Antibiotic treatment pathways and prescribing preferences in treating patients with clinically suspected hospital-acquired pneumonia using cohort pathway applications

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Background and Purpose

Hospital-acquired pneumonia is the second most frequent cause of hospital-acquired infection and the leading cause of morbidity and mortality from nosocomial infections. It remains a major health concern and contributor to hospital cost. Although these negative outcomes can be reduced by the rapid initiation of appropriate antibiotic therapy, it is a challenge to choose optimal antibiotics before identifying the offending pathogen, which is empiric. The study evaluated the preferences of empirical antibiotic use and the appropriateness of antibiotics selected for clinically suspected hospital-acquired pneumonia using the Observational Medical Outcomes Partnership Common Data Model with cohort pathway application in the Observational Health Data Sciences and Informatics tools.

Methods

Data source: Electronic health records database of Ajou University School of Medicine from 1994 to 2017 which transformed into OMOP CDM v 5.3

Analysis: HAP cohort were developed and the antibiotics treatment pathways were analyzed retrospectively. Sunburst plots were generated from medication sequences using the ATLAS v.2.7.1 and the Sankey flow chart was also used to visualize the prescription preferences and changing patterns per each antibiotic medication. (https://github.com /SandyRhie/antibioticsTreatmentPathway)

HAP, not VAP, cohort design

INDEX DATE:
Inpatients and emergency room visits for whom ≥18 years old

Treatment pathway follow-up period

One diagnosis of pneumonia and any antibiotics (≥ 1) exposures

At least ≥72 hr gap between admission and diagnosis of pneumonia

Exclusion
- Previous pneumonia
- Previous use of vancomycin or linezolid during prior 90 days
- Pregnancy
- Other infections
- Ventilator use after the index date
- Hospitalization in previous 21 days

Target cohort:
HAP suspected patients not at high risk of mortality and no factors increasing the likelihood of MRSA

Event cohort:
Pathway 1[a)]: piperacillin-tazobactam OR cefepime OR levofloxacin, imipenem/meropenem
Pathway 2[b)]: piperacillin-tazobactam OR cefepime OR levofloxacin/ciprofloxacin OR imipenem/meropenem OR aztreonam, PLUS vancomycin OR linezolid
Pathway 3[c)]: piperacillin-tazobactam OR cefepime/ceftazidime OR levofloxacin/ciprofloxacin OR imipenem/meropenem OR amikacin/gentamicin/tobramycin OR aztreonam, PLUS vancomycin OR linezolid. Ampiciilin+sulbactam OR cefotaxime.

Pathway definition: Each pathway include antibiotics recommended for HAP treatment by IDSA guidelines based on the risk of mortality and likelihood of MRSA .
a) For HAP suspected patients not at high risk of mortality and no factors increasing the likelihood of MRSA
b) For HAP suspected patients not at high risk of mortality but with factors increasing the likelihood of MRSA
c) For HAP suspected patients at high risk of mortality or receipt of intravenous antibiotics during the prior 90d. Ampiciilin+sulbactam and cefotaxime were added from regimen for patients with CAP.

The combination treatment was defined as the minimum 3 days of overlap use.

Limitations

Culture and susceptibility data were not available to assess the prescribing preferences.

Conclusion

1. Levofloxacin was most commonly prescribed medication as the initial choice.
2. Ceftriaxone was widely used as an initial treatment despite it had no activity against *Pseudomonas aeruginosa.*
3. Aminoglycoside or vancomycin monotherapy also needed further analysis.
4. Medications in combination regimens overlapped the coverage of non-Pseudomonal *pathogens*.

Take home points:
Based on the guidelines, consideration of coverage and selection of antibiotics susceptible to *Pseudomonas aeruginosa* should be considered when treating clinically suspected HAP.

Discussion

Results

Pathway 1

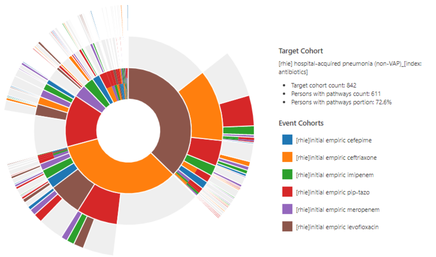

Figure 1. Treatment pathway for hospital-acquired pneumonia in pathway 1. The inner circle shows the first relevant medications that the patients were prescribed; the second circle shows the second medication, and up to the third choices of antibiotics.

