have developed an exhaustive CAP guideline document.[33] These guidelines of CAP recommend for inpatient, Non-Intensive Care Unit (ICU) treatment as: (i) A respiratory fluoroquinolone; (ii) a beta-lactam plus a macrolide (preferred beta-lactam agents include cefotaxime, ceftriaxone, and amoxicillin; ertapenem for selected patients; with doxycycline as an alternative to the macrolide. For inpatients, ICU treatment the recommendations are: (i) A beta-lactam (ceftriaxone, or amoxicillin + sulbactam) plus either azithromycin or a fluoroquinolone. (ii) For Pseudomonas infection, an antipseudomonal beta-lactam (pipercillin + tazobactam, ceftazime, imipenem or meropenem) plus ciprofloxacin or levofloxacin or the above beta-lactam plus an aminoglycoside and azithromycin. For community-acquired methicillin-resistant Staphylococcus aureus infection, vancomycin or linezolid is recommended to be added.

This retrospective study was carried out at Respiratory Medicine Department of two public tertiary care hospitals in Delhi with the objectives to find out the: (i) Pattern and frequency of antibiotics prescribed to Non-ICU inpatients, diagnosed with CAP and discharged to home; (ii) completeness of details mentioned in the case sheets especially related to antibiotics prescribed; (iii) what percentage of patients treated as per the treatment guidelines issued by the department/hospital or as per regional/international guidelines.

Methodology

**Study Design and Study Period**

This was a cross-sectional retrospective study of medical records of CAP patients hospitalized in Non-ICU wards of Respiratory Medicine Department of two public tertiary care hospitals in Delhi. The data were collected for five consecutive periods, Period 1: April 2007–March 2008; Period 2: April 2008–March 2009; Period 3: April 2009–March 2010; Period 4: April 2010–March 2011; and Period 5: April 2011–March 2012. Prior clearance was obtained from the institutional Ethics Committee.

**Inclusion Criteria**

Patients with age > 18 years, with a primary diagnosis of CAP and discharged from the hospital.

**Exclusion Criteria**

Patients’ aged below 18 years or admitted in ICU or hospital-acquired or ventilator-associated pneumonia.

**Data Collection**

Data were extracted from medical records using a detailed data collection form for sociodemographic profile, main diagnosis, comorbid conditions, history of use of antimicrobials before hospital admission (if data available), duration of hospital stay, initial antimicrobials treatment, duration of antimicrobial treatment in the hospital, change in antimicrobials prescription during treatment period, investigations, and clinical findings from hospital admission till discharge and antimicrobials prescribed with duration at the time of discharge.

A complete anonymity of patient(s) and treating physician was ensured.

**Pilot Study**

A pilot study on randomly picked 20 medical records of CAP patients meeting the inclusion criteria over 4 years from each study hospital was conducted before finalizing the data collection form for the study.

**Statistical Analysis**

SPSS version 16.0 (SPSS Inc., Chicago, USA.) for Windows statistical software package was used. Descriptive data were presented as percentages or the mean ± standard deviation. Categorical variables and proportion are compared using Chi-square test and Chi-square test of proportion.

**Results**

A total of 261 medical records were reviewed from Respiratory Medicine Department of two public hospitals over 5 years [Table 1]. The mean age of patients was 52.8 ± 16.7 years, of which 76.6% were male. Of a total of 261 patients, 181 patients had comorbidity, and majority (162 patients) had the respiratory disorders like chronic obstructive pulmonary disease COPD, and 12 patients had diabetes mellitus. All patients had chest X-ray carried out, 172 patients had single lobe involvement, and 89 had multilobe...
involvement [Table 1]. Culture and sensitivity report of sputum were available in the medical records for 97 patients (37.2%). Of these 97 reports available, 82 mentioned no pathogenic organism and only in 15 cases isolated organisms were mentioned.

Overall, for the study population, the total duration of antimicrobial therapy in the hospital was 5.5 ± 2.5 days and overall length of stay in hospital was 5.7 ± 2.9 days [Table 1].

**Pattern and Frequency of Antimicrobials Prescribed**

**Percentage of Patients Prescribed Single, Two or Three Antimicrobial Medicines as Initiation of Therapy**

The percentage of patients prescribed with single antimicrobial medicine over the five study periods was 16.0%, 16.7%, 23.8%, 8.8%, and 3.4%, respectively. Two antimicrobials were prescribed to 82.0%, 78.6%, 59.5%, 64.7%, and 67.8% of study patients and three antimicrobials were prescribed to 2.0%, 4.8%, 16.7%, 26.5%, and 28.8% over the five study periods [Table 2]. Patients with comorbidity were found to be more prone to receiving two antimicrobial agents than patients without comorbidity (P < 0.05).

### Table 1:

Demographics, comorbidities, radiological findings, microbiological data, duration of therapy, and length of stay of study population

| Characteristics of the study population | April 07– March 08 | April 08– March 09 | April 09– March 10 | April 10– March 11 | April 11– March 12 |
|-----------------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Total number of patients                | 50                 | 42                 | 42                 | 68                 | 59                 |
| Age (in years)                          |                    |                    |                    |                    |                    |
| 18-25                                   | 3                  | 4                  | 8                  | 3                  | 7                  |
| 26-30                                   | 2                  | -                  | 1                  | 3                  | 3                  |
| 31-40                                   | 8                  | 5                  | 4                  | 9                  | 3                  |
| 41-50                                   | 15                 | 7                  | 6                  | 11                 | 13                 |
| 51-60                                    | 11                 | 9                  | 9                  | 11                 | 10                 |
| 60 and above                            | 11                 | 17                 | 14                 | 31                 | 23                 |
| Mean age (in years)±SD                  | 50.4±13.0          | 53.9±15.6          | 49.6±18.2          | 56.1±17.3          | 52.6±17.0          |
| Sex                                      |                    |                    |                    |                    |                    |
| Male                                    | 29                 | 33                 | 38                 | 53                 | 47                 |
| Female                                   | 21                 | 9                  | 4                  | 15                 | 12                 |
| Comorbidity                              |                    |                    |                    |                    |                    |
| Yes                                      | 38                 | 35                 | 22                 | 43                 | 43                 |
| No                                       | 12                 | 7                  | 20                 | 25                 | 16                 |
| Types of comorbidity                     |                    |                    |                    |                    |                    |
| Respiratory disorders                    | 37                 | 33                 | 16                 | 39                 | 37                 |
| Cardiovascular disorders                 | -                  | -                  | -                  | -                  | 2                  |
| Hematological disorders                  | -                  | -                  | -                  | -                  | 2                  |
| CNS disorder                             | -                  | -                  | -                  | 1                  | -                  |
| Malignant neoplasm                       | -                  | -                  | 1                  | -                  | 1                  |
| Diabetes mellitus                        | 1                  | 2                  | 5                  | 3                  | 1                  |
| Radiological findings                    |                    |                    |                    |                    |                    |
| Single lobe involved                     | 32                 | 30                 | 32                 | 46                 | 32                 |
| Multi lobe involved                      | 18                 | 12                 | 10                 | 22                 | 27                 |
| Sputum culture and sensitivity report available|        |                    |                    |                    |                    |
| Yes                                      | 12                 | 10                 | 25                 | 21                 | 29                 |
| No                                       | 38                 | 32                 | 17                 | 47                 | 30                 |
| TDT*(in days) mean±SD                    | 5.5±2.1            | 4.8±1.5            | 5.2±2.1            | 5.6±3.0            | 6.4±2.8            |
| LOS#(in days) mean±SD                    | 5.5±2.1            | 4.8±1.5            | 5.2±2.1            | 5.6±3.0            | 6.5±2.6            |

* TDT=Total duration of antimicrobial therapy, *LOS=Length of stay in the hospital. SD=Standard deviation, CNS=Central nervous system

### Table 2:

The percentage of patients prescribed single, two, and three antimicrobial medicines at the two study hospitals over five study period

| Study period | Single antimicrobial (n (%)) | Two antimicrobials (n (%)) | Three antimicrobials (n (%)) |
|--------------|------------------------------|-----------------------------|-----------------------------|
| Period 1     | 8 (16.0)                     | 41 (82.0)                   | 1 (2.0)                     |
| Period 2     | 7 (16.7)                     | 33 (78.6)                   | 2 (4.8)                     |
| Period 3     | 10 (23.8)                    | 25 (59.5)                   | 7 (16.7)                    |
| Period 4     | 6 (8.8)                      | 44 (64.7)                   | 18 (26.5)                   |
| Period 5     | 2 (3.4)                      | 40 (67.8)                   | 17 (28.8)                   |

Period 1=April 2007-March 2008, Period 2=April 2008-March 2009, Period 3=April 2009-March 2010, Period 4=April 2010-March 2011, Period 5=April 2011-March 2012

**Pattern of Single Antimicrobial Medicines Prescribed at Study Hospitals**

Beta-lactam antibiotics constituted the most frequently prescribed single antimicrobial class in all the study periods except in Period 1, wherein 6 out of 8 patients were
prescribed fluoroquinolone (levofloxacin) class. The use of fluoroquinolone (levofloxacin) class decreased significantly in Period 3 as compared to Period 1 \((P < 0.01)\). For beta-lactam, from penicillin group, amoxicillin + clavulanate 1,200 mg intravenous was the most common antimicrobial prescribed, the mean duration of treatment being 4.4 ± 2.2 days. One patient each was prescribed cefotaxime, cefpodoxime, ceftriaxone, and ceftazidime + tazobactam parenterally.