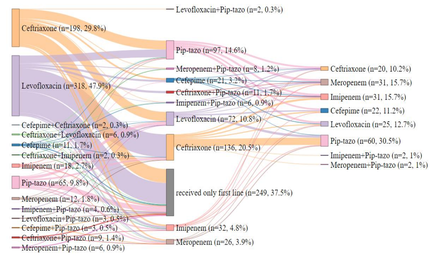

Figure 2. Sankey flow chart for proportion of antibiotics selected empirically in pathway 1.

- 611/842 (72.6%) were on antibiotic treatment and about 60% of patients on antibiotics were on medications recommended from pathway 1.
- Top 3 prescribed medications were levofloxacin (47.9%), ceftriaxone (29.8%), and piperacillin-tazobactam (9.8%) for the 1st choice.
- Among levofloxacin users, 38.6% continued it until the completion of the therapy and about 25.2% changed to other anti-pseudomonal antibiotics. The 36.2% patients changed to ceftriaxone.
- Among piperacillin-tazobactam users, about 50% continued and 42.3% changed to other anti-pseudomonal antibiotics. About 9.7% changed to ceftriaxone. (Figure 1 and 2)

Pathway 2

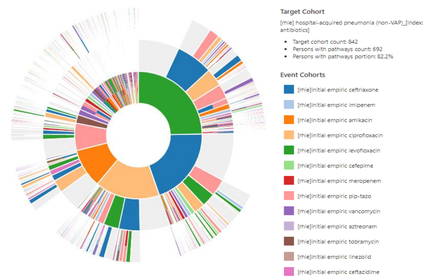

Figure 3. Treatment pathway for hospital-acquired pneumonia in pathway 2. The inner circle shows the first relevant medications that the patients were prescribed; the second circle shows the second medication, and up to the third choices of antibiotics.

- 692/842 (82.2%) were on antibiotic treatment.
- Top 3 prescribed medications were levofloxacin (24.7%), ceftriaxone (19.9%) and ciprofloxacin (16.5%) for the 1st choice.
- Among ceftriaxone users, about 59.3% were changed to anti-pseudomonal beta-lactams (21.1%), fluoroquinolones (FQ) (21.1%), carbapenems (3.0%) or vancomycin (3.0%).
- Amikacin (10%) and tobramycin (2.2%) were found to be used as a single agents.
- Combination therapy of ceftriaxone with piperacillin/tazobactam (2.2%) or with levofloxacin were observed. (Figure 3)

Pathway 3

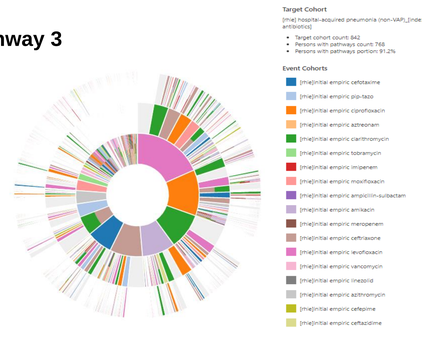

Figure 4. Treatment pathway for hospital-acquired pneumonia in pathway 3. The inner circle shows the first relevant medications that the patients were prescribed; the second circle shows the second medication, and up to the third choices of antibiotics.

- 768/842 (91.2%) were on antibiotics treatment. (Figure 4)
- Top 3 prescribed medications were levofloxacin (18.4%), ciprofloxacin (12.1%) and clarithromycin (9.5%) for the 1st choice.
- Others found as below.
  - Other anti-pseudomonal antibiotics were piperacillin-tazobactam (3.5%), cefepime (0.7%) and meropenem (0.7%).
  - Macrolides [clarithromycin (9.5%), azithromycin (3.5%)], aminoglycosides [amikacin (8.7%), tobramycin (1.8%)], and 3rd generation cephalosporins [ceftriaxone (8.6%), cefotaxime (6.8%)] were observed.
  - Moxifloxacin (2.9%) and vancomycin (0.9%) were also observed.
  - Various combination regimens were used and some were seemingly inappropriate.
    - i.g., clarithromycin+ceftriaxone (5.1%), piptazo+vanco (0.9%), tobramycin+levofloxacin (0.7%), piptazo+clarithromycin, ceftriaxone+azithromycin, cefotaxime+ciprofloxacin.

Abbreviations AUSOM: Ajou University School of Medicine, CAP: Community-acquired pneumonia, CDM: Common Data Model, HAP: hospital-acquired pneumonia, MRSA: methicillin-resistant *Staphylococcus aureus*, OMOP: Observational Medical Outcomes Partnership,

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