**Pattern of Two Antimicrobials Medicines Prescribed at the Study Hospitals**

Two antimicrobials were prescribed to more than 50.0% of patients (39.5–82.0%) at the study hospitals [Table 2]. Beta-lactam and macrolide was the most frequently prescribed regimen, being prescribed to 39.0%, 30.3%, 64.0%, 47.7%, and 65.0% of patients who received two antimicrobials over five study periods [Table 3]. Prescription of beta-lactam and a macrolide class of antimicrobial was significantly more in Period 5 as compared to Period 2 \((P < 0.01)\) and Period 1 \((P < 0.05)\). Furthermore, Period three had significantly higher prescriptions of these two antimicrobials than Period two \((P < 0.05)\). For beta-lactams, cephalosporins were prescribed with macrolides frequently except in Period 1, in which penicillins (beta-lactam) were frequently given with macrolide (amoxicillin + clavulanate with azithromycin). A total of 19 patients, in all five periods were prescribed tazobactam in combination with cephalosporins.

Over the five study periods, prescription of beta-lactams with fluoroquinolones decreased from 31.7% in Period 1 to 10.0% in Period 5, which was statistically significant \((P < 0.05)\). Aminoglycoside antimicrobial class was prescribed as a two antimicrobial regimen with beta-lactam, fluoroquinolones or with macrolides. Overall in the five study periods, 22.8% prescriptions contained aminoglycosides as one of the two antibiotic classes [Table 3].

**Table 3:**

**Pattern of two antimicrobials prescribed at study hospitals during the study periods**

| Name of antimicrobial class and antimicrobials | April 07-March 08 n (%) | April 08-March 09 n (%) | April 09-March 10 n (%) | April 10-March 11 n (%) | April 11-March 12 n (%) |
|-----------------------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| I. Beta-lactams+fluoroquinolones               | 13 (31.7)               | 8 (24.2)                | 6 (24.0)                | 7 (15.9)                | 4 (10.0)*               |
| II. Beta-lactams+macrolides                   | 16 (39.0)               | 10 (30.3)               | 16 (64.0)*              | 21 (47.7)               | 26 (65.0)**             |
| IIIA. Penicillins+macrolides                 | 10 (24.4)               | 5 (15.1)                | 1 (4.0)                 | 7 (15.9)                | 6 (20.0)                |
| IIIB. Cephalosporins+macrolides              | 6 (14.6)                | 5 (15.1)                | 10 (40)                 | 14 (31.8)               | 20 (50.0)               |
| III. Beta-lactam+beta-lactam                  | 1 (2.4)                 | -                       | -                       | 3 (9.1)                 | 2 (5.0)                 |
| IV. Beta-lactams+aminoglycosides              | 5 (12.2)                | 8 (24.2)                | 6 (24.0)                | 6 (13.6)                | 4 (10.0)                |
| V. Beta-lactams+tazobactam                    | 2 (4.8)                 | -                       | 1 (4.0)                 | 1 (3.0)                 | -                       |
| VI. Macrolides+fluoroquinolones              | 1 (2.4)                 | 3 (9.1)                 | -                       | 3 (9.1)                 | -                       |
| VII. Beta-lactams+lincomycin                  | 2 (4.8)                 | -                       | -                       | -                       | -                       |
| VIII. Macrolides+aminoglycosides              | 3 (7.3)                 | 4 (12.1)                | -                       | -                       | 1 (2.5)                 |
| IX. Aminoglycosides+tazobactam                | -                       | -                       | -                       | 1 (3.0)                 | -                       |
| X. Beta-lactams+oxazolidinones               | -                       | -                       | -                       | -                       | 1 (2.5)                 |
| XI. Metronidazole+lincomycin                  | -                       | -                       | -                       | -                       | 1 (2.5)                 |
| XII. Fluoroquinolones+aminoglycosides         | -                       | -                       | 1 (4.0)                 | 1 (3.0)                 | 1 (2.5)                 |
| XIII. Fluoroquinolones+tazobactam             | -                       | -                       | -                       | -                       | 1 (2.5)                 |
| Number of patients prescribed with two antimicrobials therapy over the periods | 41                      | 33                      | 25                      | 44                      | 40                      |

The proportions of significant changes have been obtained by using Chi-square test of proportion while comparing each period with other periods (between two periods). *\(P<0.05\) compared with Period 1; **\(P<0.05\) compared with Period 1; ***\(P<0.01\) compared with Period 2; ****\(P<0.05\) compared to Period 2.

**Pattern of Three Antimicrobial Medicines Prescribed at the Study Hospitals**

In the case of three antimicrobials, a steady increase in a prescription from 2.0% to 28.8% [Table 2] was observed over the five study periods [Table 2].

Of 45 patients, beta-lactam was prescribed to 44 patients as a part of three antimicrobial medicine regimens with different permutations and combinations of various members of beta-lactam group with two other antimicrobials. Eighteen patients (13 with cephalosporin and five with penicillin) were prescribed beta-lactam with tazobactam. Macrolide was prescribed to 34 patients and aminoglycoside to 31 patients.

**Frequency of Various Antimicrobials Prescribed in Study Population during the Study Period**

Beta-lactam constituted more than 40.0% of overall prescriptions. In beta-lactam class, penicillin group (J01C) was prescribed most frequently in Period 1 and Period 2, whereas from Period 3 onward cephalosporins (J01DA) constituted the bulk of beta-lactam prescriptions [Table 4]. Penicillin prescription decreased significantly in Period 5 as compared to Period 1 and Period 2 \((P < 0.05)\). Cephalosporins prescription increased significantly in Period 3 compared to Period 2 \((P < 0.01)\) and Period 1 \((P < 0.05)\); and in Period 5 compared to Period 2 \((P < 0.01)\).

Macrolide (J01FA) was the second most commonly prescribed antimicrobial, with prescription ranging from 21.0% to 34.0% over 5 years with no statistically significant change in prescription over the study years. Prescription of fluoroquinolone (J01MA) decreased from Period 1 to Period 5 (from 21.3% to 6.0%, \(P < 0.01\)). The percentage of prescription for aminoglycosides (J01G) ranged from 9.7% to 16.4% in five study periods.

Of a total sample of 261 cases, two patients each were prescribed the following high-end antimicrobials along with...
other antimicrobials: Piperacillin + tazobactam, linezolid, and imipenem. Similarly, nine patients received a prescription for clindamycin to be administered with other antibiotics.

**Change in Antimicrobial Therapy during Hospital Stay**

Of 261 patients, the antimicrobial regimen was changed in 21 patients during their stay in the hospital. For six patients, therapy was changed based on culture and sensitivity report; for five patients, therapy was changed due to worsening of the clinical condition. For nine patients, intravenous therapy was switched to oral therapy due to improvement in clinical condition.

**Antimicrobial Therapy Prescribed at the Time of Discharge**

The discharge summary was available for a total of 73 records and for the initial two periods very few records had discharge summary [Table 5]. Of 73 patients, 66 patients (90.0%) were prescribed antimicrobial therapy at the time of discharge. The single antimicrobial was prescribed to 47 (71.2%) of patients, while 19 (28.8%) patients were prescribed two antimicrobial medicines at the time of discharge. Overall mean duration of the antimicrobial therapy prescribed at the time of discharge was for 5.2 ± 1.1 days.

For single antimicrobial, the majority of patients, 57.4% were prescribed amoxicillin + clavulanic acid 625 mg orally for a mean duration of 7.5 ± 3.5 days. The other single antimicrobial prescribed were cefixime and azithromycin to six patients each, cefpodoxime to five patients and levofloxacin to three patients.

The most common two antimicrobial prescribed were cefixime 200 mg and azithromycin 500 mg orally to seven patients out of 19 for a mean duration of 6.4 ± 0.97.

### Table 4:

**Frequency of various antimicrobials prescribed at study hospitals during the five study periods**

| Name of antimicrobial class and antimicrobials ATC | April 07-March 08 | April 08-March 09 | April 09-March 10 | April 10-March 11 | April 11-March 12 |
|-----------------------------------------------|------------------|------------------|------------------|------------------|------------------|
| I. Beta-lactams n ATC                         |                  |                  |                  |                  |                  |
| IA. Penicillins J01C, n (%)                   | 26 (27.9)        | 25 (31.6)        | 15 (18.7)        | 28 (20.1)        | 2 (15.8)*        |
| Amoxicillin+clavulanate, n                    | 26               | 24               | 14               | 27               | 16               |
| Amoxicillin, n                                |                 |                 |                 |                 |                  |
| Piperacillin+tazobactam, n                    |                 |                 |                 | 1                | 1                |
| IB. Cephalosporin J01DA, n (%)                | 15 (16.1)        | 8 (10.1)         | 25 (30.9)**      | 28 (20.1)        | 36 (27.1)**      |
| Ceftriaxone, n                                | 4                | 6                | 14               | 21               | 19               |
| Cefotaxime, n                                 |                 | 1                |                 |                 |                  |
| Cefazidime, n                                 | 1                | 1                | 1                | 1                | 1                |
| Cefazidime+tazobactam, n                      | 9                | 1                | 8                | 10               |                  |
| Ceftriaxone+tazobactam, n                     | 1                |                 |                 |                  |                  |
| Cefoperazone+subactum, n                      | 1                | 5                | 4                |                 |                  |
| Cefpodoxime, n                                |                 | 1                |                 |                  |                  |
| Cefpodoxime+clavulanate, n                    |                 | 1                |                 |                  | 2                |
| II. Macrolides J01FA n (%)                    | 21 (22.6)        | 18 (22.8)        | 17 (21.0)        | 40 (28.8)        | 41 (30.8)        |
| Azithromycin, n                               | 21               | 18               | 17               | 36               | 29               |
| Clarithromycin, n                             |                 |                 | 4                |                  | 12               |
| III. Fluoroquinolones J01MA, n (%)            | 20 (21.5)        | 15 (19.0)        | 9 (11.1)         | 16 (11.5)        | 8 (6.0)**        |
| Levofloxacin, n                               | 19               | 12               | 6                | 14               | 8                |
| Ciprofloxacin, n                              | 1                | 3                | 2                | 1                |                  |
| Moxifloxacin, n                               |                 | 1                |                 |                  |                  |
| Gatifloxacin, n                               |                 | 1                |                 |                  |                  |
| IV. Aminoglycosides J01G, n (%)               | 9 (9.7)          | 13 (16.4)        | 12 (14.8)        | 19 (13.7)        | 18 (13.5)        |
| Amikacin, n                                   | 3                | 3                | 4                | 2                |                  |
| Gentamicin, n                                 | 6                | 8                | 9                | 15               | 16               |
| V. Metronidazole A01AB17, n (%)               |                 | 1                | 2 (1.4)          | 3 (2.3)          |                  |
| VI. Lincomamide J01FF02, n (%)                | 2 (2.1)          | 1                | 3 (2.2)          | 4 (3.0)          |                  |
| Clindamycin, n                                | 2                | 1                | 3                | 4                |                  |
| VII. Carbapenem J01DH, n (%)                  |                 | 1 (0.7)          | 1                |                  |                  |
| Imipenem, n                                   |                 | 1                |                  |                  |                  |
| VIII. Oxazolidinones J01XX, n (%)             | 1 (1.2)          | 1 (0.7)          | 1 (0.7)          |                  |                  |
| Linezolid, n                                  | 1                | 1                |                  |                  |                  |
| IX. Sulfonamides J01E, n (%)                  |                 |                 | 1 (0.7)          |                  |                  |
| Trimethoprim+sulfamethaxazole                 |                 | 1                |                  |                  |                  |
| X. Anti-influenza agents, n (%)               |                 | 2 (1.4)          |                  |                  |                  |
| Oseltamivir, n                                |                 | 2                |                  |                  |                  |
| Total number of antimicrobials                 | 93               | 79               | 81               | 139              | 133              |

The statistical method used was Chi-square test of proportion when each period was compared with others (between periods). *P<0.05 compared to Period 1 and 2, **P<0.05 compared to Period 1, ***P<0.01 compared to Period 2, ****P<0.01 compared to Period 1 and 2. ATC=Anatomical therapeutic chemical classification code, n=Total number of antimicrobial prescribed.
Information in the Case Sheets of Medical Records

The information on many aspects of antibiotic use and prescription was not available in the case sheets. None of the medical records studied had an immediate previous history of antibiotic use before admission for the condition. None of the records mentioned anything about “confusion” at the time of hospital admission, one of the parameters and criteria needed to classify the severity of pneumonia. Only 37.0% of cases had a microbiological report in the medical record. Reason or clarification for prescribing aminoglycosides, tazobactam combinations, reserve, or high-end antibiotics or prescribing three antibiotics was not written. In Period 5, one patient (52-year-old had multilobar pneumonia with COPD) was prescribed imipenem, clindamycin, and levofloxacin, however, no previous history of antimicrobial or change in therapy during hospital stay or culture sensitivity report was available for this patient.

The discharge summary was not available for most of the medical records of the study population. At one of the hospitals, discharge summary including advice and prescription for the majority of the patients were not mentioned.

Percentage of Patients Treated as per the Treatment Guidelines

The department or the surveyed hospital did not have any antimicrobial stewardship program or written guidelines for doctors to follow for the treatment of CAP. Moreover, the reason for prescribing a particular antibiotic was not clarified in the case sheet, making it difficult to judge any prescription. However, as per the guidelines prepared by DSPRUD, only four patients receiving single antibiotic were prescribed cephalexin or clindamycin including one prescription with cephalexin + tazobactam. Another option as per these guidelines is to prescribe cephalexin and an aminoglycoside in immunosuppressed patients. A total of 10 prescriptions with these two antibiotic classes were observed. Of these 10 prescriptions, five had cephalexin + tazobactam or sulbactam. However, it was not clear from the case sheets that these 10 patients were immunosuppressed. Doctors in the Respiratory Medicine Department usually follow the international ATS/IDSA guidelines. According to these guidelines for non-ICU patients, beta-lactam and macrolide are recommended. We found a total of 34.1% of prescriptions had beta-lactam and a macrolide. The prescribed beta-lactam was amoxicillin + clavulanic acid among penicillin group and for cephalosporins group, it was ceftriaxone, ceftazidime + tazobactam or cefoperazone + sulbactam. The guidelines suggest the use of cefotaxime, ceftriaxone, and ampicillin.

Discussion

CAP is one of the most common infectious diseases addressed by clinicians. Increasing rates of antibiotic resistance make it essential to be better aware of the relationship between antibiotic consumption, misuse of antibiotics, and the emergence of resistance. A clear correlation between outpatient antibiotic use and penicillin-resistant pneumococci has been demonstrated in Europe. Since, only a very small number of new antibiotics are under development, physicians cannot rely on new antibiotics to treat infections caused by multidrug-resistant bacteria, and hence, policies must be introduced to reduce the emergence and spread of resistant bacteria. Broad spectrum antibiotics, newer generations of antibiotics, and reserve antibiotics need to be used with caution. At all levels of healthcare treatment, guidelines must be followed to treat infectious diseases. The most widely referred guidelines for treatment of CAP have been those published by ATS/IDSA. Recently, Indian guidelines for the management of community and hospital-acquired pneumonia in adults have been prepared by Indian Chest Society and National College of Chest Physicians, India. These guidelines, modeled on the pattern of ATS/IDSA guidelines were published, in February 2013 and still need to be disseminated widely. The discussion is along the lines of ATS/IDSA guidelines as our study was conducted prior to the introduction of national guidelines.

Findings of this study show that cephalosporins emerged as the most frequent and commonly prescribed antibiotic group with its prescriptions increasing significantly in comparison to penicillin group over the study periods. Among penicillin group, the prescription was always for amoxicillin + clavulanic acid and never for amoxicillin or ampicillin. These findings confirm the previous surveys conducted for trends of antimicrobial use in the community in Delhi which revealed increased use of cephalosporins and preference for prescribing amoxicillin + clavulanic acid than ampicillin in the community. Another study shows a huge increase in overall of cephalosporins consumption from 2005 to 2008. Our study also gave evidence of the high use of newer generations of cephalosporins in Non-ICU hospitalized patients of CAP. After beta-lactam group of antibiotics, macrolide followed by aminoglycosides was most

Table 5:

| Number of patients | April 07-March 08 (%) | April 08-March 09 (%) | April 09-March 10 (%) | April 10-March 11 (%) | April 11-March 12 (%) |
|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Discharge summary information available in number of patients | 3 (100.0) | 9 (100.0) | 13 (100.0) | 25 (88.0) | 19 (82.6) |
| Antimicrobials prescribed in number of patients | 3 (100.0) | 9 (100.0) | 13 (100.0) | 22 (88.0) | 19 (82.6) |
| Number of patients treated with single antimicrobial therapy | 1 (33.3) | 5 (55.5) | 5 (38.5) | 17 (77.3) | 19 (100.0) |
| Number of patients treated with two antimicrobial therapy | 2 (66.6) | 4 (44.4) | 8 (61.5) | 5 (22.7) | - |
often prescribed. Prescriptions with fluoroquinolones showed a decreasing trend over the 5 years.

Of 66 patients who were prescribed antimicrobials at the time of discharge, 28.8% patients were prescribed two antimicrobial medicines. This finding points toward the excess use of antimicrobials, particularly when no reason was mentioned in the case sheet. Total mean duration of antimicrobial therapy in the hospital was 5.5 ± 2.5 days and total mean duration of antimicrobial therapy at the time of discharge was for 5.2 ± 1.1 days.

The survey findings of prescription of high-end antibiotics lack of information on prescribing reasons and disregards for maintaining clinical case sheets and discharge summary indicate the need for prompt action in the form of stewardship programs. The WHO policy briefs have also reiterated the need for stewardship programs in hospitals.25 Antimicrobial stewardship programs aim to promote appropriate use of antimicrobials – right choice, duration, dose, and route of administration and these programs also include prescriber education, formulary restriction, antibiotic cycling, computer-assisted programs, and surveillance of antibiotic use.26 Effective antimicrobial stewardship involves a comprehensive program incorporating multiple strategies and collaboration among various specialties within a given health-care institution.27 Recently, Bosso and Drew (2011) concluded that the application of stewardship strategies (alone or in combination) for management of CAP increased physician awareness of guidelines, improve appropriate antimicrobial use and reduce unnecessary antimicrobial prescribing.28 In addition, antimicrobial stewardship application had a profound favorable impact on patient outcomes, including in-hospital mortality rates reduced the length of stay, reduced treatment failure rates, and reduced healthcare costs. Studies have also shown that adherence to evidence-based guidelines has a profound and positive impact on patient outcomes and healthcare costs.29,30 Prescription review by clinical pharmacists with feedback to the prescriber and multidisciplinary case conferences has been found to be very effective in improving prescribing.31 An effective stewardship program if implemented for CAP treatment in hospitals would go a long way in containing the scourge of AMR.

**Recommendations**

In the light of the findings of the present study, urgent implementation of the antimicrobial stewardship program is needed in the hospitals. The foremost recommendation is to have detailed STGs in consensus with the multidisciplinary institute team on the lines of national treatment guidelines recommendations. Second, strict implementation of these guidelines using educational strategies targeting providers, guidelines adherence by providers, formulary restriction and prior approval for prescribing reserve antibiotics needs to be ensured. The third recommendation is to write in detail the medical case sheet and proper maintenance of medical records. Fourth, prescriptions should be audited by pharmacist/pharmacologist routinely and findings to be presented in the hospital meetings for feedback. A monitoring and evaluation system would help in improving the adherence to treatment guidelines and in achieving the ultimate goal of the rational use of antimicrobials.

**Strengths and Limitations**

The main strength of our study is it being a detailed retrospective prescription audit survey of hospitalized CAP patients for 5 years in two Respiratory Medicine Departments in Delhi. This is probably the first such study from India. The findings have revealed pattern of prescriptions for CAP in non-ICU hospitalized patients. A lead can be taken from this study to do more such studies in different hospitals in respiratory and medicine wards to get a baseline data. This study had some inherent limitations, e.g., it was undertaken in Respiratory Medicine Department at two tertiary care hospitals of Delhi and thus, the prescription patterns may not be representative of general practice as a whole. Though common trend of antimicrobial use did emerge from the study; yet caution should be taken in generalizing the findings. Moreover, the pattern of antimicrobial use may be different in medicine ward or in private hospitals. Therefore, there is an urgent need to do prescription audit from medical department where the majority of patients are treated for CAP.

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**Conflicts of Interest**

There are no conflicts of interest.

**References**

1. Schouten JA, Prins JM, Bonten MJ, Degener J, Janknegt RE, Hollander JM, et al. Revised SWAB guidelines for antimicrobial therapy of community-acquired pneumonia. Neth J Med 2005;63:323-35.
2. Armitage K, Woodhead M. New guidelines for the management of adult community-acquired pneumonia. Curr Opin Infect Dis 2007;20:170-6.
3. World Health Organisation. The Evolving Threat of Antimicrobial Resistance: Options for Action. Switzerland, Geneva: World Health Organisation; 2012. Available from: http://www.whoibloc.who.int/publications/2012/9789241503181_eng.pdf.[Last accessed on 2015 Apr 04].
4. McNabb WR, Shanson DC, Williams TD, Lant AF. Adult community-acquired pneumonia in central London. J R Soc Med 1984;77:550-5.
5. MacDougall C, GuglielmoBJ, Maselli J, Gonzales R. Antimicrobial drug prescribing for pneumonia in ambulatory care. Emerg Infect Dis 2005;11:380-4.
6. Natalia RD, Momchil V, Ilko G. Study of the antibiotic prescription practice for safety purposes for inpatients hospitalized due to pneumonia. Marmara Pharm J 2010;14:74-8.
7. Kotwani A, Holloway K. Trends in antibiotic use among outpatients in New Delhi, India. BMC Infect Dis 2011;11:99.
8. Molstad S, Cars O, Struve J. Strama – A Swedish working model for containment of antibiotic resistance. Euro Surveill 2008;13 pii=19041.
9. Adriaenssens N, Coenen S, Vserporten A, Muller A, Minalu G, Faes C, et al. European Surveillance of Antimicrobial Consumption (ESAC): Outpatient antibiotic use in Europe (1997-2009). J Antimicrob Chemother 2011;66 Suppl 6:v13-12.
10. Zarb P, Goossens H. European Surveillance of Antimicrobial Consumption (ESAC); Value of a point-prevalence survey of antimicrobial use across Europe. Drugs 2011;71:745-55.
11. World Health Organisation. How to Investigate Drug use in Health Facilities: Selected Drug Use Indicators. The Organization WHO/DAP/93.1. Switzerland, Geneva: World Health Organisation; 1993.
12. World Health Organization. Using Indicators to Measure Country Pharmaceutical Value of a point-prevalence survey of antimicrobial use across Europe. Drugs 2011;71:745-55.
13. Kotwani A, Holloway K. Trends in antibiotic use among outpatients in New Delhi, India. BMC Infect Dis 2011;11:99.
14. Delhi Society for Promotion of Rational Use of Drugs. Acute diarrhea. In:
Kotwani, et al.: Antibiotic prescribing for community-acquired pneumonia

Sharma S, Sethi GR, Gupta U, editors. Standard Treatment Guidelines: A Manual for Medical Therapeutics. 3rd ed. New Delhi: BI Publications; 2009. p. 119-20.

15. Niederman MS, Mandell LA, Anzueto A, Bass JB, Broughton WA, Campbell GD, et al. Guidelines for the management of adults with community-acquired pneumonia. Diagnosis, assessment of severity, antimicrobial therapy, and prevention. Am J Respir Crit Care Med 2001;163:1730-54.

16. Bartlett JG, Dowell SF, Mandell LA, File Jr TM, Musher DM, Fine MJ. Practice guidelines for the management of community-acquired pneumonia in adults. Infectious Diseases Society of America. Clin Infect Dis 2000;31:347-82.

17. Mandell LA, Wunderink RG, Anzueto A, Bartlett JG, Campbell GD, Dean NC, et al. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis 2007;44 Suppl 2:S27-72.

18. Lim WS, Baudouin SV, George RC, Hill AT, Jamieson C, Le Jeune I, et al. BTS guidelines for the management of community acquired pneumonia in adults: Update 2009. Thorax 2009;64 Suppl 3:i11-i55.

19. Harbarth S, Samore MH. Antimicrobial resistance determinants and future control. Emerg Infect Dis 2005;11:794-801.

20. Levy SB. Antibiotic resistance-the problem intensifies. Adv Drug Deliv Rev 2005;57:1446-50.

21. Albrich WC, Monnet DL, Harbarth S. Antibiotic selection pressure and resistance in Streptococcus pneumoniae and Streptococcus pyogenes. Emerg Infect Dis 2004;10:514-7.

22. Goossens H. Antibiotic consumption and link to resistance. Clin Microbiol Infect 2009;15 Suppl 3:i12-5.

23. Gupta D, Agarwal R, Aggarwal AN, Singh N, Mishra N, Khilnani GC, et al. Guidelines for diagnosis and management of community- and hospital-acquired pneumonia in adults: Joint ICS/NCCP(I) recommendations. Lung India 2012;29 Suppl 2:S27-82.

24. Ganguly NK, Arora NK, Chandy SJ, Fairoze MN, Gill JP, Gupta U, et al. Rationalizing antibiotic use to limit antibiotic resistance in India. Indian J Med Res 2011;134:281-94.

25. World Health Day. Combat Drug Resistance: No Action Today Means no Cure Tomorrow. Geneva: Statement by WHO Director-General, Dr. Margaret Chan; 2011. Available from: http://www.who.int/mediacentre/news/statements/2011/whd_20110407/en/. [Last accessed on 2014 Apr 09].

26. Fishman N. Antimicrobial stewardship. Am J Med 2006;119:S53-61.

27. Drew RH. Antimicrobial stewardship programs: How to start and steer a successful program. J Manag Care Pharm 2009;15 2 Suppl: S18-23.

28. Bosso JA. Drew RH. Application of antimicrobial stewardship to optimize management of community acquired pneumonia. Int J Clin Pract 2011;65:775-83.

29. Capelastegui A, España PP, Quintana JM, Gorordo I, Ortega M, Idoiaga I, et al. Improvement of process-of-care and outcomes after implementing a guideline for the management of community-acquired pneumonia: A controlled before-and-after design study. Clin Infect Dis 2004;39:955-63.

30. Omick JJ, Segal R, Johns TE, Russell W, Wang F, Yin DD. Resource use and cost of care for patients hospitalised with community acquired pneumonia: Impact of adherence to infectious diseases society of america guidelines. Pharmacoeconomics 2004;22:751-7.

31. Kaur S, Mitchell G, Vitetta L, Roberts MS. Interventions that can reduce inappropriate prescribing in the elderly: A systematic review. Drugs Aging 2009;26:1013-28.